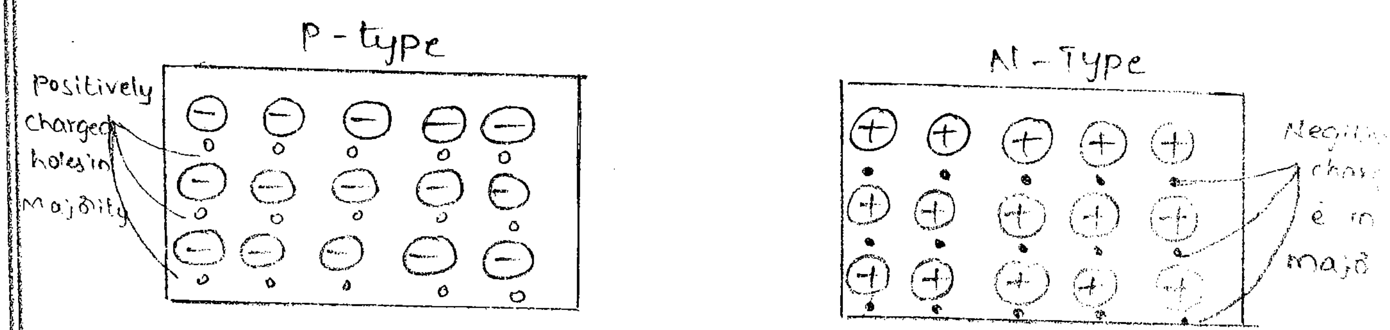
5- Rectifiers & Linear IC's 2-1 civil

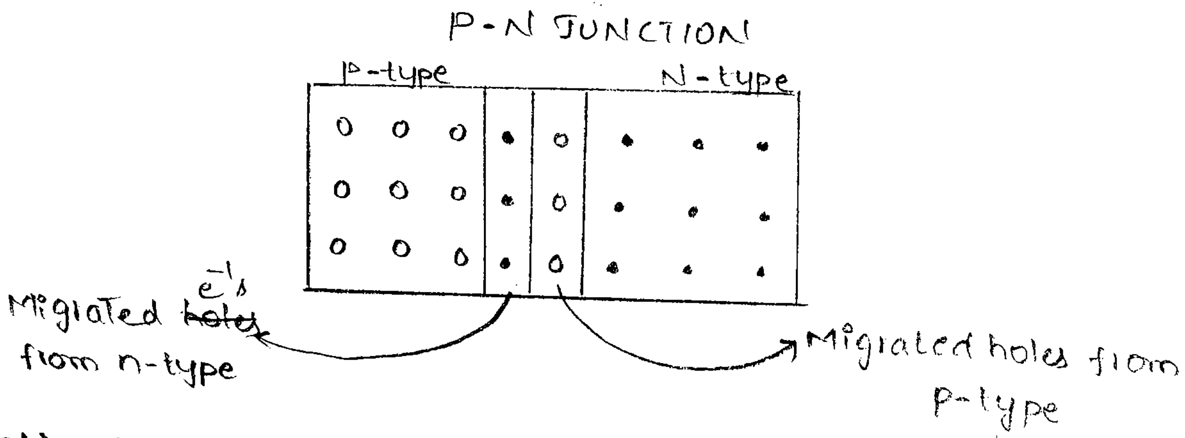
BEEE UNIT=5

1 P-n Junction Diode :—

When a p type material is intimately Joined to n type then a p-n Junction is formed. The below diagram shows the p type & n type semi conductor before they are Joined. In p type semi conductor has negative acceptor ions & positively charged free holes which about moves on p-side.

Similarlly n-type semi conductor has positively donor ions and negitively charged free electrons which move about n side

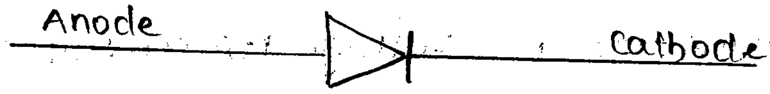




Function :

In p-type material has high concentration of holes and n-type material has high concentration of free electrons and hence there is a tendency of holes to diffuse over to n-side & è To p-side. This process is known as Diffusion.

