Introduction About Semiconductor (THEORY) :-

A semi conductor is a substance which has Resistivity (10^{-4} to 0.5 Ωm) in between conductors and insulators. E.g. Germanium, silicon, carbon etc..

→ Resistivity of a semiconductor is less than an insulator but more than a conductor.

→ Semiconductors have negative temperature coefficient of Resistance. i.e when temperature increases, Resistance of semi conductor decreases.

→ When a suitable metallic impurity (E.g. Arsenic, gallium) is added to a semi conductor, its current conducting properties change appreciably.

→ Two commonly used semi conductors are Germanium (Ge) and Silicon (Si)

→ A semi conductor in an extremely pure form is known as an intrinsic semi conductor.

→ After adding a small amount of suitable impurity to an intrinsic semicon-ductor, it will become extrinsic semi conductor.

→ The process of adding impurities to a semi conductor is known as Doping.

→ Depending upon the type of impurity added, extrinsic semi conductors are classified into two types. They are

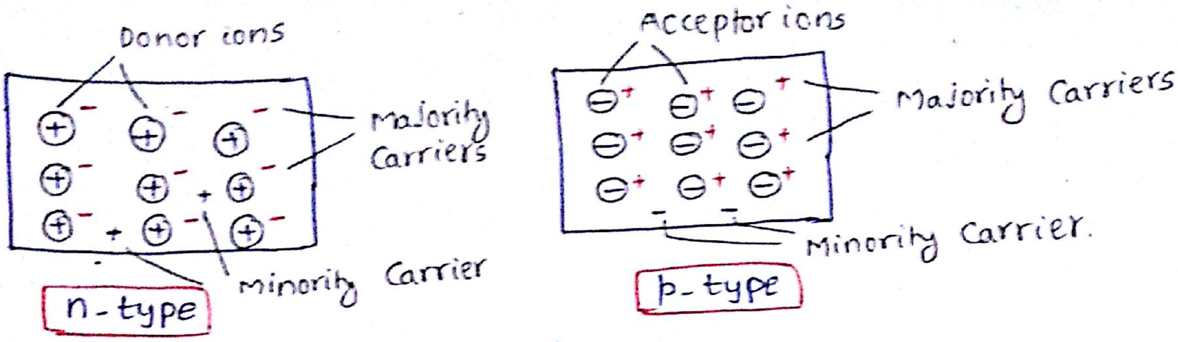
i) n-type semi conductor and (ii) p-type semiconductor.

→ n-type Semiconductor :-

When a small amount of pentavalent impurity (arsenic, antimony etc..) to a pure semiconductor, it is known as n-type semiconductor.

→ p-type Semiconductor :-

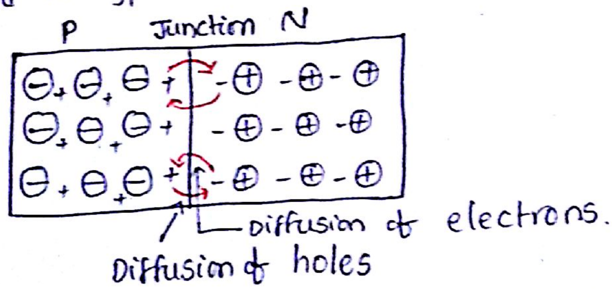
When a small amount of trivalent impurity (Gallium, Indium ..) is added to a pure semiconductor. it is known as p-type semiconductor.



PN Junction Diode :-

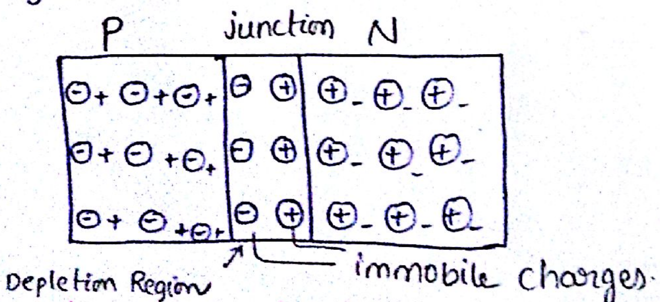
→ when p-type Semiconductor and n-type semiconductor joined (or) Sandwi-tched properly by using ion implantation, A P-N Junction Diode will be formed.

→ when ever P and n semiconductors are joined together, holes will be crossed from left side to Right side and electrons will be crossed from Right side to left side at the Junction by diffusion. i.e Diffusion of holes and Diffusion of electrons will take place when ever you joined P and n type Material.



→ when electrons travelled from ~~left to Right~~ Right to left, holes travelled from left to right, there will be Recombination of charges. Because, Holes will be Recombined with free electrons. Vice-Versa.

→ Because of this effect, A layer of +ve charges in n-side and A layer of -ve charges in p-side will be formed as immobile charges. And the formed Region is known as Depletion region.



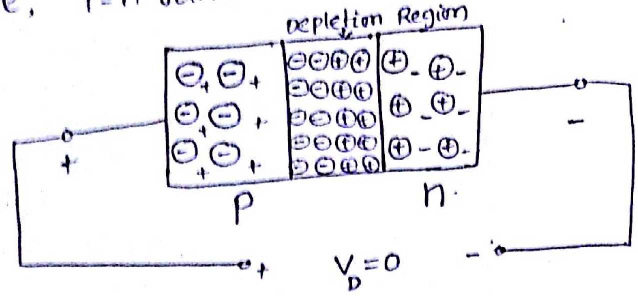
p-n junction under Open Circuit Connection.

→ After formation of Depletion Region, Holes in p-type can't move into n-side. Vice-Versa.

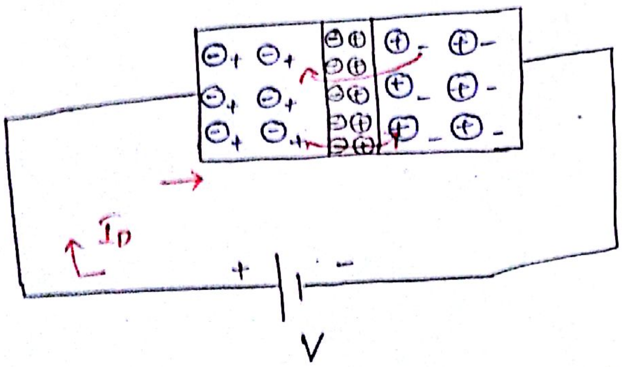
→ When minority carriers in p-type are moved into n-type. i.e Drift of Minority Carriers results in Minority current. But in open circuit condition Minority Carrier Current = Majority Carrier Current. i.e Net Current in P-n junction diode is zero.

→ **P-n junction diode in Forward Bias :-**

→ Let us assume, P-n junction diode in open circuit as follows.

