Chapter : 08

DC Power Supply

DC power supply is required for the operation of most of the electronic device and circuits. Nowadays almost all electronic devices includes a ckt that converts AC supply into a DC supply.

The Basic block diagram of DC power supply is shown below:

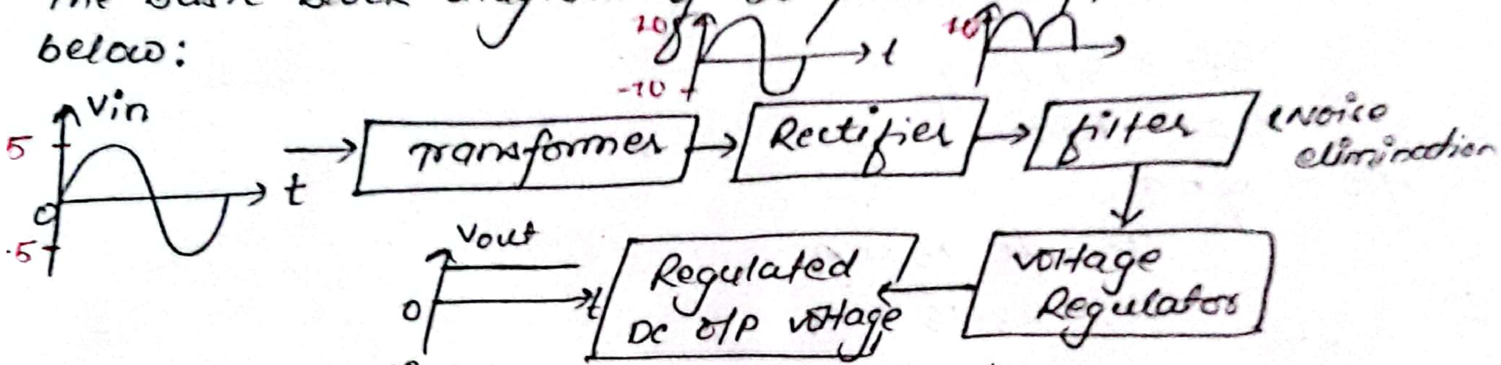
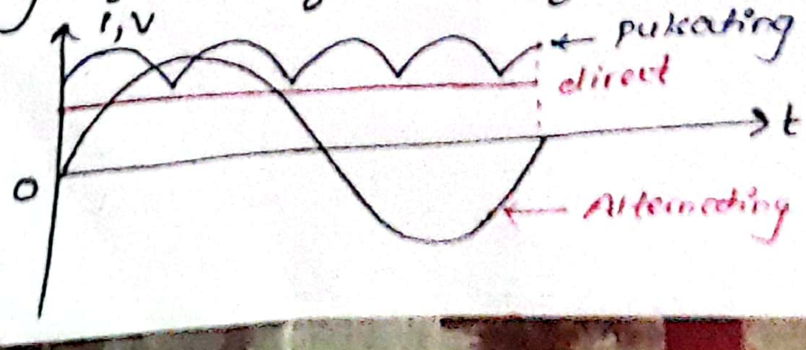


fig: Block diagram of DC power supply.

a) Transformer: The input to the transformer is normally an AC signal that is generated by a line voltage such as the power from an electric outlet. The transformer's main function is to step-down (lower the amplitude) or step-up (increase the amplitude) the signal to produce the desired DC level required at the output of the power supply.

b) Rectifier: The signal at the output of the transformer is fed to the rectifier. The diode circuits which are used to convert input AC signal to DC signal are called rectifiers. It produces pulsating DC signal. A pulsating DC signal is a signal (voltage or current) that does not change polarity, but its magnitude is a function of time.



Rectifiers are of two types:

i) Halfwave Rectifier (HWR)

ii) fullwave Rectifier (FWR)

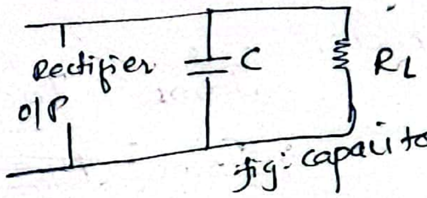


fig: capacitor filter.

c) **filter:** In order to convert pulsating DC signal into a non-pulsating DC signal, a filter is needed. Normally a simple capacitor filter suffices. The output of the filter is DC voltage, which usually has some ripple or small AC variation.

d) **Regulator:** The regulator has two functions:

i) To smooth the signal from the filter producing DC signal with no ripple

ii) To produce a constant voltage at the output.

Rectifier parameters

1. **Efficiency (η):** The ratio of output dc to input ac power of a rectifier is called its efficiency (η).

$$\eta = \frac{P_{out}(dc)}{P_{in}(AC)} \times 100\%$$

where,
P_{out} = output power
P_{in} = input power.

2. **Ripple factor (r):**
The output of a rectifier is not pure dc signal. It consists of DC as well as AC components. This AC component present at at the output of a rectifier are called ripples. The ratio of AC component to the dc component present at the output of a rectifier is called ripple factor 'r'

$$r = \frac{\text{ac components}}{\text{dc component}}$$

$$r = \frac{I_{ac}}{I_{dc}} \quad \text{--- (1)}$$

we know,

$$I_{rms}^2 = I_{ac}^2 + I_{dc}^2 \Rightarrow I_{ac} = \sqrt{I_{rms}^2 - I_{dc}^2} \quad \text{—(ii)}$$

$$\cancel{\therefore I_{rms} = \sqrt{I_{ac}^2 + I_{dc}^2} \quad \text{—(ii)}}$$

from (i) and (ii)

$$\gamma = \frac{\sqrt{I_{rms}^2 - I_{dc}^2}}{I_{dc}}$$

$$\gamma = \sqrt{\frac{I_{rms}^2 - I_{dc}^2}{I_{dc}^2}}$$

$$\boxed{\gamma = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}}$$

3. Peak Inverse voltage (PIV):

During operation of rectifiers diode is either forward biased or reversed biased. The maxm voltage across reverse biased diode of a rectifier is called peak inverse voltage.

4. Types of Rectifier

1. Half wave Rectifier:

The rectifier ckts which converts any of half cycle either +ve half cycle or -ve half cycle of i/p ac signal to pulsating DC signal is called half wave rectifier. It consists of a diode and step down transformer connected to a load R_L as shown in fig.

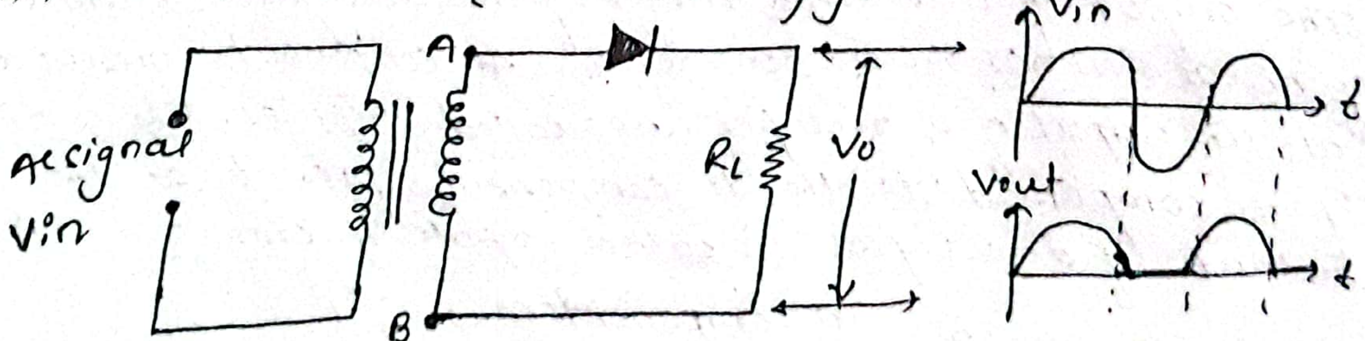
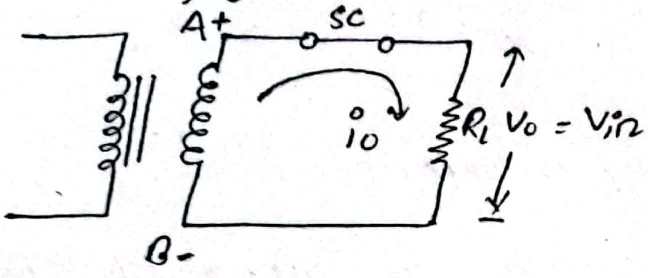


fig: I/O waveform.

operation:

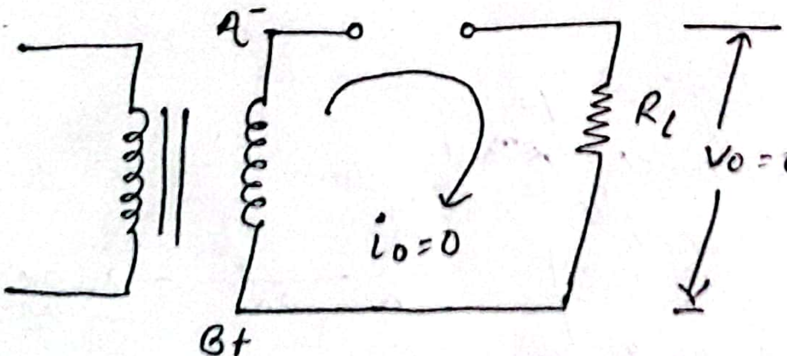
1. **for +ve cycle of Input AC cycle:** During this cycle the end A of secondary winding of transformer becomes +ve where end B becomes −ve. so the diode is forward biased (short circuit) so it conducts current through the load R_L as shown in fig below:



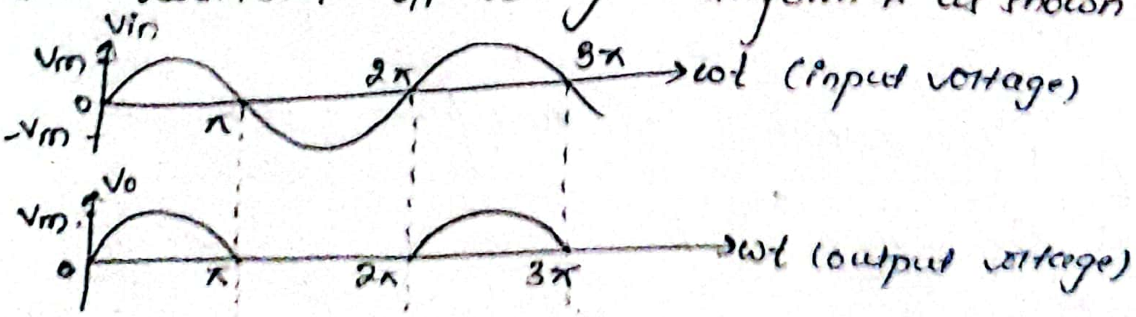
Here, $V_0 = V_{in}$

2. **for −ve cycle of Input AC cycle:**

During this cycle the end A of 2ndry winding of transformer becomes −ve whereas end B becomes +ve. so the diode is R.B (open circuit). so it doesnot conduct current through the load R_L as shown in fig below.