Diode Symbol :—



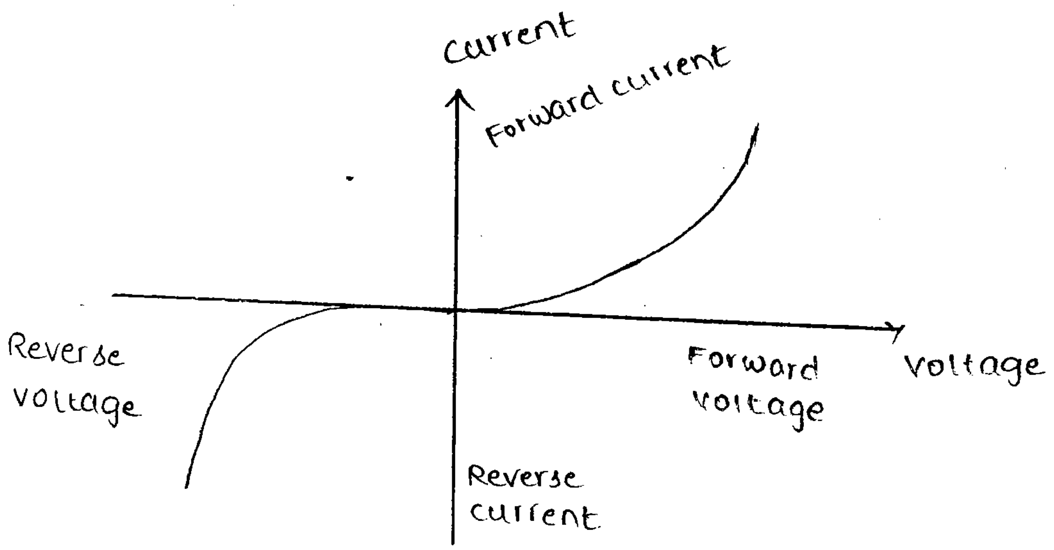
Forward Biased Diode :—

When an external voltage is applied to p-n junction in such a following way the positive terminal of the battery is connected to p-type while the negitive terminal is connected to n-type then it is called Forward Biased Diode.

Reverse Biased Diode :—

When an external voltage is applied to p-n junction in such a following way the positive terminal of the battery is connected to n-type while the negitive terminal of the battery is connected to p-type then it is called Reverse Biased Diode