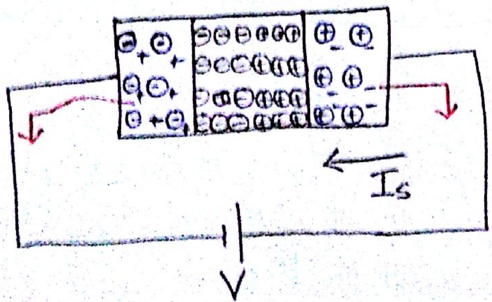


→ When $V_D > 0$, The p-n junction is in Forward bias and the width of Depletion Region will be reduced. So More and More holes will be crossing over the junction results in Forward current I_D. i.e Diffusion current is increasing



→ A Small amount of Minority Current will also be generated but it Can be neglected.

→ **P-n junction diode in Reverse Bias :-**

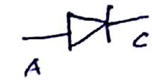


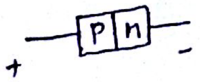
→ When negative terminal of Battery is connected to P-side and +ve terminal is connected to the n-side of P-n diode, Then That diode is in Reverse Bias.

→ At this stage, holes in p-side will be attracted towards negative terminal, and electrons in n side are attracted towards positive terminal, results in increasing the width of Depletion region. So no current will be flown from p side to n side. But still, a small amount of Minority current will be flown from n side to p side. This current is known as Reverse Saturation Current. (I_s).

→ P-n junction is the Backbone of Semiconductor Diode.

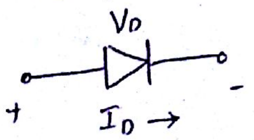
→ SEMI CONDUCTOR DIODE :-

→ symbol for Semi conductor diode using P-n junction is given by 

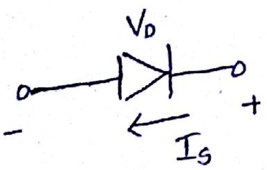


where A is Anode (+ve) and C is Cathode (-ve)

→ In Forward Bias, Diode should have Diode voltage, Diode current (I_D mA).



→ In Reverse Bias, Diode is having V_D and I_s (Reverse Saturation Current)



→ The current passing thorugh the Diode when it is in Reverse Bias is known as Reverse Saturation Current and it is in the order of μA.

→ The General VI characterstics of a semiconductor diode can be defined by following Equation for the forward and Reverse-bias regions.

i.e Diode Equation is given by

$$I_D = I_s\left(e^{KV_D/T_K} - 1\right)$$

where I_s = Reverse Saturation Current (μA)

I_D = Diode Current

V_D = Diode voltage.

$T_K = T_c + 273^\circ C$, (T_c = Temp. in centigrade, T_K = Temp in kelvin)

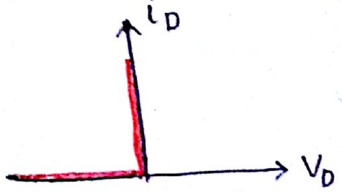
$k = \frac{11600}{\eta}$, η is the ideality factor

with $\eta = 1$ for Ge and $\eta = 2$ for Si } for lower levels of diode current

and

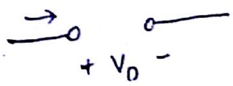
$\eta = 1$ for Ge and Si for higher levels of diode current.

→ **VI Characterstics of ideal Diode :-**



In Reverse Bias.

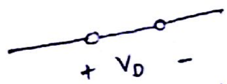
$i_D = 0$ for $V_D < 0$



(open ckt)

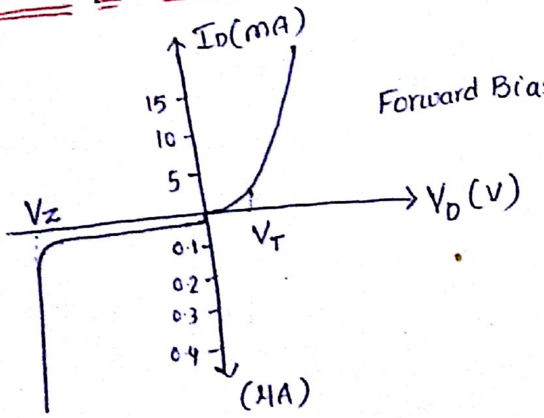
In Forward Bias,

$i_D > 0$ for $V_D = 0$.



(short circuit)

→ **VI characterstics of Diode (practical) :-**



V_T = Threshold voltage
= 0.3V (Ge)
= 0.7V (Si).

V_Z = Around (-30V) (Ge)
= Around (-40V) (Si)
= Zener Voltage.

→ The Forward potential at which sharp rise of current occurs is commonly known as offset Voltage (or) Threshold voltage (or) Firing potential. (or) knee voltage.

→ **Diode Resistance :-**

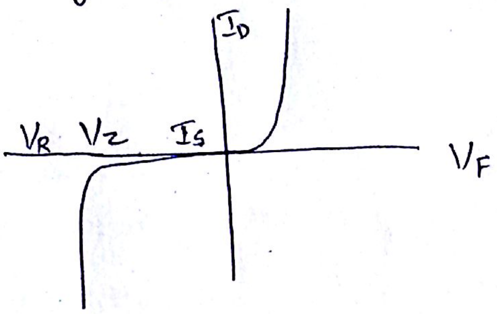
It is of two types. They are

i) Dc or Static Resistance and

ii) Ac or Dynamic Resistance.

BREAKDOWN MECHANISM IN DIODES :-

If the Reverse bias applied to a P-N junction increased, a point is reached when the Junction breaksdown and reverse current rises sharply to a value limited by the external resistance connected in series with the Junction. See following Figure. This critical value of the voltage is known as Breakdown voltage.



→ once breakdown has occured, very little further increase in voltage is required to increase the current to relatively high values. The junction itself offers almost zero resistance at this point.

→ The following two mechanism are responsible for ~~d~~ Breakdown under increasing Reverse voltage.

i) Zener Breakdown and ii) Avalanche Breakdown.

⇒ Zener Breakdown :-

→ This Breakdown occurs in junctions which, being heavily doped, have Narrow depletion layers.

→ The Breakdown voltage Sets up a very strong electric field across this narrow layer.

→ This field is strong enough to break or rupture the covalent bonds there by generating electron hole pairs. Even a small further increase in reverse voltage is Capable of producing large number of Current Carriers.

⇒ Avalanche Breakdown :-

→ This Breakdown occurs in junctions which, being Lightly doped, have wide depletion layers where electric field is not strong enough to produce zener breakdown.

→ Instead, the Minority Carriers (accelerated by this field) Collide with the semiconductor atoms in depletion region, Collide with valance electrons, covalent bonds are broken and electron hole pairs are generated.

→ These newly-generated charge Carriers are also accelerated by electric field resulting in more collisions. This leads to avalanche (or flood) of charge Carriers. This is the Main Reason for Avalanche Breakdown in Diode.