The diode conducts the current during +ve half cycle only and resultant o/p voltage waveform is as shown below



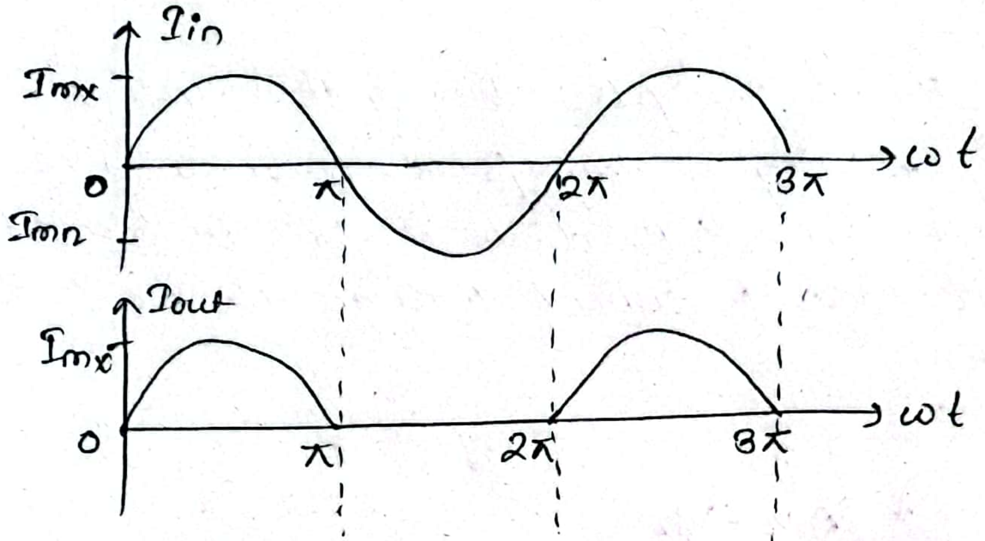
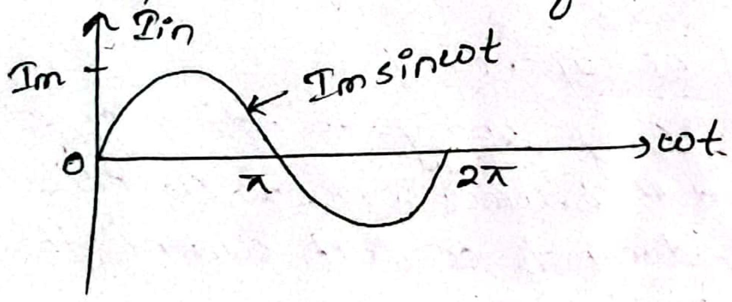


fig: input and o/p current waveform.

Efficiency, Ripple factor and PIV of Half wave Rectifier.

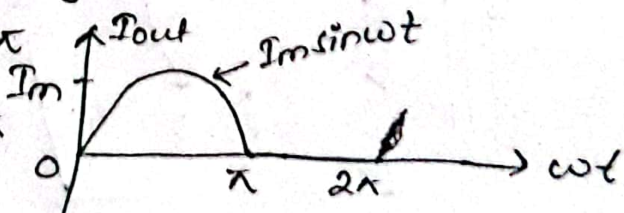
consider an input ac current for HWR be:



$I_{in} = I_m \sin\omega t$ for $0 < \omega t < 2\pi$

The o/p current of HWR is given by,

$$I_{out} = \begin{cases} I_m \sin\omega t & \text{for } 0 < \omega t < \pi \\ 0 & \text{for } \pi < \omega t < 2\pi \end{cases}$$



now, Average / DC value of I_{out} is,

$$I_{avg} = I_{dc} = \frac{1}{2\pi}\int_0^{2\pi} I_{out}\, d\omega t$$

$\left[\because y(t) = \frac{1}{T}\int_0^T f(t)\, dt\right]$

$T = 2\pi$ = Time period

$f(t) = I_{out}$

$$I_{avg} = \frac{1}{2\pi}\left[\int_0^{\pi} I_{out}\, d\omega t + \cancel{\int_{\pi}^{2\pi} I_{out}\, d\omega t}^{\,0}\right]$$

$$I_{avg} = \frac{1}{2\pi}\left[\int_0^{\pi} I_{out}\, d\omega t + 0\right]$$

$$I_{avg} = \frac{1}{2\pi} \int_0^{\pi} I_m \sin \omega t \, d\omega t$$

$$I_{avg} = \frac{I_m}{2\pi} \left[-\cos \omega t \right]_0^{\pi}$$

$$I_{avg} = -\frac{I_m}{2\pi} \left[\cos \pi - \cos 0 \right]$$

$$I_{avg} = -\frac{I_m}{2\pi} \left[-1 - 1 \right] \quad [\because \cos \pi = -1]$$

$$I_{avg} = \frac{2 I_m}{2\pi}$$

$$\boxed{I_{avg} = \frac{I_m}{\pi}}$$

Similarly, RMS value of o/p current is,

$$I_{rms} = \sqrt{\frac{1}{2\pi} \int_0^{2\pi} (I_{out})^2 d\omega t} \quad \left[\because y(t)_{rms} = \sqrt{\frac{1}{T} \int_0^T x^2(t)\, dt} \right]$$

$$= \sqrt{\frac{1}{2\pi} \left[\int_0^{\pi} I_{out}^2 \, d\omega t + \int_{\pi}^{2\pi} I_{out}^2 \, d\omega t \right]}$$

$$\left[\begin{array}{l} \cos 2\theta = 1 - 2\sin^2\theta \\ 2\sin^2\theta = 1 - \cos 2\theta \\ \sin^2\theta = \frac{1 - \cos 2\theta}{2} \end{array} \right]$$

$$= \sqrt{\frac{1}{2\pi} \left[\int_0^{\pi} I_m^2 \sin^2 \omega t \, d\omega t \right]}$$

$$= \sqrt{\frac{I_m^2}{2\pi} \int_0^{\pi} \left(\frac{1 - \cos 2\omega t}{2} \right) d\omega t}$$

$$= \sqrt{\frac{I_m^2}{4\pi} \int_0^{\pi} (1 - \cos 2\omega t) \, d\omega t}$$

$$= \sqrt{\frac{I_m^2}{4\pi} \left\{ [\omega t]_0^{\pi} - \left[\frac{\sin 2\omega t}{2} \right]_0^{\pi} \right\}}$$

$$= \sqrt{\frac{I_m^2}{4\pi} \left\{ [\pi - 0] - \frac{1}{2} [\sin 2\pi - \sin 0] \right\}}$$

$$= \sqrt{\frac{I_m^2}{4\pi} \times \pi} = \sqrt{\frac{I_m^2}{4}} = \frac{I_m}{2} \qquad \boxed{\therefore I_{rms} = \frac{I_m}{2}}$$

Now,

$P_{ac} = I_{ac}^2 (R_s + R_L + r_f)$ হবে।

ac current secondary winding, Load & diode সবগুলো available হবে।

(i) Efficiency $(\eta) = \dfrac{P_{dc}}{P_{ac}}$

where,

$P_{dc} = I_{dc}^2 \cdot R_L$ and, $P_{ac} = \left(\dfrac{I_m}{2}\right)^2 (R_L + r_D)$

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

$= \left(\dfrac{I_m}{\pi}\right)^2 \cdot R_L$ where, r_D = diode resistance or, r_f

$\therefore \eta = \dfrac{\left(\dfrac{I_m}{\pi}\right)^2 \times R_L}{\left(\dfrac{I_m}{2}\right)^2 (R_L + r_D)}$

[During conduction period the instantaneous value of resistance $= R_L + r_D$]

for, maximum efficiency, $r_D = 0$

$\therefore \eta_{max} = \dfrac{\left(\dfrac{I_m}{\pi}\right)^2 \times R_L}{\left(\dfrac{I_m}{2}\right)^2 \times R_L} = \left(\dfrac{I_m}{\pi}\right)^2 \times \left(\dfrac{2}{I_m}\right)^2$

$= \dfrac{4}{\pi^2}$

$= 0.405$

$\therefore \boxed{\eta_{max} = 40.5\%}$

(ii) Ripple factor $(r) = \sqrt{\left(\dfrac{I_{rms}}{I_{dc}}\right)^2 - 1}$

$= \sqrt{\dfrac{(I_m/2)^2}{(I_m/\pi)^2} - 1}$

$= \sqrt{\dfrac{\pi^2}{4} - 1}$

$= 1.21$

(iii) Peak Inverse voltage (PIV)

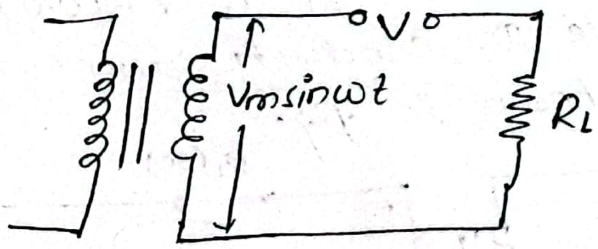
for -ve cycle of input, diode is R.B in HWR.

Here, $V = V_m \sin\omega t$

for, maxm value, $\sin\omega t = 1$

$\therefore V_{max} = V_m$

$\therefore \boxed{PIV = V_m}$



2. full wave Rectifier

The rectifier circuit which converts both +ve and -ve cycle of ac input signal to dc o/p signal is called full-wave rectifier.

There are two types of full wave rectifier.

i) center - Tap full wave rectifier

ii) Bridge full wave rectifier.

a) Center - Tap full wave rectifier

The center - Tap full wave rectifier consists of a center - tap step down transformer and two diodes D_1 and D_2 connected across secondary winding of transformer and connected to load resistance R_L as shown in fig below;

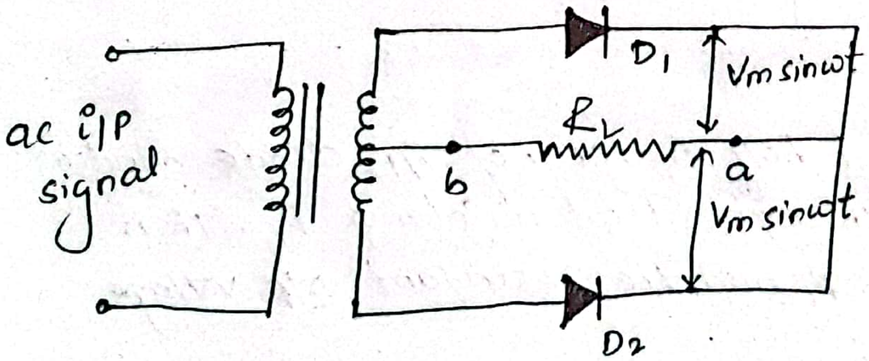
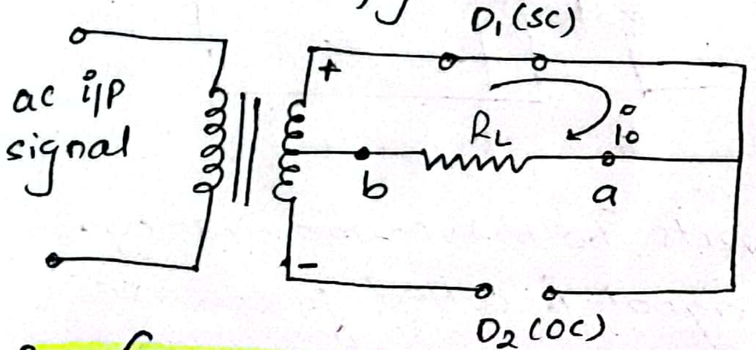


fig: center - tap FWR.

operation

1. for +ve cycle of input signal:

During +ve cycle of ac input signal end A of 2ndry winding of transformer becomes +ve and end B becomes -ve. so diode D_1 is f.B(ON) and D_2 is R.B (OFF). The f.B diode D_1 conducts current through R_L from end a to b as shown in fig.