V-I characterstics of P-n Junction diode :—

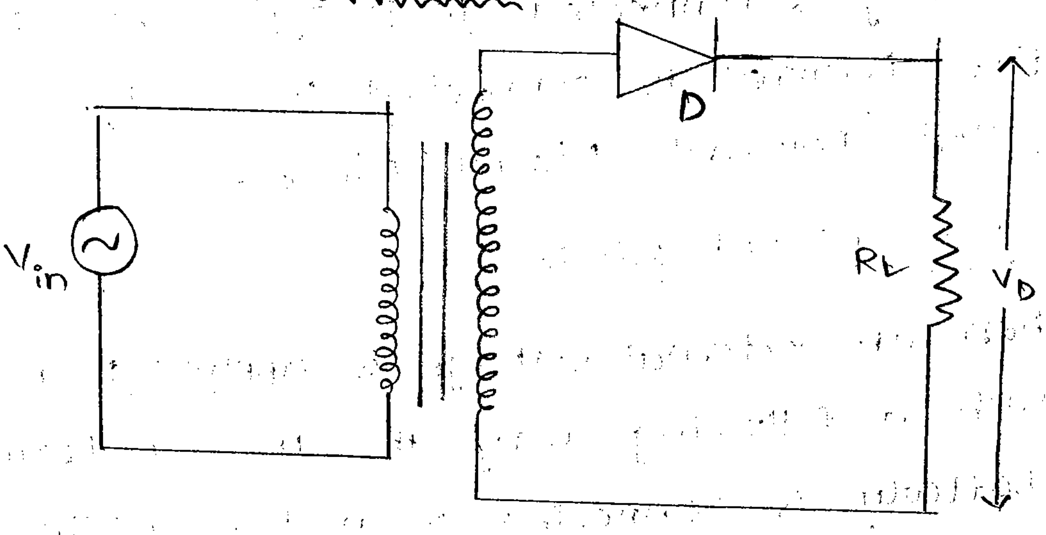


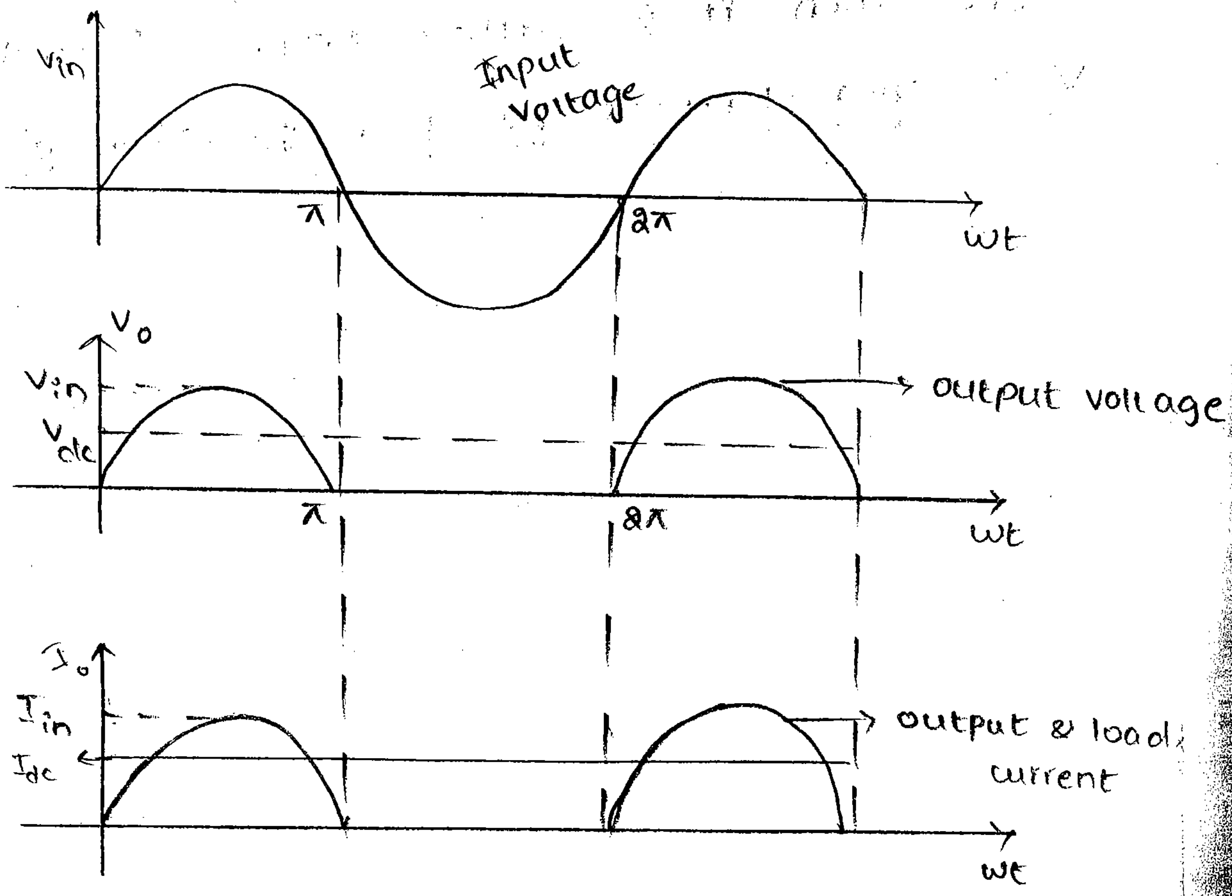
Rectifier :-

A Rectifier is defined as an electronic device used for converting AC voltage (or) current into uni-directional (D.C) voltage (or) current

For this purpose a uni directional conduction device such as p-n Junction Diode is used.

Half wave Rectifier :-





In this half wave rectifier AC voltage to be rectified is applied to a single Diode connected in series with a load resistance (R_L) as shown in above dig