NOTE :- (ZENER BREAKDOWN)

The Breakdown potential V_z can be brought to lower levels by increasing the doping levels in p-type and n-type materials of diode. In this Case Breakdown is initiated through a direct rupture of covalent bonds due to existence of strong electric field at the junction.

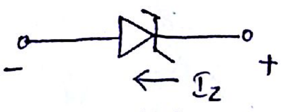
→ Zener diode :-

zener diodes are Special diodes manufactured with adequate power dissipation Capabilities to operate in the breakdown region.

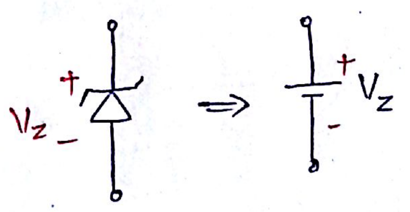
→ zener diode Can handle More power dissipation. But normal diode can't handle high power dissipation.

→ Doping Concentration is More for zener diode when compared with normal diode.

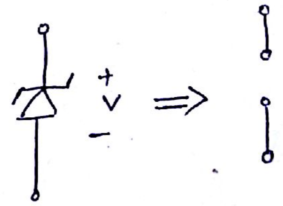
→ Circuit Symbol for Zener diode is given by.



→ zener diode Equivalent Circuits for ON and OFF States is given by



(ON)



(OFF)

Temperature Effects :-

The zener breakdown voltage of a zener diode is very sensitive to the temperature of operation. The temperature coefficient (T_c) can be used to find the change in V_z due to a change in temperature using

$$T_c = \frac{\Delta V_Z / V_Z}{T_1 - T_0} \times 100 \ \% / ^\circ C$$ where

T_1 = New temperature level

T_0 = Room temperature = $25^\circ C$

V_Z = Nominal zener potential at $25^\circ C$

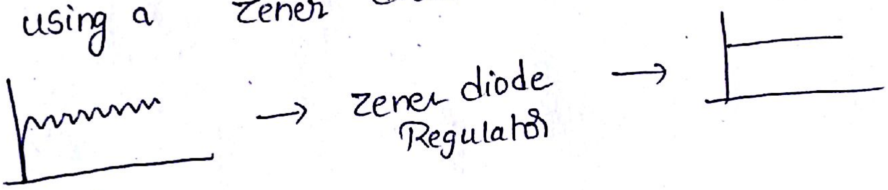
ΔV_Z = Change in V_Z.

Application of zener diode :-

→ one major application of zener diode is voltage Regulator.

A voltage Regulator is a combination of elements designed to ensure that output voltage of a supply remains fairly constant.

→ The Ripples obtained in Fullwave rectifier o/p, will be removed if you are using a zener diode in the next stage. i.e



Basic Zener Regulator Circuit :-

(a) A Simple Basic Circuit to show how Regulation of voltage occurs. It is given by the following circuit.

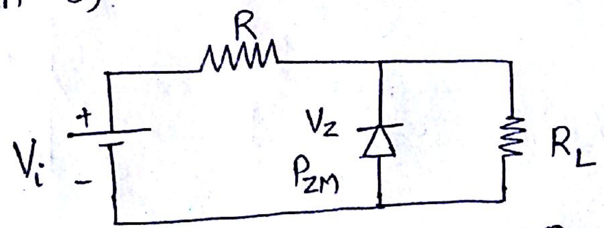


Fig ①

V_i (Supply voltage) and load Resistance (R_L) is fixed. zener diode is having V_Z voltage after Break down and Maximum power dissipation

BIPOLAR JUNCTION TRANSISTORS

→ Transistor is a three terminal device which was invented in 1948 at Bell laboratories by Jhon Bardeen and walter Brattain under direction of william Shockley.

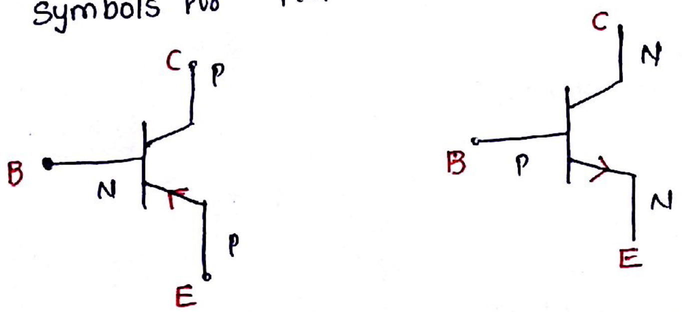
→ Physical structure of a Transistor :-

→ Transistor has 3 regions. They are emitter, base and collector regions.

→ Base region is Sandwitched between Emitter and Collector region.

→ Transistors are of two types. one is npn transistor and the other is pnp transistor.

→ Schematic symbols for PNP and NPN type BJT (Bipolar Junction transistor) are



E = Emitter
B = Base
C = collector.

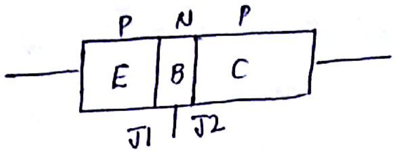
→ An arrow marked in emitter terminal that will indicate the difference between PNP and NPN and actually denotes the conventional direction of emitter current through transistor.

→ In BJT, Emitter Region Size is Moderate
Collector Region Size is largest.
Base Region Size is Thinest (Narrow)

Similarly. Emitter Region is heavily doped
Base Region is lightly doped and
Collector Region is moderately doped.

→ The Current flowing through Emitter is I_E, Current through Base is I_B, and Current through Collector is I_C.

→ Transistor has two Junctions. J1 and J2 which are shown in Following



→ J1 is Emitter Base Junction, J2 is Collector Base Junction.

→ Transistor Modes of operation :-

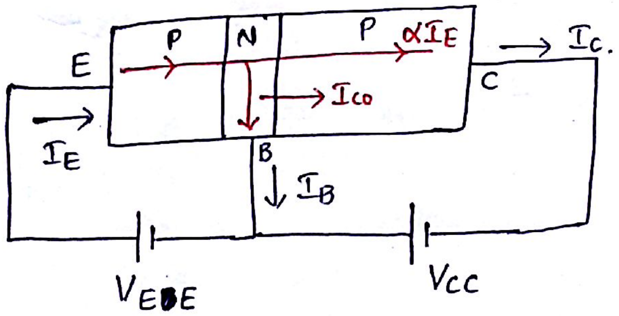
MODE	Emitter-Base Junction	Collector Base Junction
ACTIVE	FORWARD BIAS	REVERSE BIAS
SATURATION	FORWARD BIAS	FORWARD BIAS
CUTOFF	REVERSE BIAS	REVERSE BIAS

→ In Active Mode, Transistor act as an Amplifier, and in Saturation and Cutoff mode is used for Switching Applications.

→ OPERATION OF TRANSISTOR in ACTIVE MODE :-

(we may take npn also).