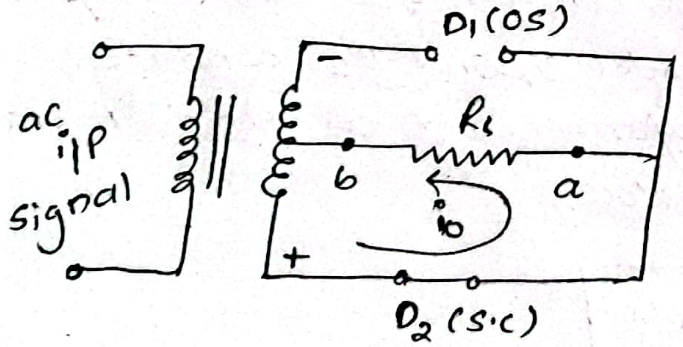


$D_1 \rightarrow$ forward Biased $\rightarrow$ short circuit

$D_2 \rightarrow$ Reverse Biased $\rightarrow$ open circuit

2. for -ve cycle of input signal.

During -ve cycle of ac input signal end A of 2ndry winding of transformer becomes -ve and end B becomes +ve, so the diode D_1 is R.B (off) and D_2 is f.B (ON). The f.B D_2 conducts current through the load R_L from end 'a' to end 'b' as shown in fig.



$D_1 \rightarrow$ reverse bias $\rightarrow$ o.c

$D_2 \rightarrow$ forward bias $\rightarrow$ s.c.

Since, in both +ve and -ve half cycles of i/p diode conducts current in same dirn through load resistance R_L. Then dc o/p is obtained across R_L and the resultant o/p voltage and current waveform is,

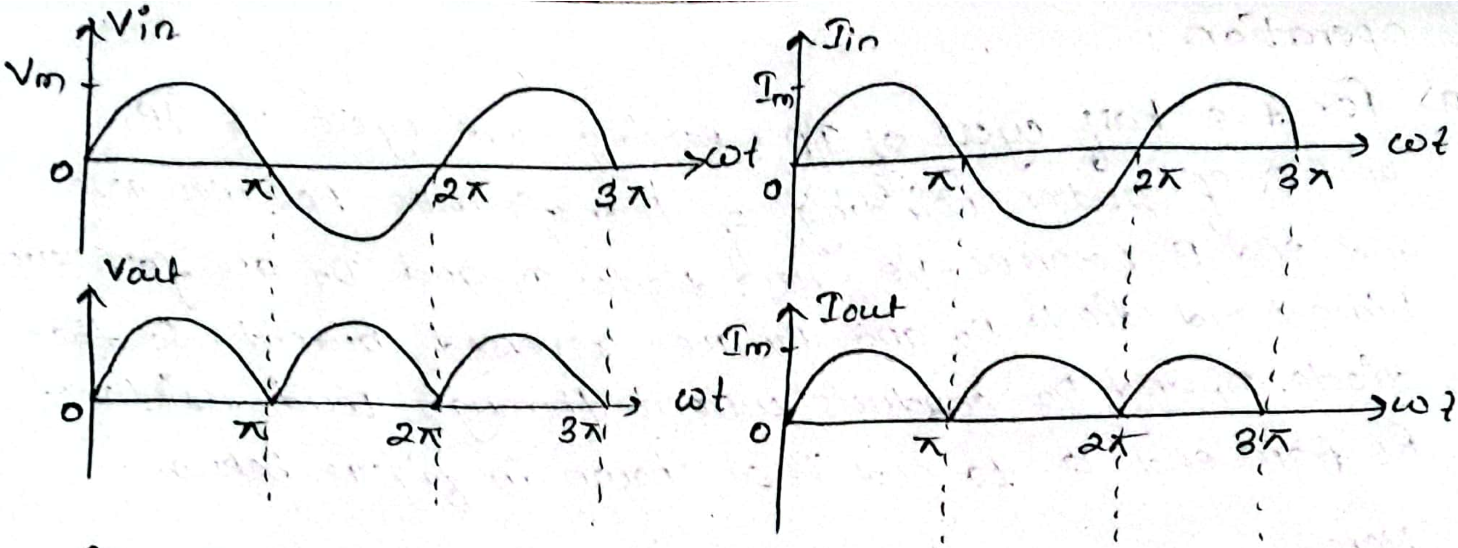


fig: I/P and O/P waveform of voltage and current in center tap full wave rectifier.

b) Bridge full wave Rectifier

Bridge full wave rectifier consists of a diode bridge circuit with four diodes D_1, D_2, D_3 and D_4 along with a load resistor connected as shown in fig. below. (and step down transformer).

The secondary winding of the transformer is connected to one diagonally opposite end of diode bridge ckt and load R_L is connected to the next diagonally opposite ends.

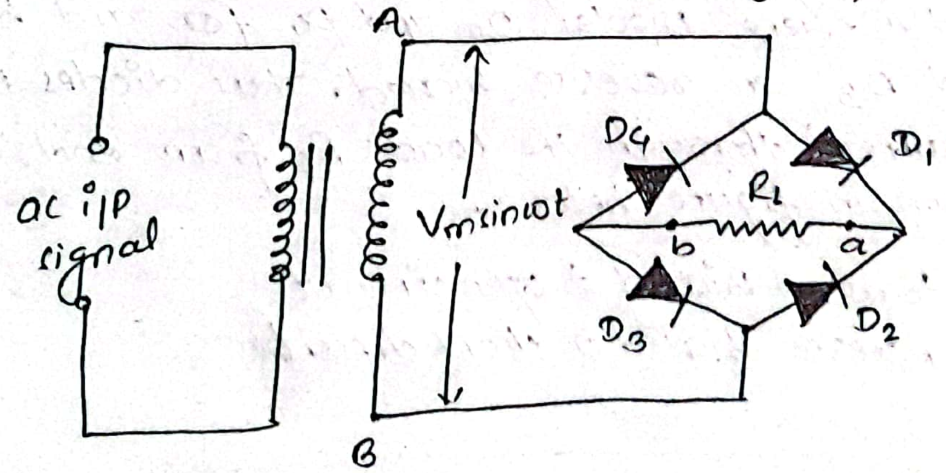


fig: Bridge full wave rectifier.

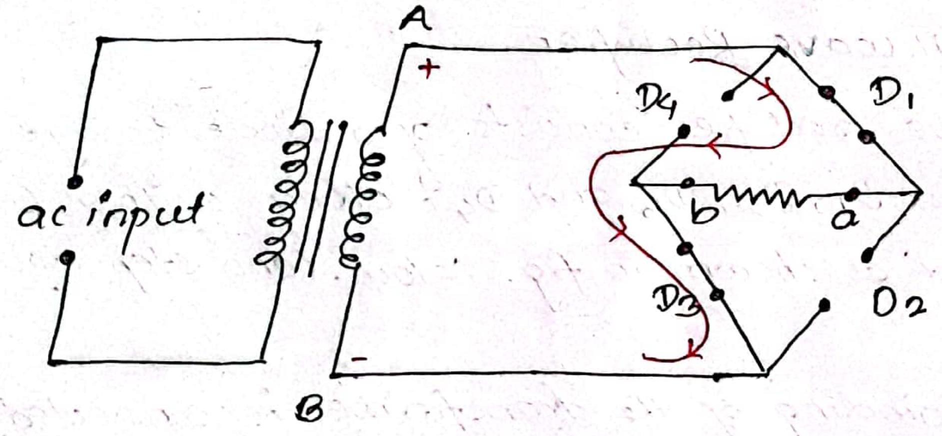
Operation :

a) for +ve half cycle of I/P : During +ve cycle of i/P, end A of 2ndry winding of transformer becomes +ve and end B becomes -ve. Here diodes D_1 and D_3 are forward biased and diode D_2 and D_4 are reversed biased. So that diode D_1 and D_3 conducts current through load resistance R_L from end 'a' to end 'b' as shown in figure below.

Here,

$D_1, D_3 \Rightarrow$ forward Biased $\Rightarrow$ short circuit

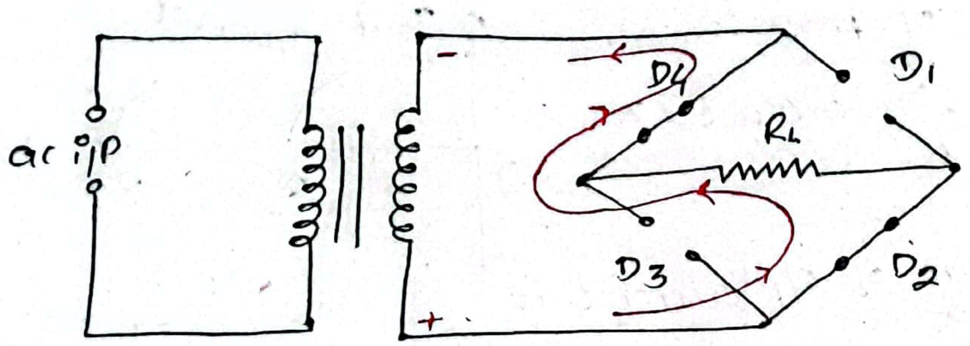
$D_2, D_4 \Rightarrow$ Reverse Biased $\Rightarrow$ open circuit



b) for -ve half cycle of I/P: During -ve half cycle of i/P, end A of 2ndry winding of transformer becomes -ve and end B becomes +ve. Here Diodes D_2 and D_4 forward biased and diodes D_1 and D_3 are reverse biased. Thus diodes D_2 and D_4 conducts current through the load R_L from end 'a' to end 'b' as shown in figure below.

Here, $D_2, D_4 \Rightarrow$ forward Biased $\Rightarrow$ open circuit

$D_1, D_3 \Rightarrow$ Reverse Biased $\Rightarrow$ short circuit



As current flows in same direction in load resistance R_L for both +ve and -ve half cycle of i/p, the resultant o/p waveform is as shown below.