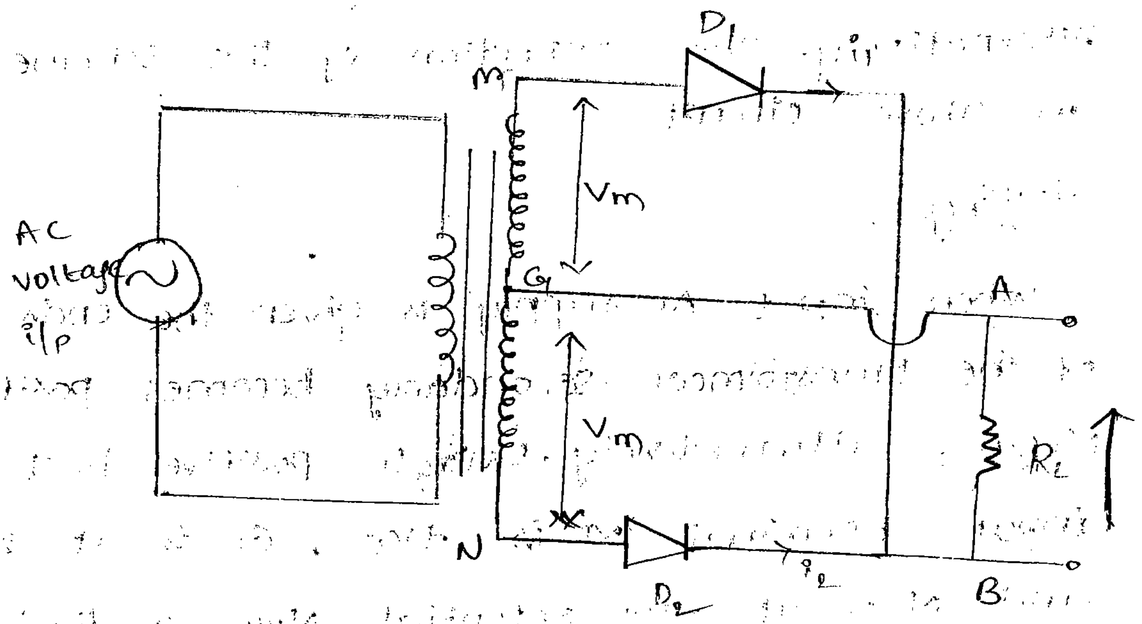
Working of Half wave Rectifier :—

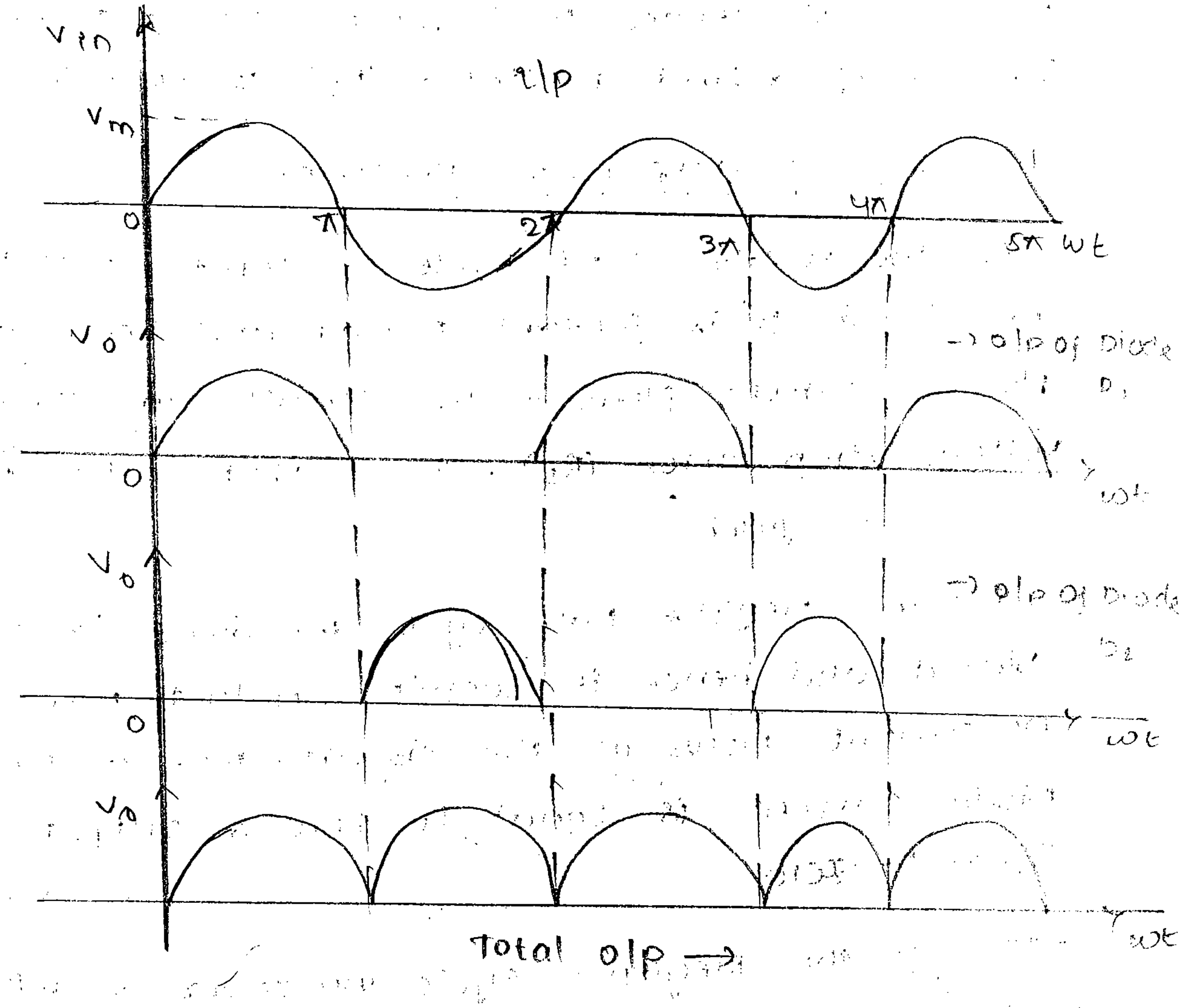
For the positive half cycle of Input AC voltage the diode 'D' is forward Biased and hence it conducts Now a current flows in the circuit and there is a voltage drop across (R_L). this output voltage & current as shown in above graph.

For the Negitive half cycle the diode 'D' is reverse Biased and hence it doesn't conduct. Now there is no current flows in the circuit i.e load current (or) Diode current is Equal to zero & output voltage is Equal to zero.

- thus for the Negitive cycle no power is delivered to the load

Full Wave Rectifier :—





In Full wave Rectifier both Half cycle of the input are utilized with the help of two diodes working Alternatively. The connection of this scheme as shown in above circuit