→ consider a pnp transistor For explination.



By KCL,

$I_E = I_B + I_c$.

→ we can represent V_{EE} as V_{EB} and V_{cc} as V_{BC} also.

→ In Active Mode, Emitter Base Junction is Forward Bias and Collector Base Junction is reverse Bias.

→ Holes are majority Charge Carriers in p-regin and electrons are majority charge Carriers in N-region.

→ whenever Emitter Base Junction is in Forward Bias, Majority Charge Carriers i.e Holes in emitter (p-type) are flow towards Base and Similarly electrons in N type will move towards emitter. So the Net Current direction is from left to Right. P→n.

→ The holes which entered in Base region, they combine with electrons, But still some portion of holes move into the Collector region.

→ Since Base region is Lightly doped and Narrow, even though after recombination, some holes will move towards I_C.

→ The portion of I_E Current which is flown towards I_C after crossing Base region is known as α. i.e $\alpha = I_C/I_E$ if Reverse Saturation current i.e Minority Charge Carrier Current neglected.

→ In case of Reverse Bias, i.e At Collector Base Junction, The Minority Current will be flown from left to Right (i.e from Base to Collector region).

(or)

→ At Collector Base Junction, The Minority charge Carriers in n-region i.e Holes will be moved into collector region and electrons (Minority charge Carriers in p-region) will be moved into Base region from Collector region. Therefore the Net Minority Charge Carrier Current will be flown from Base to Collector region. and is denoted by I_{CO} minority.

→ This Current I_{CO} is in Micro Amps. so, most of the time, this will be neglected in transistor.

$$\therefore \boxed{I_C = \alpha I_E + I_{CO}\,(\text{minority})} \quad \text{and.}$$

$$\boxed{I_E = I_C + I_B.}$$

→ I_{CO} is the I_C Current when Emitter is open and is also called as leakage current. so the two main Equations involved in Transistor are.

$$I_E = I_C + I_B \quad —— ①$$

$$I_C = \alpha I_E + I_{CO} \quad — ②.$$

By placing ① in ②.

$$\Rightarrow I_C = \alpha(I_C + I_B) + I_{CO}.$$

$$\Rightarrow I_C(1-\alpha) = \alpha I_B + I_{CO}.$$

$$\Rightarrow I_C = \left(\frac{\alpha}{1-\alpha}\right) I_B + \frac{I_{CO}}{1-\alpha} \quad — ③$$

β = Current gain between I_c and I_B.

i.e $\beta = I_c/I_B$ when leakage current is neglected.

$\Rightarrow \quad I_c = \beta I_B \quad -(4).$

In (3), if leakage current is neglected. i.e $I_{co} = 0$.

then $I_c = \left(\frac{\alpha}{1-\alpha}\right) I_B \quad -(5).$

By Comparing (4) and (5).

$$\boxed{\beta = \frac{\alpha}{1-\alpha}}$$

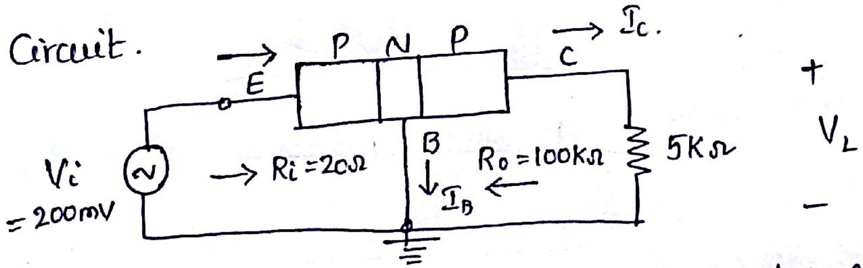
and (3) can also be written as.

$$I_c = \beta I_B + \frac{I_{co}}{1-\alpha}$$

$$\Rightarrow \boxed{I_c = \beta I_B + (\beta+1) I_{co}}$$

→ TRANSISTOR AMPLIFYING ACTION :-

→ The Basic Amplifying action of the transistor can be introduced using following circuit.



→ The input Resistance is determined by Input characterstics of CB configuration.

→ The input Resistance is determined by Input characterstics, practically it varies from 10Ω to 100Ω Eg: 20Ω.

→ By Input characterstics, practically o/p resistance varies from 50kΩ − 1MΩ.

→ output Characterstics, practically o/p resistance varies from 50kΩ − 1MΩ. Eg: 100kΩ

→ For Above Circuit, $R_i = 20\Omega$ $R_o = 100k\Omega$ (choosen)

By choosing $V_i = 200mV$, $R_i = 20\Omega$ $I_i = \frac{V_i}{R_i} = \frac{200mV}{20\Omega} = 10mA = I_E$.

→ $\alpha = 1$ (given as 1). $\therefore I_c = \alpha I_E = 10mA$.

$\therefore V_L = 5K(10mA) = 50V. \quad \Rightarrow V_o = 50V.$

Voltage Amplification = voltage gain = $\frac{V_o}{V_i} = \frac{50}{200m} = 250$

→ In this way transistor acts as an Amplifier.

→ Transistor Configurations :-

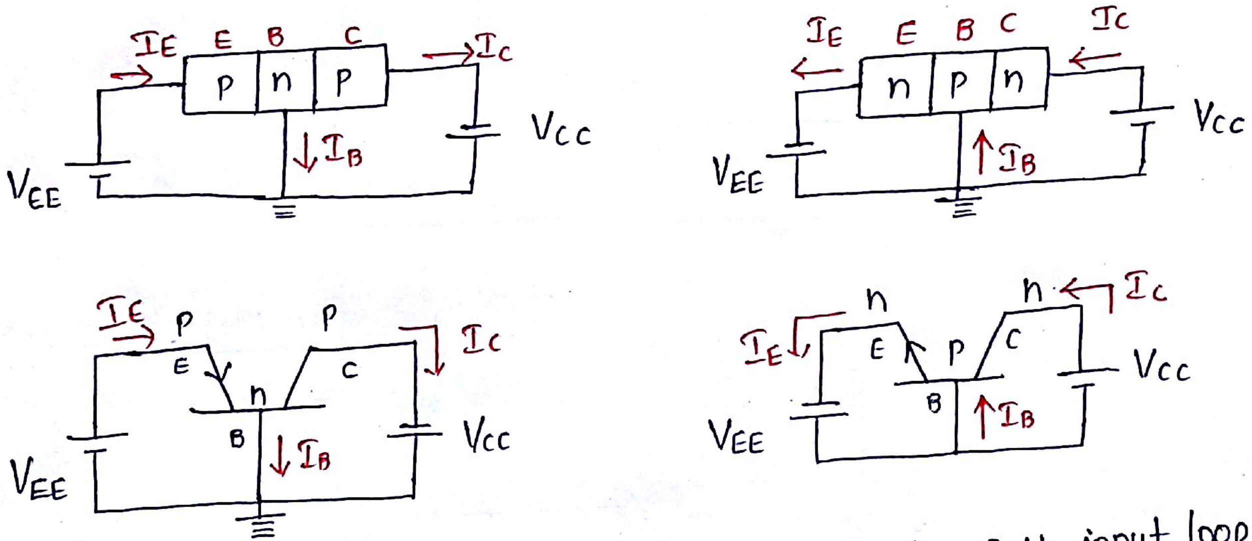
→ There are three types of configurations are possible in transistor.

i) Common Base configuration.

ii) Common Emitter Configuration

iii) Common Collector Configuration.