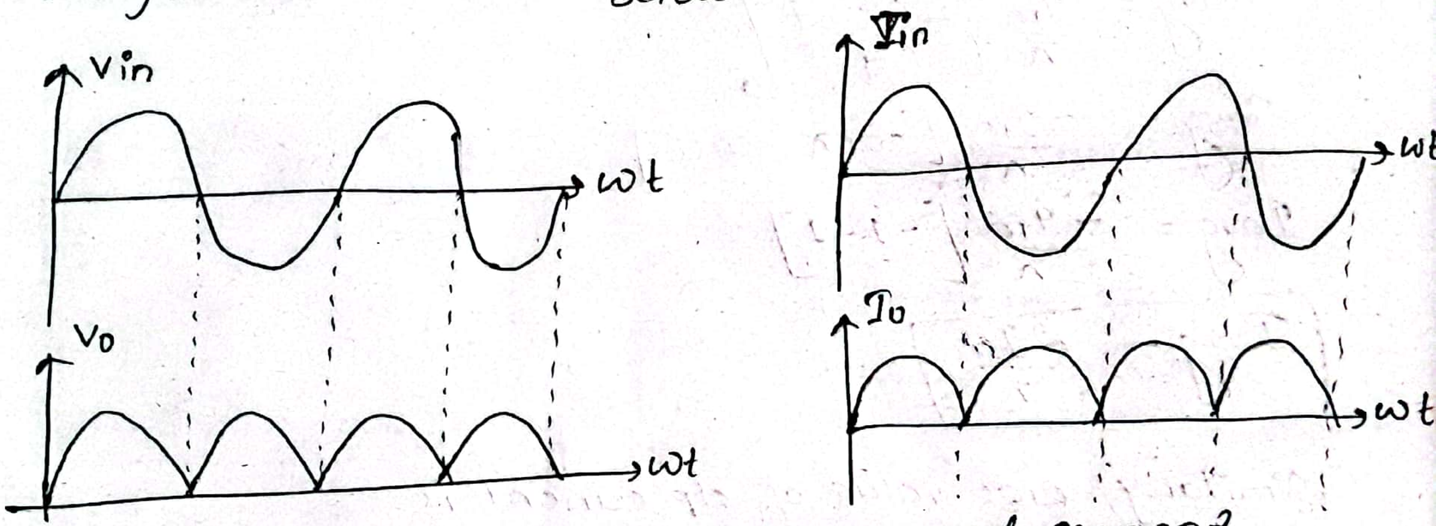
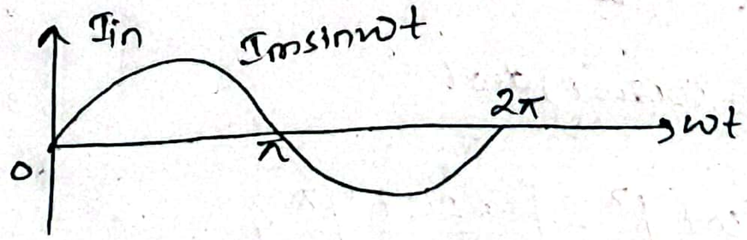


fig: I/P and O/P waveform for voltage and current for Bridge full wave Rectifier circuit

Efficiency, Ripple factor and PIV of full wave Rectifier.

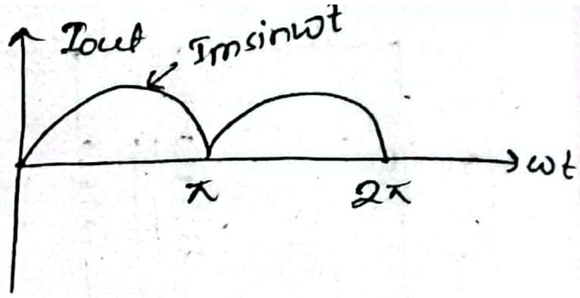
consider a sinusoidal ac i/p current supplied to full wave rectifier,

$I_{in} = I_m \sin\omega t$ for $0 < \omega t < 2\pi$



The output current of FWR is

$I_{out} = I_m \sin\omega t$ for $0 < \omega t < \pi$



Now,

Average / DC value of o/p current is

$$I_{avg} = \frac{1}{\pi}\int_0^{\pi} I_{out}\, d\omega t \qquad [\because \text{Time period } (T) = \pi]$$

$$I_{avg} = \frac{1}{\pi}\int_0^{\pi} I_m \sin\omega t\, d\omega t$$

$$I_{avg} = \frac{I_m}{\pi}\left[-\cos\omega t\right]_0^{\pi}$$

$$I_{avg} = -\frac{I_m}{\pi}\left[\cos\pi - \cos 0\right]$$

$$I_{avg} = -\frac{I_m}{\pi}\left[-1-1\right]$$

$$\boxed{I_{avg} = \frac{2I_m}{\pi}}$$

Similarly, RMS value of o/p current is

$$I_{rms}^2 = \frac{1}{\pi}\int_0^{\pi} (I_{out})^2\, d\omega t$$

$$I_{rms}^2 = \frac{1}{\pi}\int_0^{\pi} (I_m \sin\omega t)^2\, d\omega t$$

$$I_{rms}^2 = \frac{1}{\pi} \times I_m^2 \int_0^{\pi} \sin^2\omega t\, d\omega t$$

$$I_{rms}^2 = \frac{I_m^2}{\pi}\int_0^{\pi}\left[\frac{1-\cos 2\omega t}{2}\right] d\omega t$$

$$I_{rms}^2 = \frac{I_m^2}{2\pi}\int_0^{\pi}(1-\cos 2\omega t)\, d\omega t$$

$$I_{rms}^2 = \frac{I_m^2}{2\pi}\left\{\left[\omega t\right]_0^{\pi} - \left[\frac{\sin 2\omega t}{2}\right]_0^{\pi}\right\}$$

$$I_{rms}^2 = \frac{I_m^2}{2\pi}\{\pi - 0\}$$

$$I_{rms}^2 = \frac{I_m^2}{2\pi} \times \pi$$

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

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

i) Efficiency (η) = $\frac{\text{output power}}{\text{input power}} = \frac{P_{dc}}{P_{ac}}$ — ①

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

$$P_{avg} = I_{dc}^2 \cdot R_L = \left(\frac{2I_m}{\pi}\right)^2 \cdot R_L$$

$$P_{ac} = I_{rms}^2 (R_L + r_D')$$

$$= \left(\frac{I_m}{\sqrt{2}}\right)^2 (R_L + r_D')$$

Note:

$\left[\begin{array}{l} r_D' = 2r_D \text{ for bridge FWR} \\ r_D' = r_D \text{ for centre tap FWR} \end{array}\right]$

r_D = Diode resistance

for maxm η, $r_D' = 0$

$$\therefore \eta_{max} = \frac{\left(\frac{2I_m}{\pi}\right)^2 R_L}{\left(\frac{I_m}{\sqrt{2}}\right)^2 \times R_L} = \frac{4 I_m^2}{\pi^2} \times \frac{2}{I_m^2} = \frac{8}{\pi^2} = 0.810$$

$$\boxed{\therefore \eta_{max} = 81\%}$$

ii) Ripple factor (r)

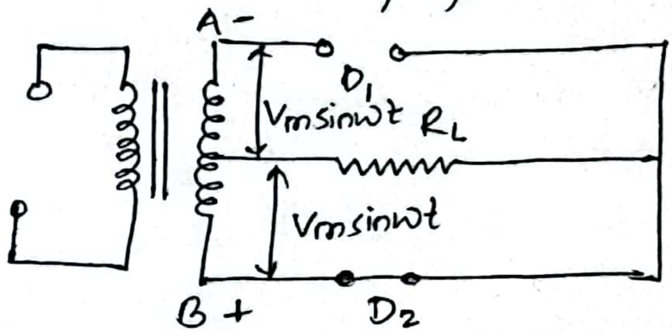
we know,

ripple factor (r) = $\sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1} = \sqrt{\left(\frac{I_m/\sqrt{2}}{\frac{2I_m}{\pi}}\right)^2 - 1}$

$$= \frac{\sqrt{2}}{\pi} = 0.45$$

iii> Peak Inverse voltage (PIV)

a> for center tap full wave Rectifier.



for -ve cycle, ~~diode D~~ diode D_2 is off.

$V = V_m \sin\omega t + V_m \sin\omega t$

$V = 2V_m \sin\omega t$

for max^m case, $\sin\omega t = 1$

$\therefore V_{max} = 2V_m$

$\boxed{PIV = 2V_m}$

b> for Bridge ~~forward~~ full wave Rectifier.

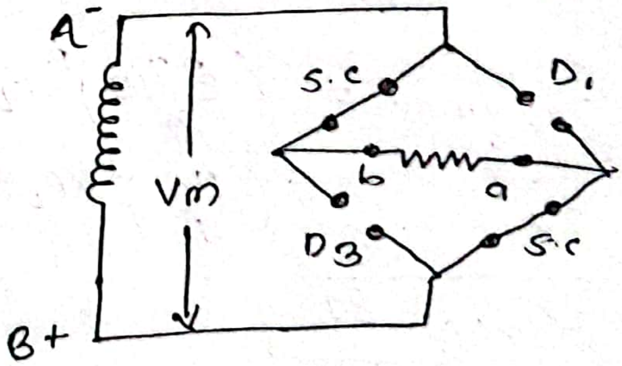
Here, $V = V_m \sin\omega t$

for -ve cycle, diode D_1 and D_3 are off.

for max case, $\sin\omega t = 1$

$\therefore V_{max} = V_m$

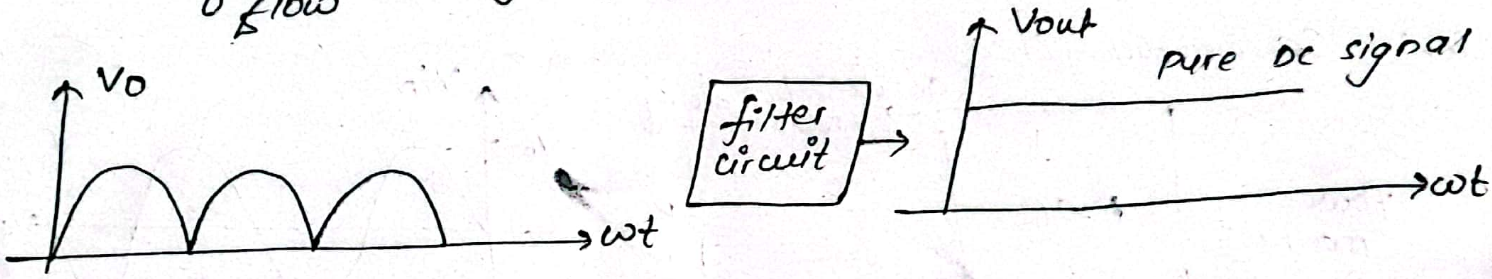
$\therefore \boxed{PIV = V_m}$



#. filtering process

The o/p of rectifier ckt contains both DC and AC components. The AC components are undesirable and must removed from rectified o/p voltage. The process of removing undesired AC signal from the o/p signal obtained after rectification is known as filtering process.

Basically a filter circuit is a device which removes the AC components of ~~a~~ rectifier o/p and allows the DC components to ~~follow~~ flow through load.



↳ There are various types of filter circuits.