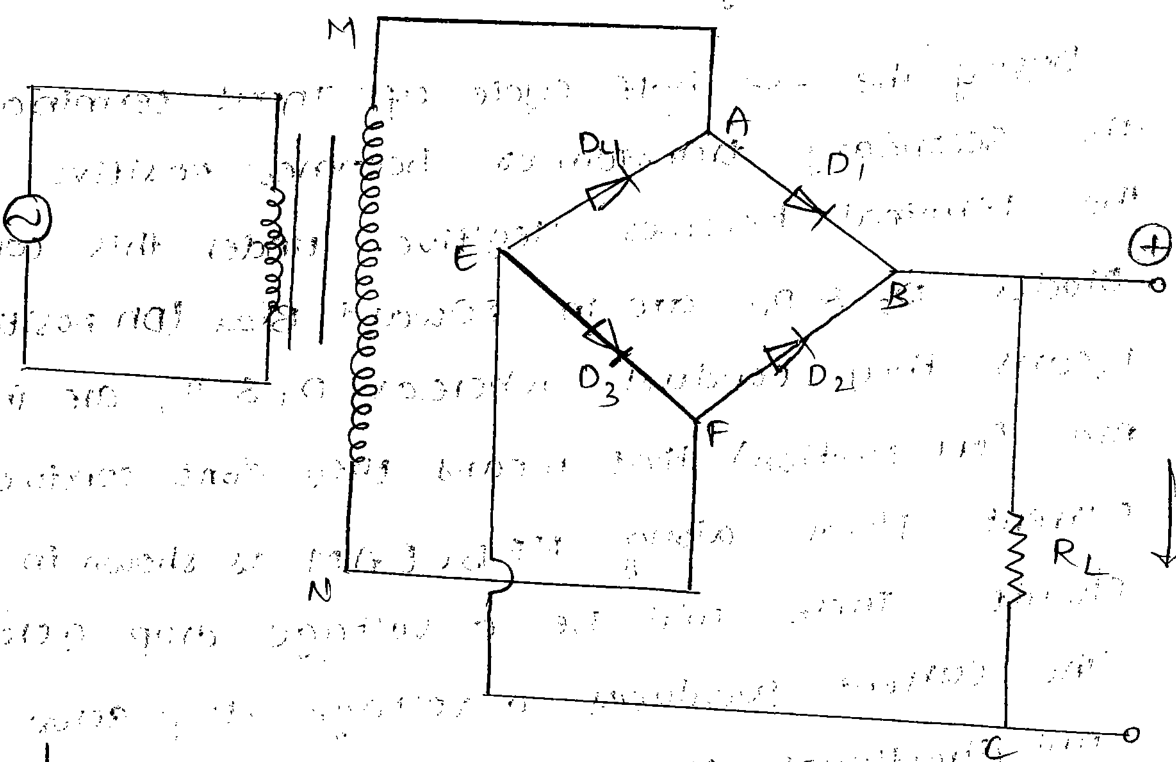
Working :—

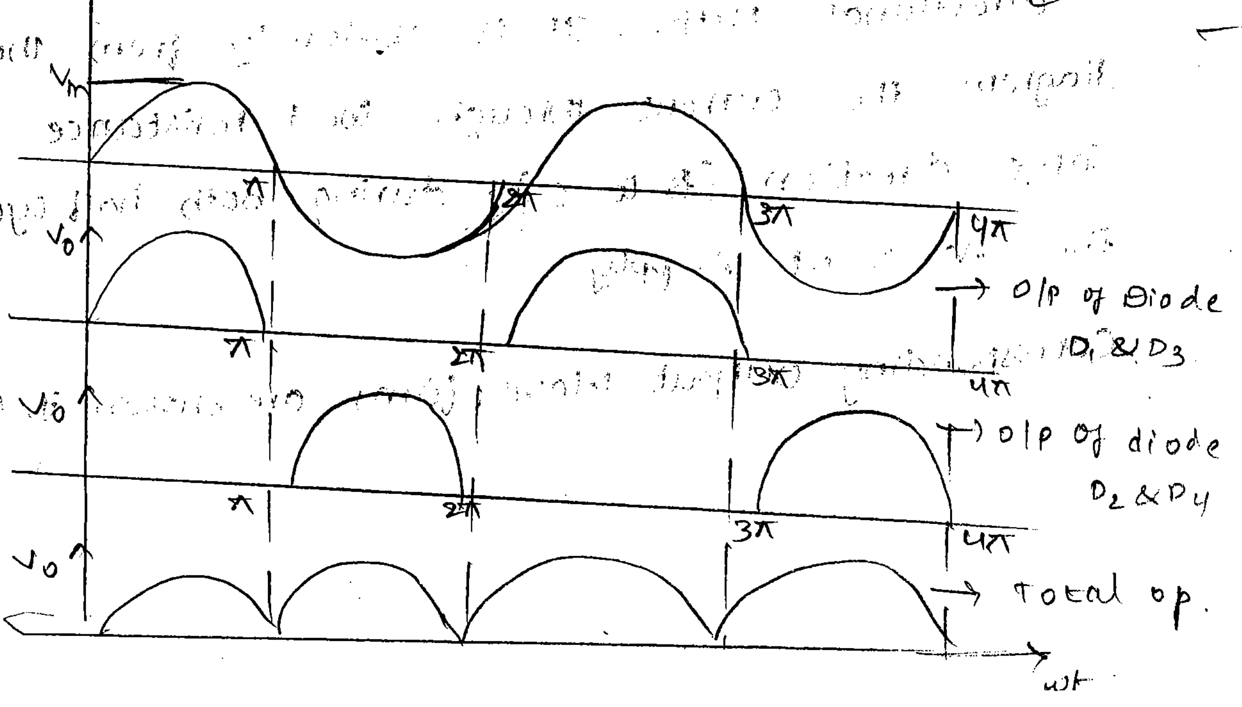
When input Ac supply is given the ends M & N of the transformer secondary becomes positive & Negitive alternatively. During to positive half of ac input terminal M is +ve, G is at zero potential and N is at –ve potential. Now, a diode D_1 is Forward Biased that means it conducts and causes a current(i_1) in load Resistance (R_L)

Diode D_2 remains non conducting being reverse Biased.