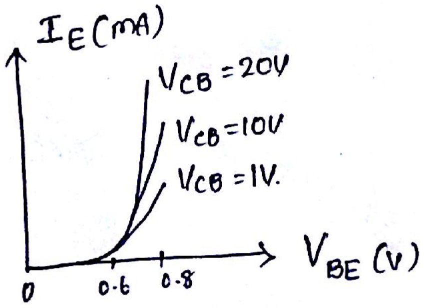
→ COMMON BASE CONFIGURATION :-



→ In Common Base configuration, Base is Common for Both input loop and output loop.

→ Input Characterstics of CB Configuration is given by following. (npn transistor)

Generalized for any config.



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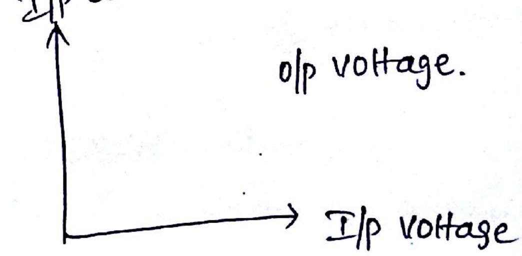
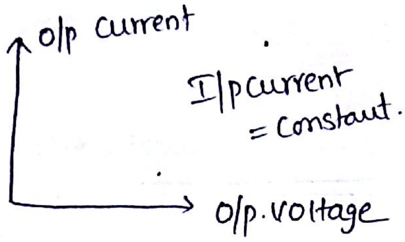
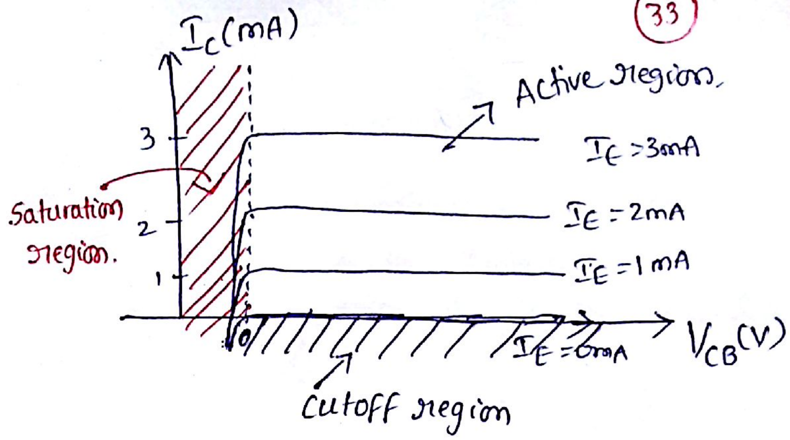


→ For Explination you have to refer the Text Book.

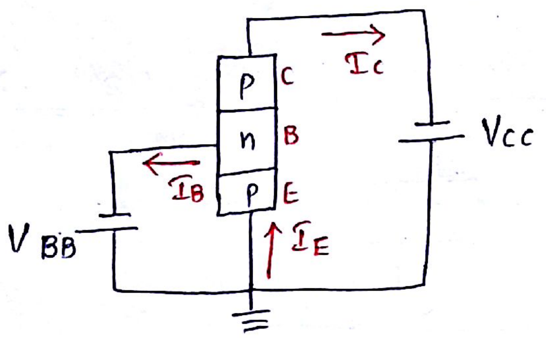
→ **output characterstics :-**

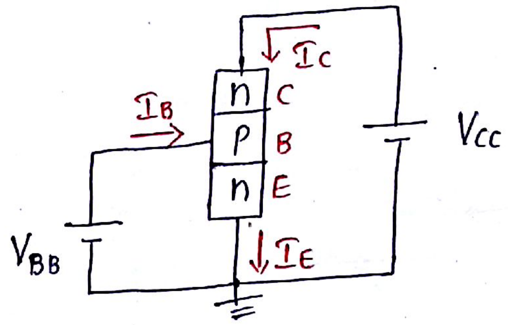


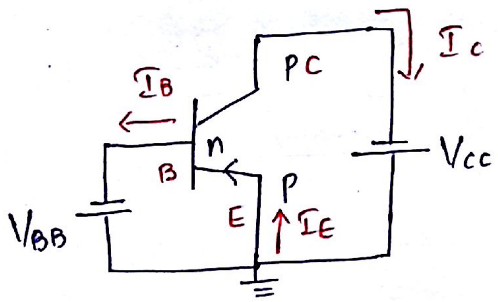
i.e

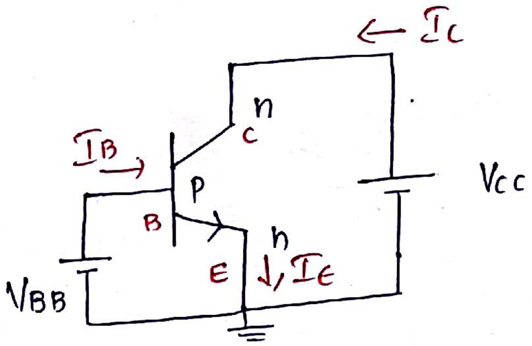


→ **COMMON EMITTER CONFIGURATION :-**

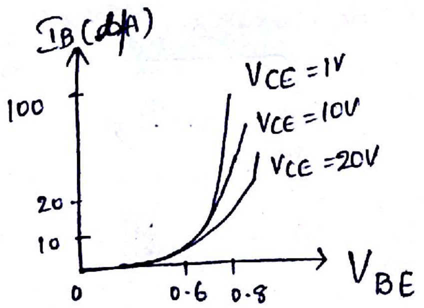




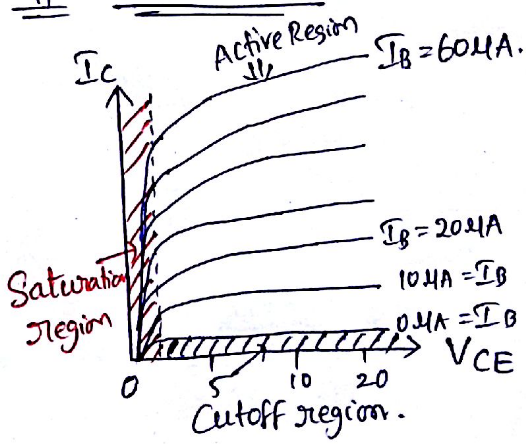




→ **I/p characterstics (npn)**



o/p characterstics (npn)



→ DIODE EQUIVALENT CIRCUITS :-

→ In order to apply Diode in a Circuit, we must get the Equivalent Circuit for the pn Junction Diode.