1> capacitor filter / shunt capacitor filter.
2> Inductor filter
3> LC filter and
4> π-filter

1. capacitor / shunt capacitor filter

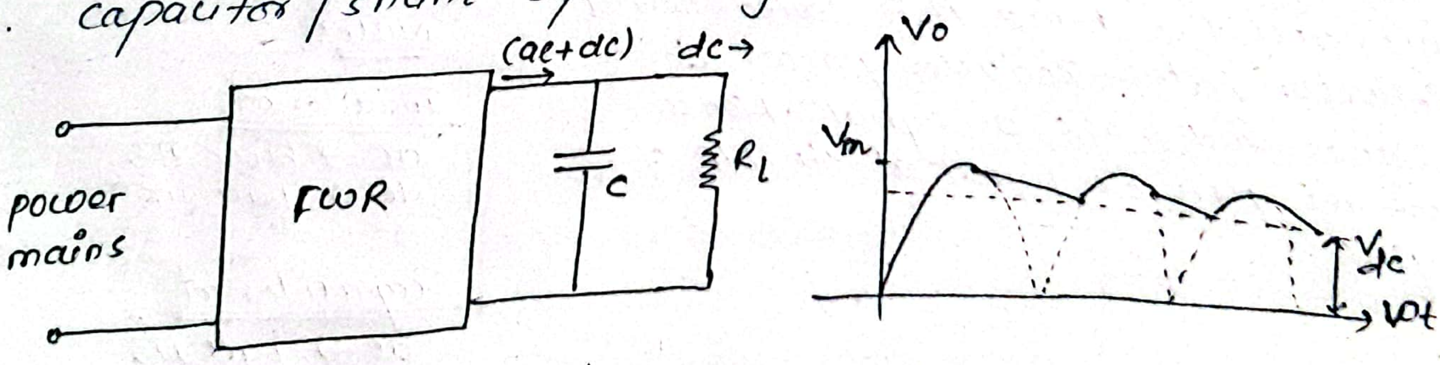


fig: shunt capacitor filter and its o/p waveform.

The output obtained from rectifier gives pulsating DC o/p voltage containing both ac and DC components. When capacitor is shunt to o/p (load) resistance, it allows the ac components to pass and block the dc components. So that o/p contains a small portion of ac components and large dc components.

Here, it still contains some ripples. It can further minimized using higher values of capacitance or using an LC or π-filter.

2> Series inductor filter

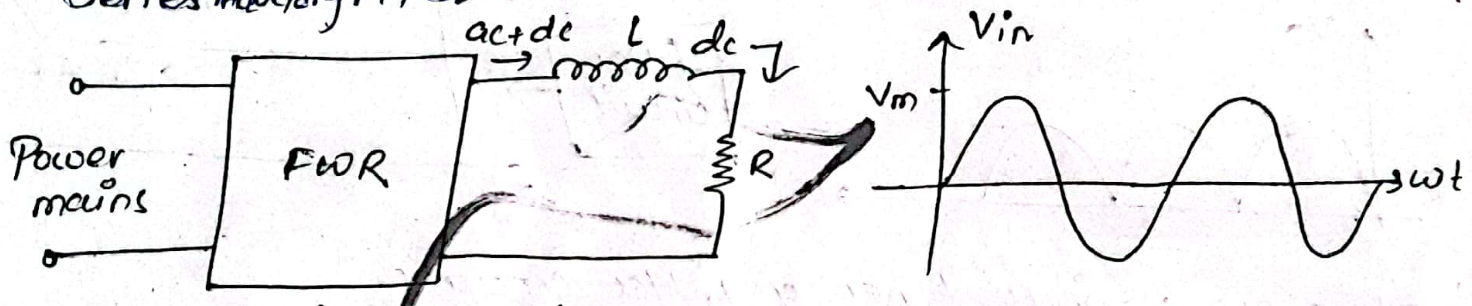
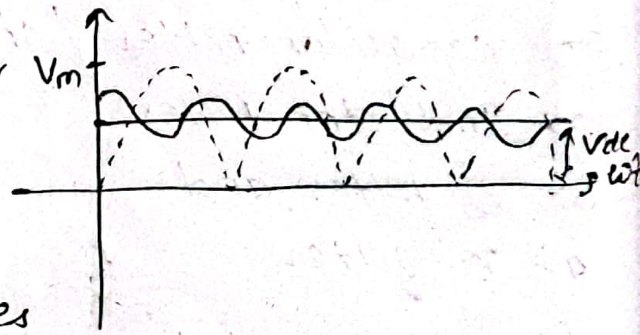


fig: series inductor filter

Series inductor filter consists of inductor and load resistance connected in series to o/p of a rectifier.



Inductor is normally connected in series with rectifier hence it is called series inductor filter. Inductor passes dc signal and block ac signal. Hence we get pure dc signal at the o/p of filter.

Note:

Inductor ले

ac → block गर्छ

dc → pass गर्छ

capacitor ले

ac → pass गर्छ

dc → block गर्छ

3. LC filter

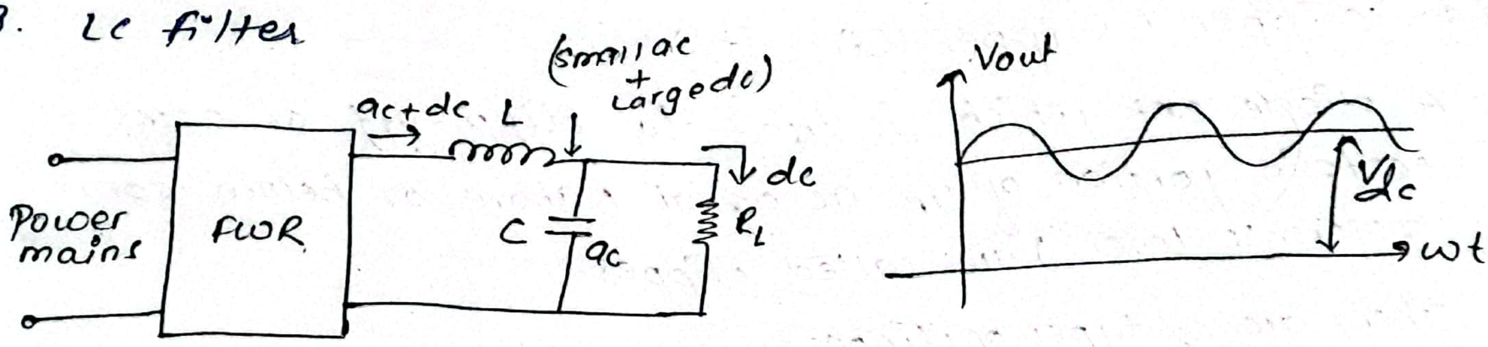
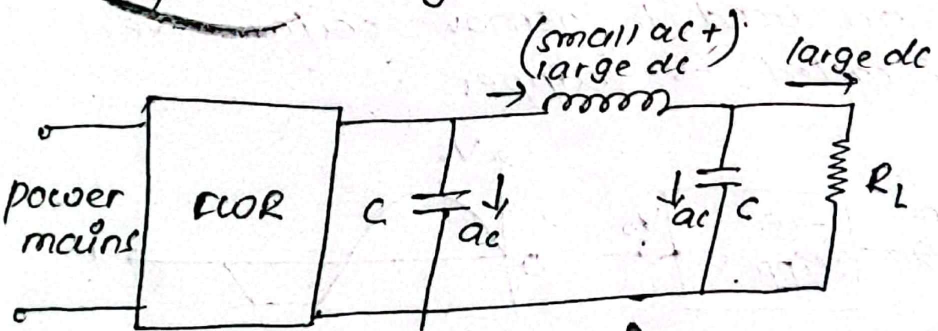


fig: LC filter and I/p o/p waveform.

The LC filter contains series inductor and shunt capacitor. The inductor allows the dc components to pass and block ac components (ie. small ac + large dc). And capacitor blocks dc components which allows only ac components to pass. Thus there will be large dc components ~~to pass~~ and only small components of ac as an o/p.

4. π filter / CLC filter / capacitor input filter.

The π-filter or CLC filter consists of 2 capacitors that are separated by inductor as shown in fig. below.



Capacitor blocks dc components and so dc component and small ac components pass towards inductor, which blocks ac components and only pass dc component. If small ac components are present after the inductor, it is passed through shunt capacitor. Thus, more smooth dc o/p voltage is obtained.

#. Clipper (Clipper Circuits)

A diode ckt which is used to clipp-off or remove certain portion of i/p ac signal (above or below some reference level) are called clippers.

There are 3 types of clippers:

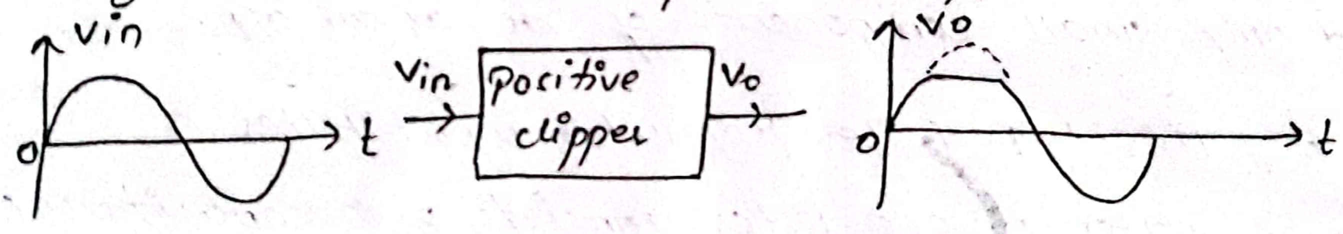
i) positive clipper

ii) Negative clipper

iii) Dual clipper (+ve and -ve clippers)

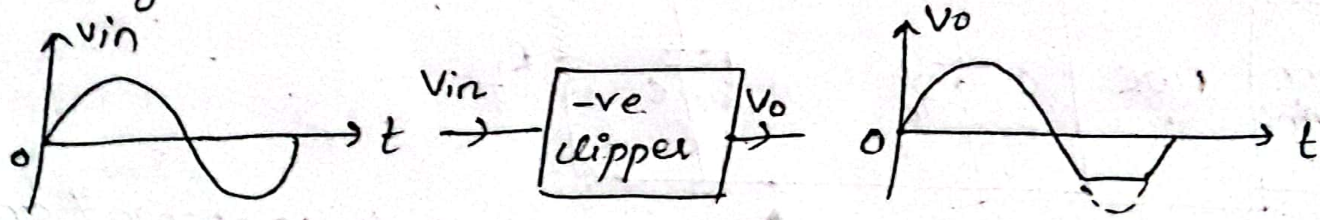
i) positive clipper

The diode ckt which are used to remove certain positive portion of ac signal are called positive clipper.



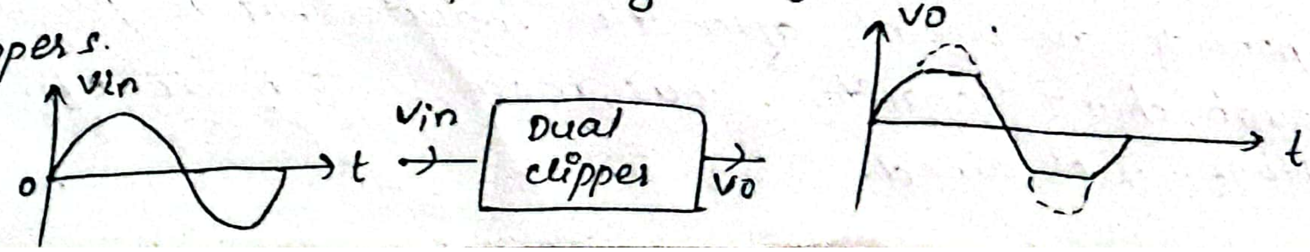
ii) Negative clipper

The diode ckt which are used to remove certain -ve portion of ac signal is called -ve clipper.