During the negitive half cycle terminal N becomes +ve, G is at zero potential & M is at -ve potential Now, a Diode D_2 ~~(is in Reverse Bias)~~ conducts and current i_2 flows through the Load Resistance R_L. Diode D_1 is non conducting thus the current flows through R_L in the same direction (from A to B) in both cycles of AC input

Bridge Rectifier :-





The above diagram shows the full wave bridge rectifier and corresponding output wave forms.

During the +ve half cycle of input, terminal M attains positive of secondary of Transformer. while the terminal N is negitive. In this situation Diode D_1 & D_3 are in Foward Bias (On position) that means they conduct whereas diodes D_2 & D_4 are in Reverse Bias (off position) that means they dont conduct. So the current flows along MABCEFN as shown in above circuit. There will be a voltage drop across RL

During the -ve half cycle of Input terminal N of the Secondary transformer becomes positive while the terminal becomes Negitive. under this condition Diodes D_2 & D_4 are in Foward Bias (On position) that means they conduct whereas D_1 & D_3 are in reverse Bias (off position) that means they dont conduct. So the current flows along NFBCEAM as shown in above circuit. There will be a voltage drop across RL.

The current produces a voltage drop across R_L in uni directional Path. It is obviously from the above diagram the current through load resistance is in Same direction (B to C) during both half cycles of the Ac input supply

Corresponding output wave forms are shown in above

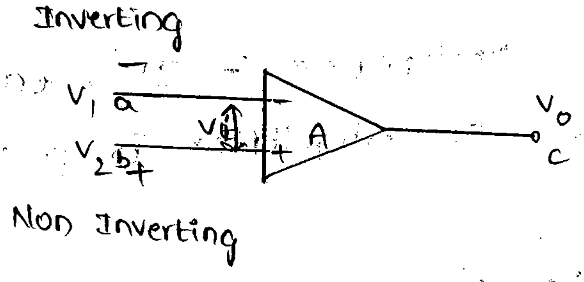
Advantages :

* No centre Tap is required on Transformer
* It is suitable for high voltage Application

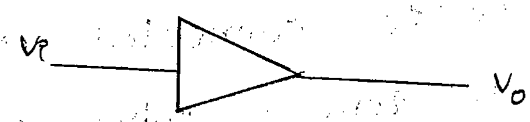
Operational Amplifiers :— (op Amp)

An op Amp with high gain and high input Impedance used especially in circuits for performing mathematical operations on an input voltage.

Circuit symbol for op Amp :—



(b)



(a)

Standard Regctangular symbol is generally used for an op Amp. The early operational Amplifiers had only one input and one output terminal as shown in (a) The output was always inverted w.r.t input.

The op Amp's now available are usually of differential type with 2 input terminals and a single output terminal as shown in (b)

The Negative sign Indicates that the signal applied at the terminal 'A' will appear amplified but phase inverted (opposite polarity) at terminal 'C'. Similarly the terminal 'B' is called Non inverting input terminal here the positive sign indicates that a signal applied at the terminal 'B' will appear amplified but inphase (same polarity) at terminal 'c'.

The output voltage is directly propotional to the input voltage which is difference of V_1 & V_2 that means

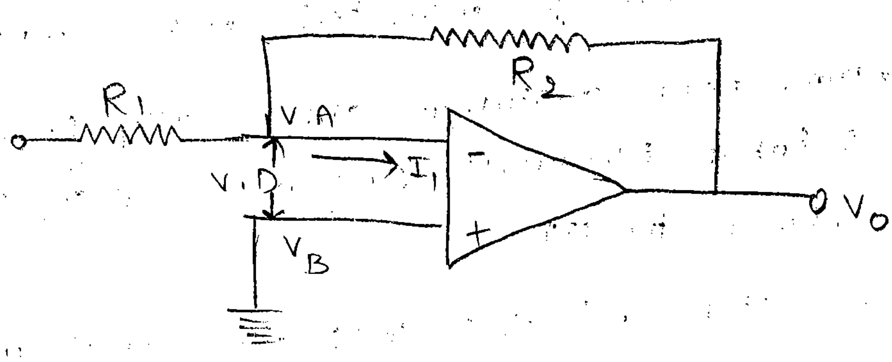
$$V_{in} = V_2 - V_1$$

$$V_o \propto V_{in}$$

Characterstics of (Op-Amp) :—

* It has an Infinite voltage gain
* It has an Infinite Band width
* Infinite Input Resistance - It means the input current is zero. ∴ Amplifier is a voltage control Input Device
* zero output Resistance - It means V_o is Independent of the load Resistor connected across o/p.
* The output is zero - when equal voltages are applied at the two input terminals $V_2 = V_1$