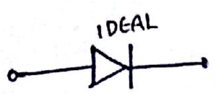
→ Diode Equivalent circuit is a combination of elements properly choosen to best represent the Characterstics of a Device in a particular operating region.

→ we will represent an Equivalent Circuit by combination of electrical elements. But these components properly choosen in order to represent characterstic which is shown by the Diode and should be in operating region.

→ we can represent idle diode and its characterstics with two types of Equivalent Circuits. They are

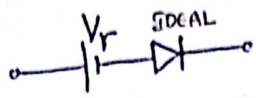
i) piece wise Linear Model

ii) Constant Voltage Drop Model.



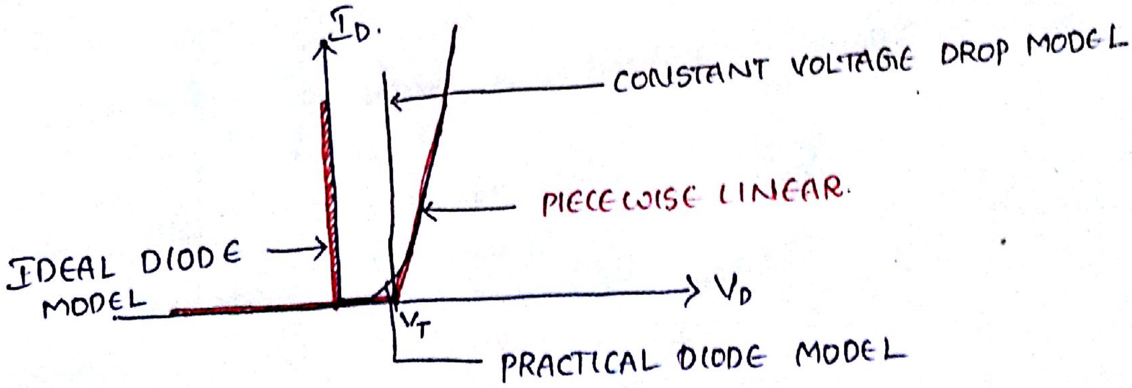
IDEAL DIODE

PIECE WISE LINER DIODE



CONSTANT VOLTAGE DROP MODEL DIODE

→ V-I Characterstics of above three Models with practical Diode is given as follows :



V_T = Threshold voltage = 0.7V (Si) (or) offset voltage

= 0.3V (Ge)

= potential at which sharp rise of current occurs.

RECTIFIER :-

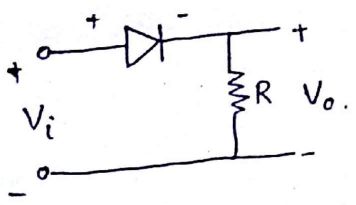
Rectifier is a circuit which converts AC ~~into~~ voltage into pulsating DC voltage. It is of two types.

i) Half wave Rectifier. (with and without Filter)

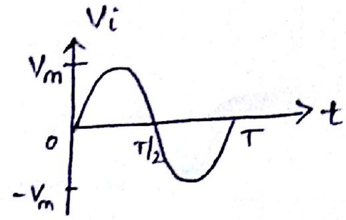
ii) Full wave Rectifier (with and without Filter)

HALFWAVE RECTIFIER (WITHOUT FILTER) :-

→ Halfwave Rectifier Circuit is given as follows.



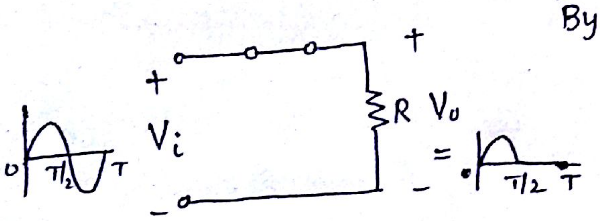
$V_i = V_m \sin\omega t$ i.e



→ If I assume ideal diode, when V_i is applied to above circuit as input, then In the +Ve half cycle Diode will be in Forward bias and we will get $V_o = V_i$.

→ But in −Ve half cycle, Diode will be in Reverse bias and we will get $V_o = 0V$.

i.e In FB, (+Ve half cycle)



By KVL,

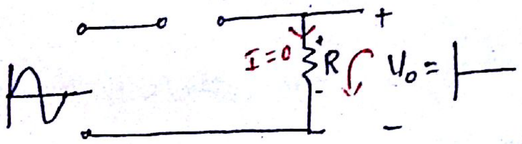
$-V_i + V_o = 0$

$\Rightarrow V_i = V_o$. $\Rightarrow V_o = V_i$

If it is practical diode,

$V_o = V_i - V_T$

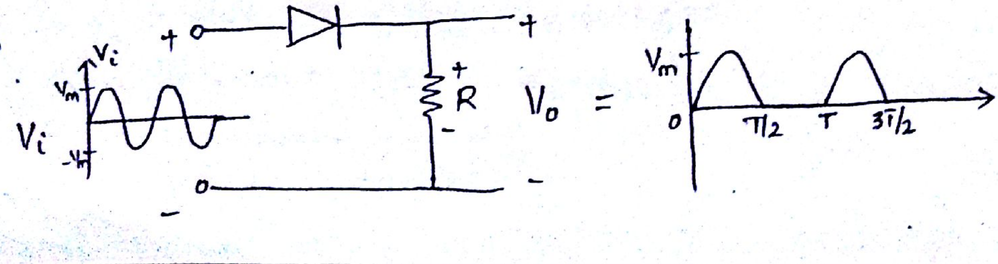
In RB, (−Ve half cycle)



By KVL

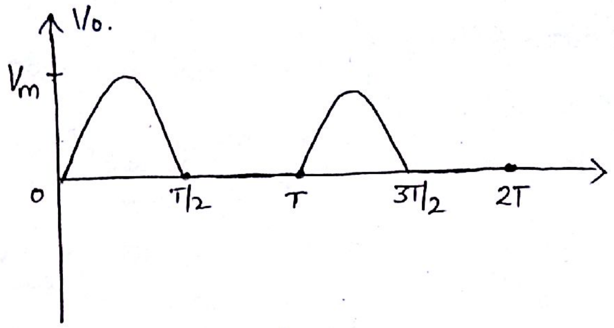
$-V_o + 0\,(R) = 0$

$\Rightarrow V_o = 0V$



→ Average Value Calculation for Half wave Rectifier output :-

→ The halfwave Rectifier output is as Follows.