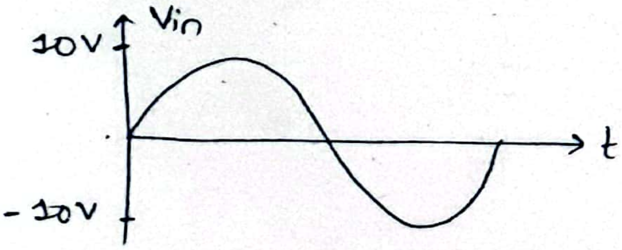


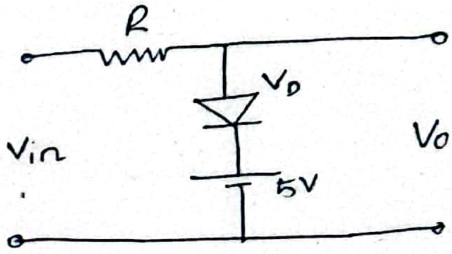
iii) Dual clipper

The diode ckts which are used to remove certain portion of both +ve and -ve parts of ac signal are called dual clippers.

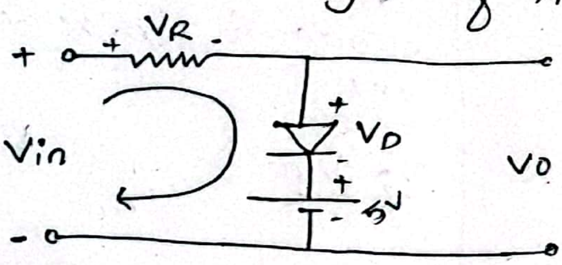


Q.1. Draw output waveform for following i/p ckt (Assume ideal diode).





Soln consider a +ve cycle of i/p.



Applying KVL,

$$V_{in} - V_R - V_D - 5 = 0$$

On negleting V_R,

$$\boxed{V_D = V_{in} - 5}$$

condition for diode to be ON,

$V_D > 0$

or, $V_{in} - 5 > 0$

$$\boxed{\therefore \ V_{in} > 5V}$$

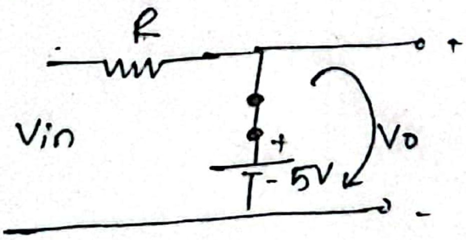
If diode is ON,

Replace diode by short ckt,

Applying KVL,

$5 - V_o = 0$

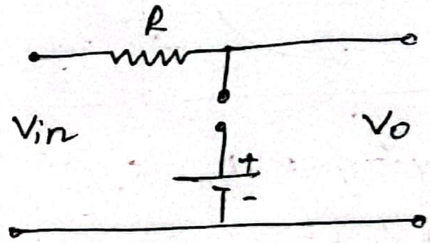
$$\boxed{\therefore V_o = 5V}$$



If diode is OFF,

Replace it by open ckt,

Here, $V_o = V_{in}$



Now,

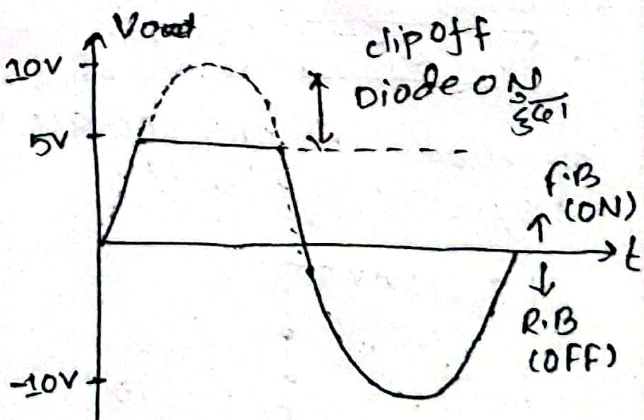
condition is,

$V_{in} > 5V$

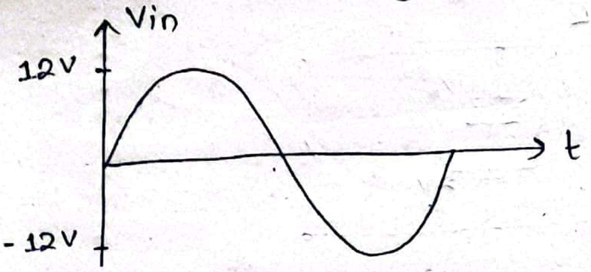
Diode ON, $V_o = 5V$.

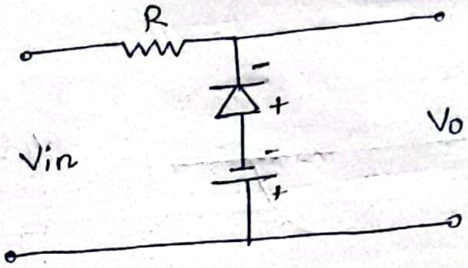
Diode OFF, $V_o = V_{in}$

Thus,

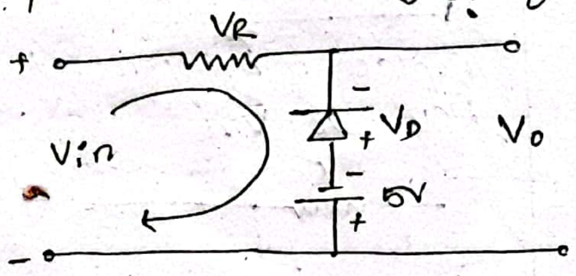


Q.2. Draw o/p waveform (Assume ideal diode).





Soln consider +ve cycle of i/p.



Applying KVL, we get,

$V_{in} + V_D + 5 = 0$

$V_D = V_{in} - 5$

Condition for diode to be ON.

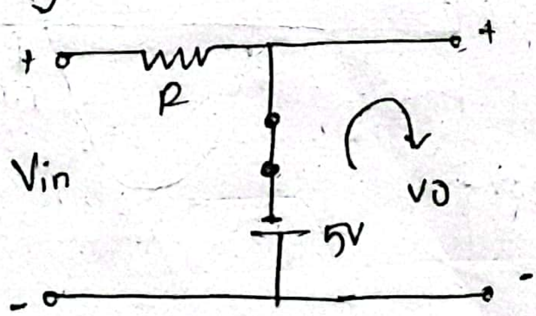
$V_D > 0$

$\therefore -V_{in} - 5 > 0$

or, $-V_{in} > 5$

or, $\boxed{V_{in} < -5}$ [यो भन्दा भन्दा सानो भाग सबै clip off हुन्छ।]

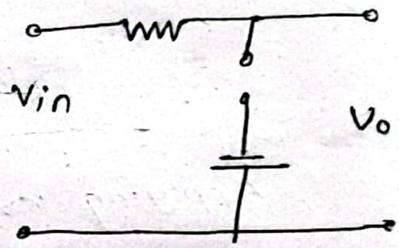
If diode is ON, replace diode by short circuit:



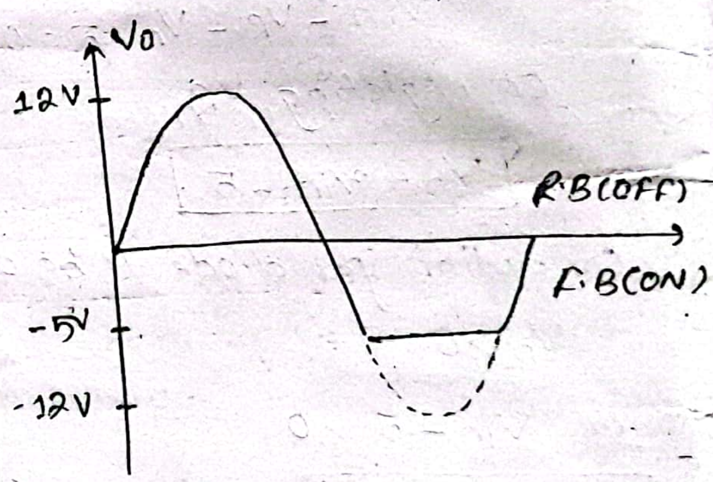
Applying KVL,

$$\left[\begin{array}{l} -5 - V_0 = 0 \\ \Rightarrow V_0 = -5V \end{array}\right]$$

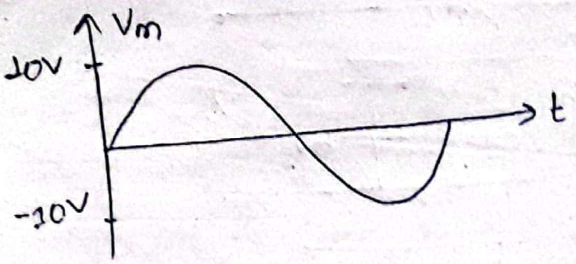
If diode is OFF, diode is replaced by open ckt.

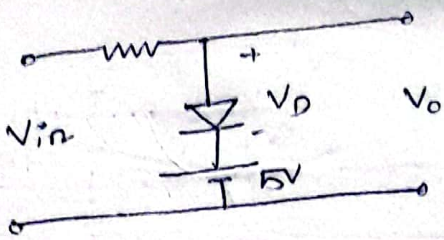


$\underline{V_0 = V_{in}}$



Q1. Draw o/p waveform (assume Si diode).



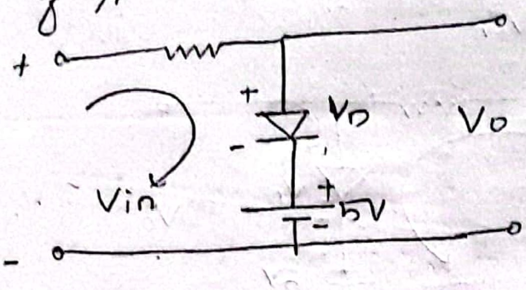


soln consider +ve cycle of i/p.

Applying KVL,

$V_{in} - V_D - 5 = 0$

$\therefore V_D = V_{in} - 5$



condition for diode to be ON,

$V_D > 0.7$

$V_{in} - 5 > 0.7$

$\boxed{V_{in} > 5.7V}$

If diode is ON, replace diode by 0.7V source.

$-V_o + 5 + 0.7 = 0$

$\Rightarrow \boxed{V_o = 5.7V}$

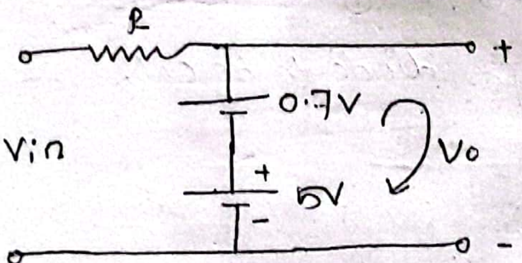


fig: If diode is ON.