Virtual ground concept of an op-Amp :—



Inverting Amplifier

This is an impotant concept of an op Amp. It Plays a virtual role while deriving the expression for o/p voltage

V_B is a potential defined at Non inverting I/p

V_A is a potential defined at Feed back point of Inverting I/p

V_D is the diff b/w V_B & V_A i.e $V_D = V_B - V_A$

According to Ideal characteristics of Op-Amp

Input Resistance R_i is Infinite. ∴ The current entering into the op Amp (I_1) will be zero That means differential voltage V_D will be zero

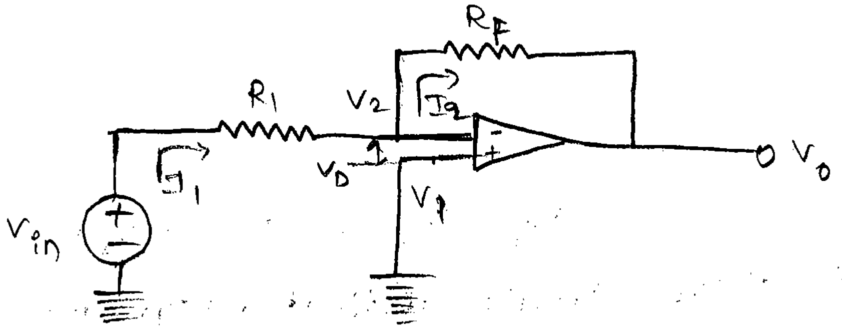
$$\therefore V_D = V_B - V_A = 0 \Rightarrow V_B = V_A$$

Note:

The Node voltage V_b at positive terminal is same as the Negitive Feed back Node point V_A

Applications of an Op Amp :—

1. Inverting Amplifier :—



The above diagram shows the Inverting Amplifier Its Non-inverting I/p terminal is grounded where has the external input signal V_{in} is applied to the Inverting I/p through Resistance R_1. A Feed back Resistance R_f connected from O/p to Inverting i/p terminal Of the op Amp.

According to virtual ground concept $V_1 = V_2$

Apply KCL at Node V_2,

$$I_{in} = i_1 + i_f$$

$$I_{in} = i_f \quad (\because i_1 = 0)$$

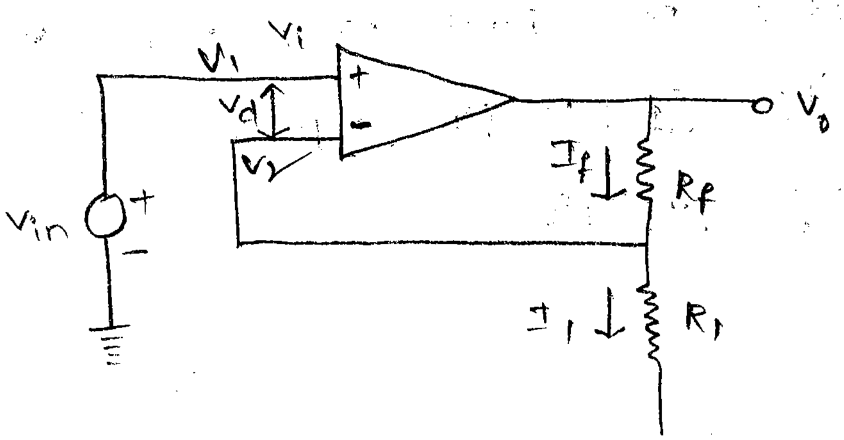
$$\frac{V_{in} - V_2}{R_1} = \frac{V_2 - V_0}{R_F}$$

As $V_1 = 0 \Rightarrow V_2 = 0$

$$\frac{V_0}{V_{in}} = -\frac{R_f}{R_1}$$ → gain Equation

Here the Negitive sign Indicates that the Input & Output voltages are out of phase by 180°

Non Inverting Amplifier :-



$$V_{in} = V_2 \quad (\because V_1 = V_2)$$

In the above circuit indicates non inverting Amplifier with feed Back (or) closed loop Non inverting Amplifier In this case inverting terminal of Amplifier is grounded through Resistance R_1 & o/p is applied to the Inverting I/p terminal through Feed Back circuit composed of a Resistors R_f & R_1 according to virtual Ground concept

$$V_{in} = V_2 \quad (\because V_1 = V_2)$$

$$I_f = I_1$$

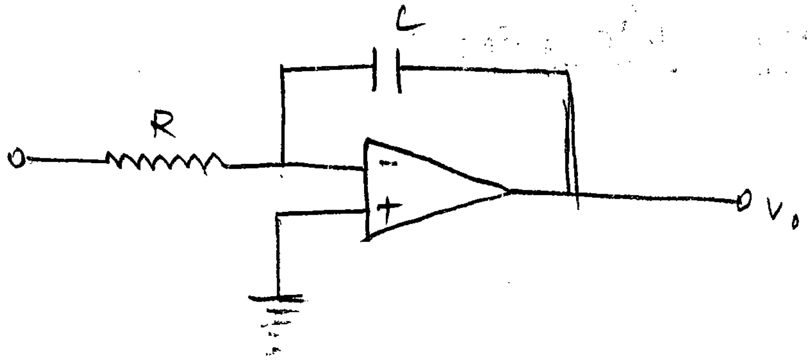
$$\frac{V_0 - V_{in}}{R_f} = \frac{V_{in}}{R_1}$$

$$\frac{V_o}{R_f} = \frac{V_{in}}{R_1} + \frac{V_{in}}{R_f}$$

$$\frac{V_o}{V_{in}} = 1 + \frac{R_f}{R_1}$$ → gain eq

In the above expression R_f & R_1 are +ve & gain eq also Positive also there is no phase Inversion.