Fig(1)

→ i.e $V_o = V_m \sin\omega t \qquad 0 < t < T/2$

$= 0 \qquad \frac{T}{2} < t < T.$

$$V_{avg} = V_{DC} = \frac{1}{T}\int_0^T V_o . dt.$$

$$= \frac{1}{T}\left[\int_0^{T/2} V_o . dt + \int_{T/2}^{T} V_o . dt\right]$$

$$= \frac{1}{T}\left[\int_0^{T/2} V_m \sin\omega t\, dt + \int_{T/2}^{T} \cancel{V_m \sin\omega t}\; 0 \; dt\right]$$

$$= \frac{1}{T}\left[\int_0^{T/2} V_m \sin\omega t . dt\right] = \frac{-V_m}{T}\left[\frac{\cos\omega t}{\omega}\right]_0^{T/2}$$

$$= \frac{-V_m}{T}\left[\frac{\cos\omega\frac{T}{2}}{\omega} - 1\right] = \frac{-V_m}{\cancel{T}}\left[\frac{\cos\frac{2\pi}{\cancel{T}}.\frac{\cancel{T}}{\cancel{2}} - 1}{2\pi/\cancel{T}}\right]$$

$$= \frac{-V_m}{\pi}\left[\frac{-\cancel{2}}{\cancel{2}}1\right] \Rightarrow \frac{V_m}{\pi} = 0.318\, V_m.$$

i.e $\boxed{V_{avg} = V_{DC} = 0.318\, V_m}$

→ RMS Value Calculation for Halfwave rectifier output Waveform :-

→ Fig(1) is the o/p wave form of Halfwave rectifier.

i.e $V_o = V_m \sin\omega t \qquad 0 < t < T/2$

$= 0. \qquad T/2 < t < T.$

$$V_{rms} = \left[\frac{1}{\text{Time period}} \int_{\text{Time period}} (V_o)^2 . dt \right]^{1/2}$$

$$= \left[\frac{1}{T} \int_0^T V_o^2 . dt \right]^{1/2} = \left[\frac{1}{T} \int_0^{T/2} V_o^2 dt + \frac{1}{T} \int_{T/2}^{T} V_o^2 dt \right]^{1/2}$$

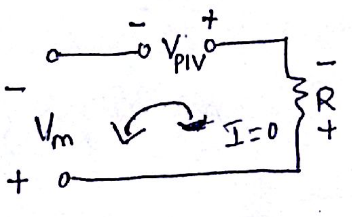
$$= \left[\frac{1}{T} \int_0^{T/2} V_m^2 \sin^2 \omega t . dt + \frac{1}{T} \underbrace{\int_{T/2}^{T} 0 \, dt}_{=0} \right]^{1/2}$$

$$= \left[\frac{1}{T} \int_0^{T/2} \frac{V_m^2}{2} [1 - \cos 2\omega t] . dt \right]^{1/2} = \left[\frac{1}{T} \int_0^{T/2} \frac{V_m^2}{2} - \frac{1}{T} \int_0^{T/2} \cos 2\omega t . dt \right]^{1/2}$$

$$= \left(\frac{1}{T} \left[\frac{V_m^2}{2} (t)_0^{T/2} \right] \right)^{1/2} = \left(\frac{1}{\cancel{T}} . \frac{V_m^2}{2} . \frac{\cancel{T}}{2} \right)^{1/2} = \frac{V_m}{2}$$

→ **PIV Calculation for Half wave Rectifier :-**

→ Take the Diode Reverse bias condition in Halfwave rectifier Circuit then find the Voltage across the Diode, then that Voltage is known as Peak Inverse Voltage.



Negative half cycle.

By KVL.

$0(R) + V_{PIV} - V_m = 0$

$\Rightarrow \boxed{V_{PIV} = V_m}$ $\therefore \boxed{V_{PIV} \geq V_m}$

→ In the case of practical Diode,

$V_D = (V_m - V_T) \sin \omega t \quad 0 < t < T/2$

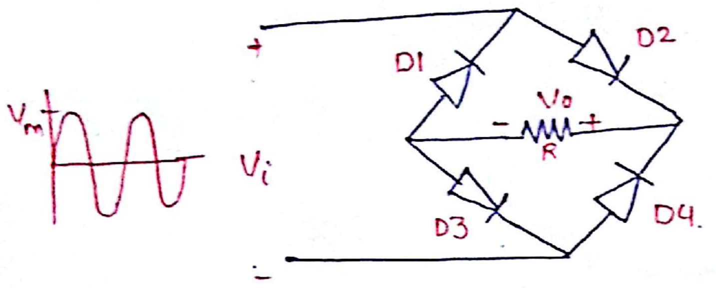
$= 0 \quad T/2 < t < T$

→ $V_{avg} = \frac{V_m - V_T}{2}$

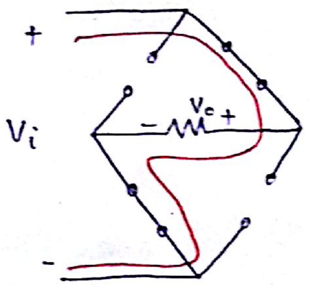
→ $V_{rms} = 0.318 (V_m - V_T)$

FULL WAVE RECTIFIER (BRIDGE NETWORK) :-

→ Full wave Bridge Rectifier circuit is given as follows.



→ In +ve half cycle,

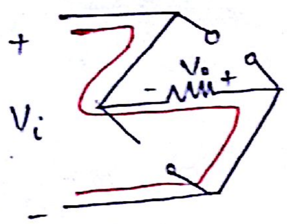


$V_o = V_i$ (By KVL)

D1, D4 = open circuit = OFF

D2, D3 = short circuit = ON.

→ In −ve half cycle,

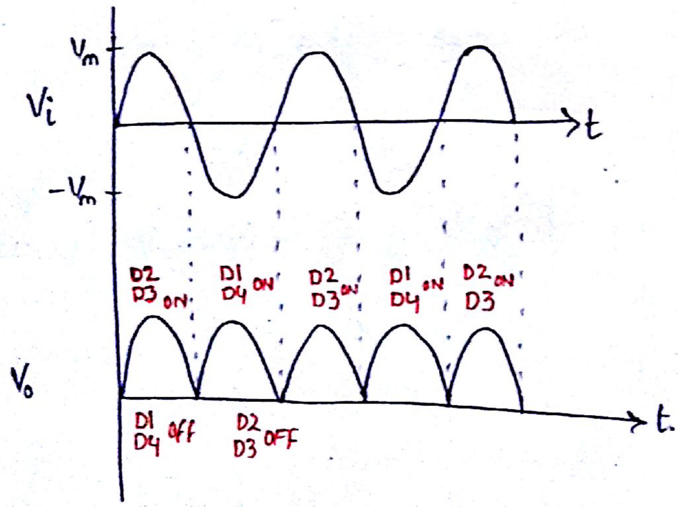


By KVL,

$V_o = -V_i$

D1, D4 = ON

D2, D3 = OFF.