If diode is OFF.
replace diode by open ckt

$\boxed{\therefore V_o = V_{in}}$

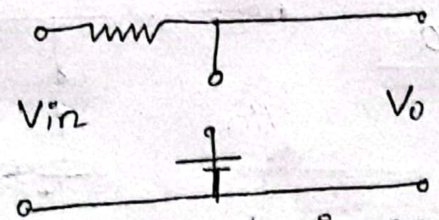
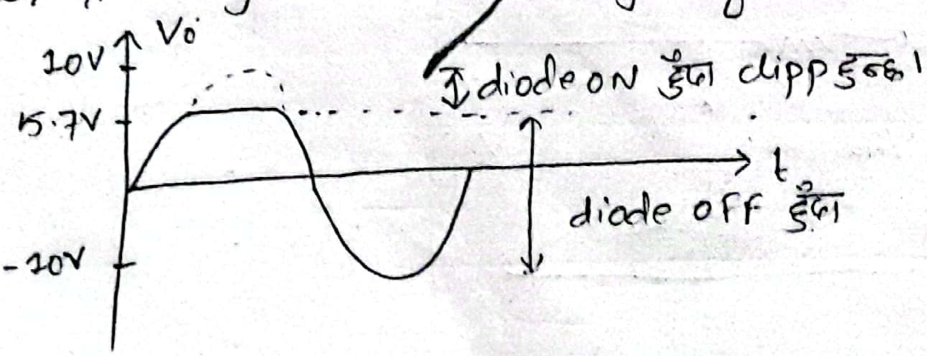
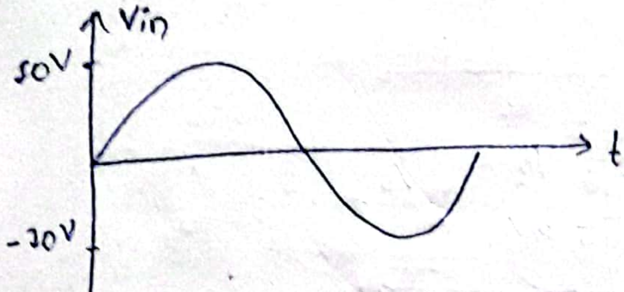


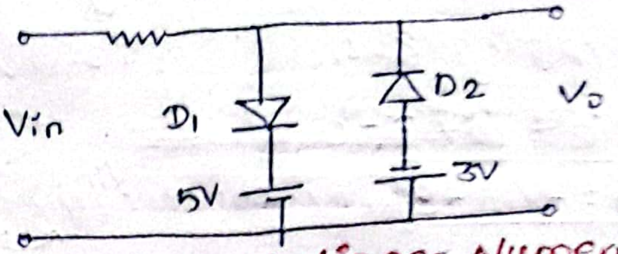
fig: If diode is OFF

Now, o/p waveform is,



85# Draw output waveform (assume silicon diode)





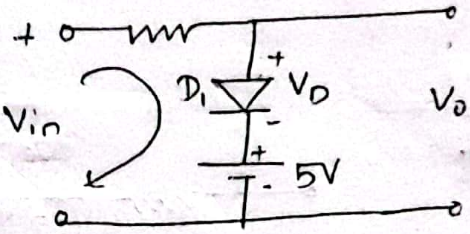
Dual clipper Numerical

Soln consider diode D_1 only,

Applying KVL,

$V_{in} - V_0 - 5 = 0$

$\boxed{V_0 = V_{in} - 5}$



Condition for diode to be ON,

$V_D > 0.7$

$V_{in} - 5 > 0.7$

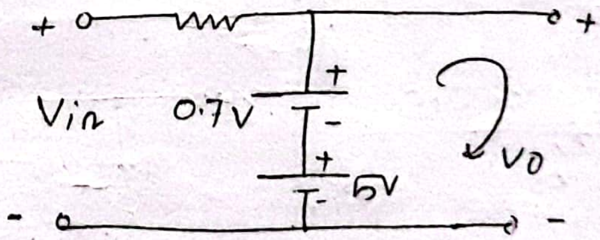
$\boxed{V_{in} > 5.7V}$

If diode is ON,

Applying KVL,

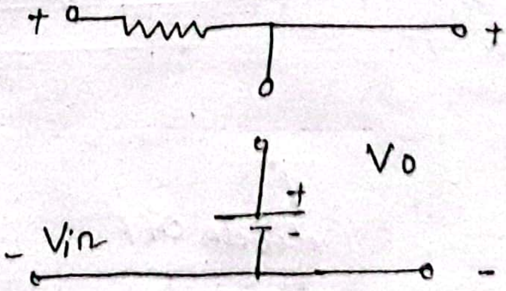
$5 + 0.7 - V_0 = 0$

$\therefore \boxed{V_0 = 5.7V}$

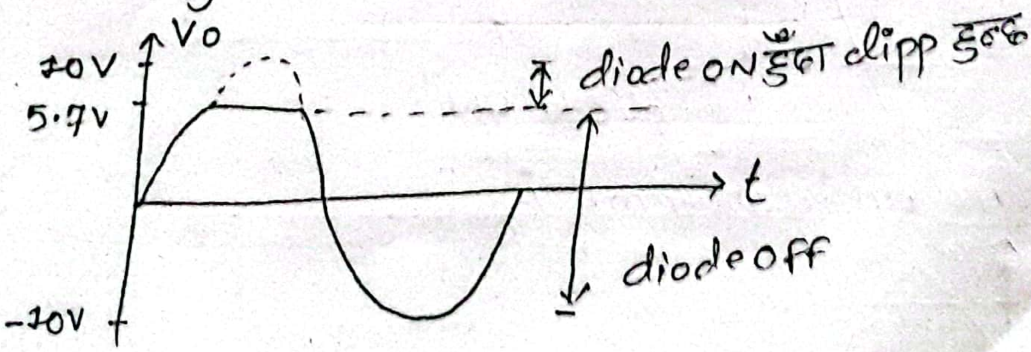


If diode is OFF,

Here, $\boxed{V_0 = V_{in}}$

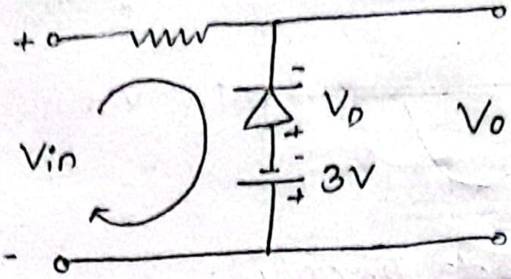


Now, o/p waveform is,



consider diode D_2 only,

Applying KVL,



$V_{in} + V_D + 3 = 0$

$\boxed{V_D = -V_{in} - 3}$

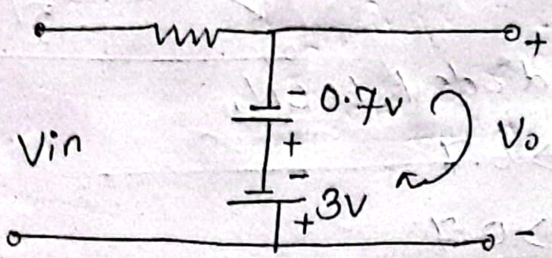
condition for diode to be ON,

$V_D > 0.7$

or, $-V_{in} - 3 > 0.7$

or, $-V_{in} > 3.7$

or, $\boxed{V_{in} < -3.7V}$



If diode is ON,

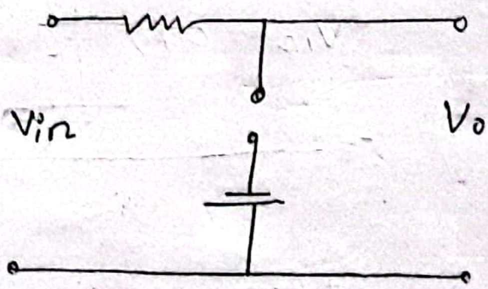
Applying KVL,

$-3 - 0.7 - V_o = 0$

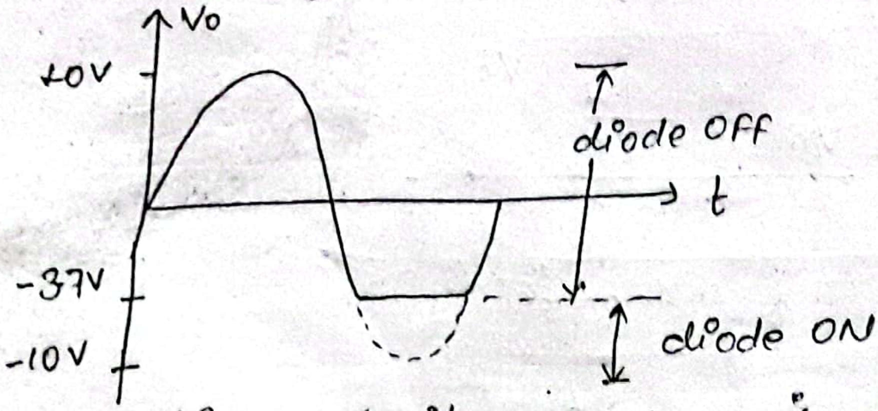
$\Rightarrow \boxed{V_o = -3.7V}$

If diode is OFF,

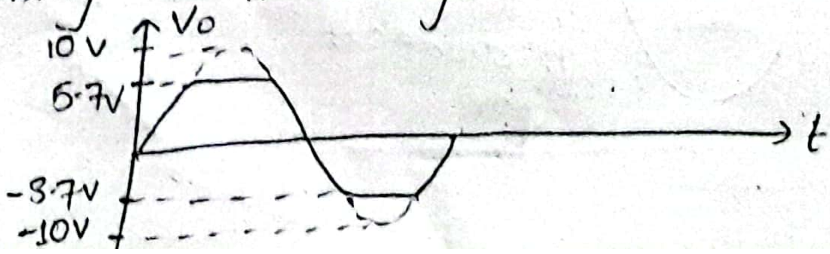
$\boxed{V_o = V_{in}}$



Now, o/p waveform is.



on, combining the o/p waveform is,



#. clampers

The diode ckts which are used to shift the DC level of AC signal or at DC voltage to AC signal are called clampers.
It can also be defined as the diode ckts that are used to add a dc signal to an ac signal.

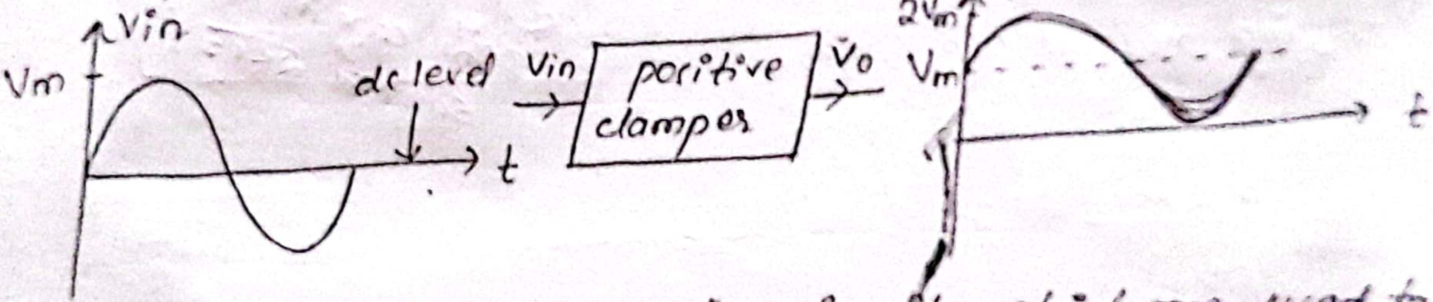
①circuit [illegible]

There are 2 types of clampers.

i) positive clamper
ii) Negative clamper.