Op Amp Integrator :—



An Integrator is a circuit that performs a mathematical Operation called Integration. Integration is a process of continuous addition. The most popular application of an Integrator is to produce a ramp of o/p voltage which is a linearly increasing (or) Decreasing voltage. The Feed back is through capacitor 'c' instead of Resistor R_f. From the above dig

According to virtual ground concept

$$0 - V_o = V_C$$

$$V_o = -V_C$$

$$V_o = -\frac{1}{C}\int i\,dt = -\frac{1}{C}\int \frac{V_{in}}{R}\,dt$$

$$V_o = -\frac{1}{T}\int V_{in}\,dt$$

where, $T = RC$ (Time constant)

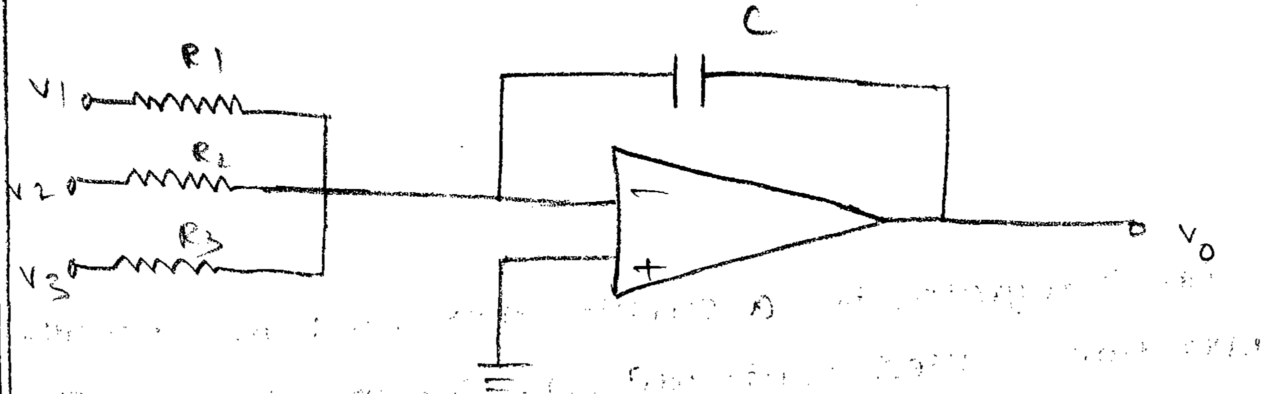
Note :

1. If the I/p voltage is step voltage the o/p voltage will be a ramp (or) linearlly change in voltage

2. If the I/p voltage is square wave the o/p voltage is Triangular wave

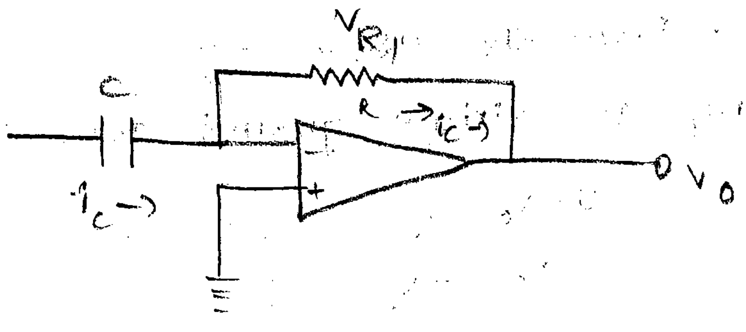
3. If the I/p voltage is sinasoidal wave the o/p voltage will be cosine wave

Summing Integrator :—



$$V_o = -\left[\frac{1}{R_1C}\int v_1\,dt + \frac{1}{R_2C}\int v_2\,dt + \frac{1}{R_3C}\int v_3\,dt\right]$$

Op Amp Differentiator :—



Differentiator circuit can be obtained by interchanging Resistor and capacitor of Integrator circuit.

Note : 1. The common Application of op Amp Differentiator is to produce very narrow spikes

2. A cosine wave i/p will generate sine wave o/p

3. A Triangular i/p will produce square wave o/p

$$i_c = C\frac{dV}{dt}$$

$$0 - V_a = V_a$$

$$V_o = -V_a$$

$$V_o = -i_c R = -RC\frac{dv}{dt}$$

$$v_o = -RC\frac{dv_1}{dt}.$$

$$V_o = -\tau\frac{dv}{dt}$$