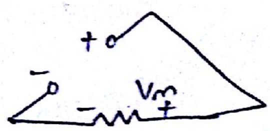
In practical Diode,

$V_o = V_i - V_T$ (+ve half)

$V_o = -V_i - V_T$ (−ve half)

→ PIV :-

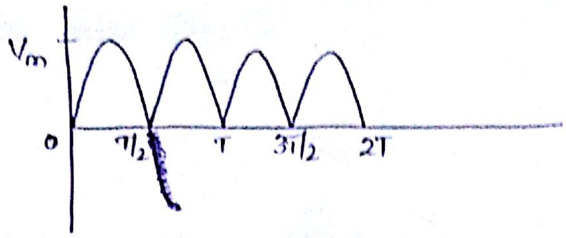
$PIV \geq V_m$.



$PIV \geq V_m$.

→ Second type popular fullwave rectifier is Centertapped transformer full wave rectifier.

Average value and rms value calculation for full wave Rectifier o/p:-



$\rightarrow \quad V_{avg} = V_{dc} = \dfrac{1}{\text{Time period}} \displaystyle\int_{\text{Time period}} V_o \cdot dt$ Time period = $T/2$.

$$= \frac{2}{T}\int_0^{T/2} V_m \sin\omega t \cdot dt$$

$$= \frac{2V_m}{T}\left[-\frac{\cos\omega t}{\omega}\right]_0^{T/2} = \frac{2V_m}{\pi} = 0.636\, V_m.$$

$$\boxed{V_{avg} = V_{dc} = 0.636\, V_m}$$

$\rightarrow \quad V_{rms} = \left[\dfrac{1}{\text{Time period}} \displaystyle\int_{\text{Time period}} V_o^2 \cdot dt\right]^{1/2}$

$$= \left[\frac{2}{T}\int_0^{T/2} V_m^2 \sin^2\omega t \cdot dt\right]^{1/2}$$

$$= \left[\frac{2}{T}\int_0^{T/2} \frac{V_m^2}{2} - \frac{2}{T}\int_0^{T/2} \frac{\cos 2\omega t}{2} \cdot dt\right]^{1/2}.$$

$$= \left[\frac{\cancel{2}}{\cancel{T}} \cdot \frac{V_m^2}{2}\left[\frac{\cancel{T}}{\cancel{2}}\right] - 0\right]^{1/2}$$

↖ In Exam prove above integral value to zero.

$$= \frac{V_m}{\sqrt{2}}$$

$$\boxed{V_{rms} = \frac{V_m}{\sqrt{2}}}$$

In practical Fullwave rectifier, $V_{dc} = 0.636(V_m - 2V_T)$

FULL WAVE RECTIFIER WITH CENTER-TAPPED TRANSFORMER :-

→ The circuit is given by the following figure.

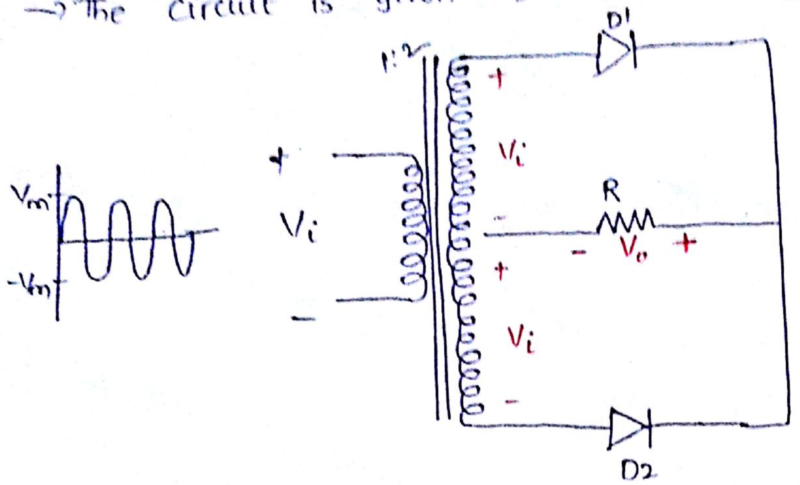
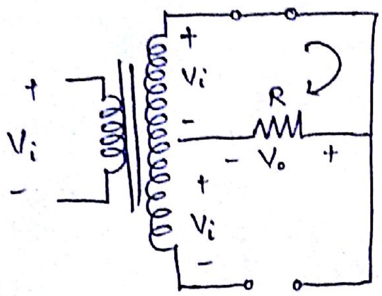


Fig: Centertapped transformer full-wave rectifier.

→ In +Ve half cycle, D1 is ON, D2 OFF. and the circuit becomes as follows.

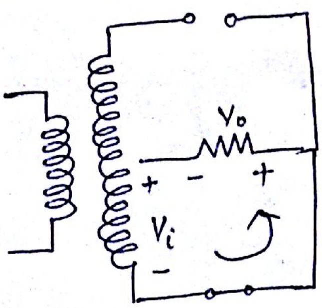


By KVL, $-V_i + V_o = 0$.

$\Rightarrow V_o = V_i$

i.e for +Ve input o/p will be positive.

→ In −Ve half cycle, D1 is OFF, D2 ON. and the circuit becomes as follows.

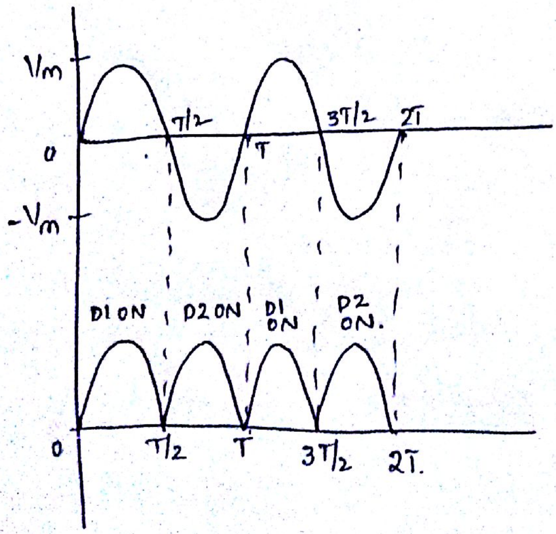


$+V_i + V_o = 0$.

$\Rightarrow V_o = -V_i$

i.e In −Ve half cycle, we will get +Ve halfcycle as o/p. i.e $V_o = -V_i$ but V_i is −Ve.

$\therefore$ V_o is again +Ve.



|||ly $V_{rms} = V_m/\sqrt{2}$

and $V_{avg} = 2V_m/\pi$.