[clamper को circuit मा capacitor available हुन्छ तर clipper ckt मा capacitor हुँदैन]

i) **Positive clamper** : The diode circuit which are used to add positive DC voltage to AC signal are called clamper.



ii) **Negative clamper**: The device circuits which are used to add a negative DC voltage to AC signal are called -ve clampers.

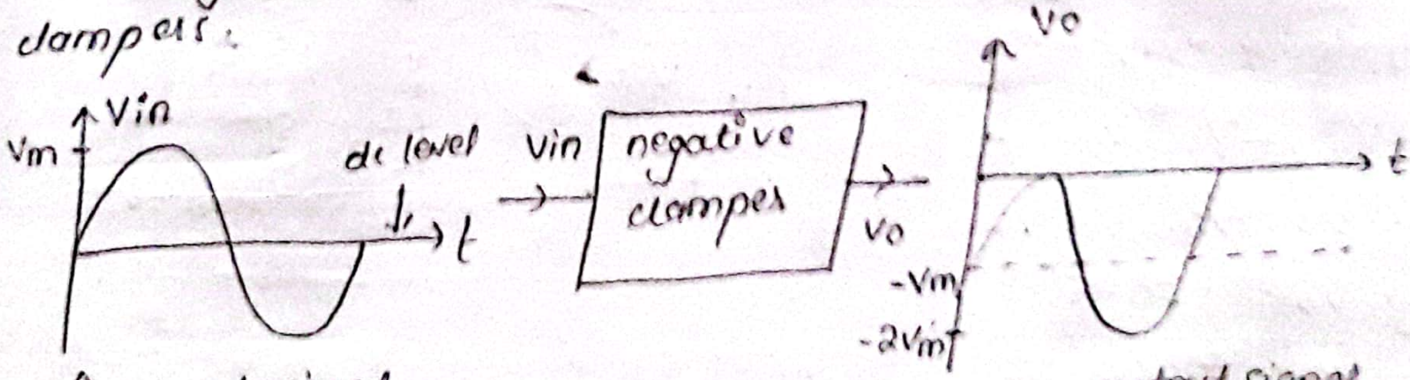
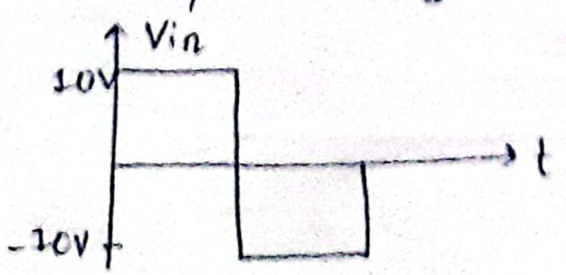
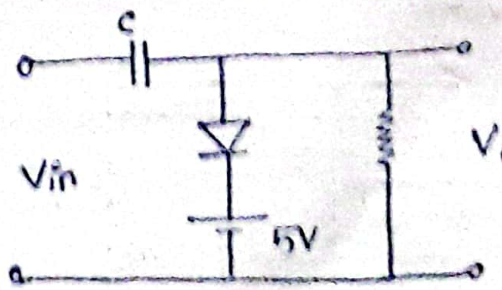


fig: Input signal

output signal

①# Draw output waveform (assum ideal diode)



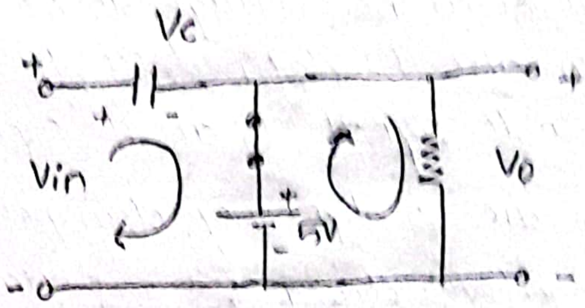


Soln. Here diode is forward biased for +ve cycle of input

i) **for +ve cycle of i/p**

Replace diode by short circuit.

Applying KVL at i/p loop



$$V_{in} - V_c - 5 = 0$$

or, $V_c = V_{in} - 5$

$= 10 - 5$

$\boxed{\therefore V_c = 5V}$

[Vc लाई first case मा भएको polarity को नै अर्को case मा पनि same नै रहन्छ।]

Applying KVL at o/p loop,

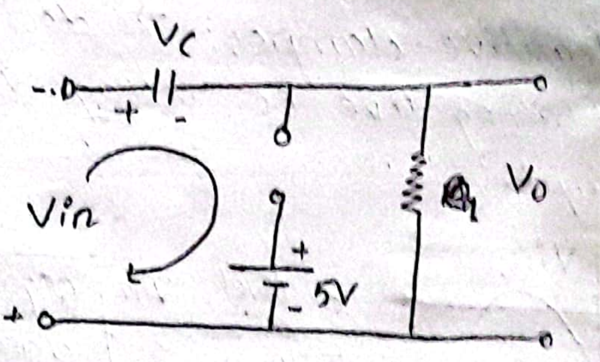
$$5 - V_o = 0$$

$\boxed{\therefore V_o = 5V}$

ii) **for -ve cycle of i/p**

Replace diode by open circuit.

Applying KVL,



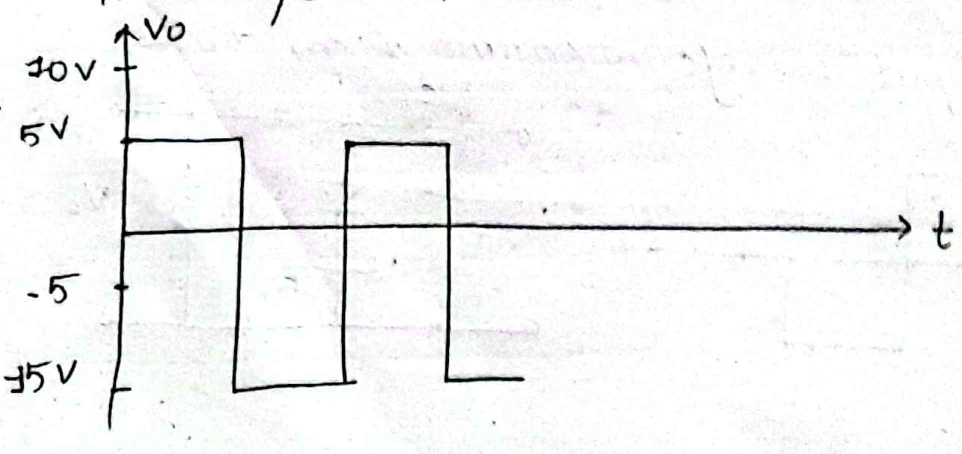
$$-V_{in} - V_c - V_o = 0$$

or, $V_o = -V_{in} - V_c$

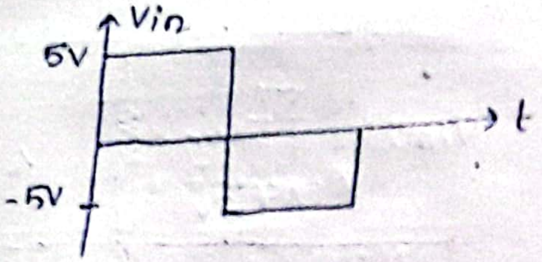
or, $V_o = -10 - 5$

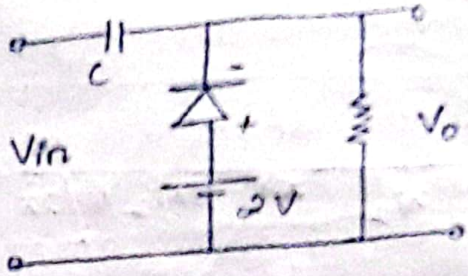
or, $\boxed{V_o = -15V}$

Now, the o/p waveform is,



② # Draw o/p waveform (Assume ideal diode)



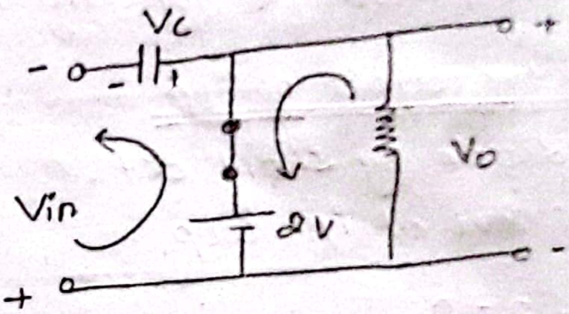


soln: Here, diode is forward biased for -ve cycle of i/p

i) for -ve cycle of i/p

Replace diode by short ckt.

Applying KVL on i/p loop.



$V_{in} + 2 - V_c = 0$

$\Rightarrow V_c = V_{in} + 2 = 5 + 2 = 7V$

$\therefore \boxed{V_c = 7V}$

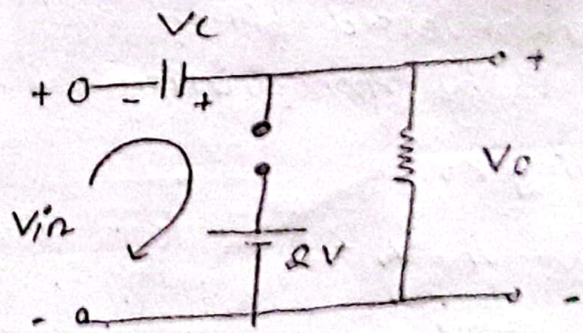
Applying KVL in o/p loop.

$V_o - 2V = 0$

$\Rightarrow \boxed{V_o = 2V}$

ii) for +ve cycle of i/p

Replace diode by open ckt.
because diode is reversed
biased.



Applying KVL,

$V_{in} + V_c - V_o = 0$

$\Rightarrow V_o = V_{in} + V_c = 5 + 7 = 12V$

$\boxed{\therefore V_o = 12V}$

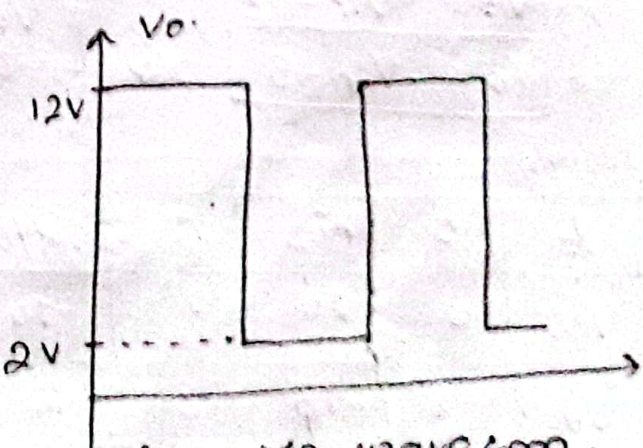
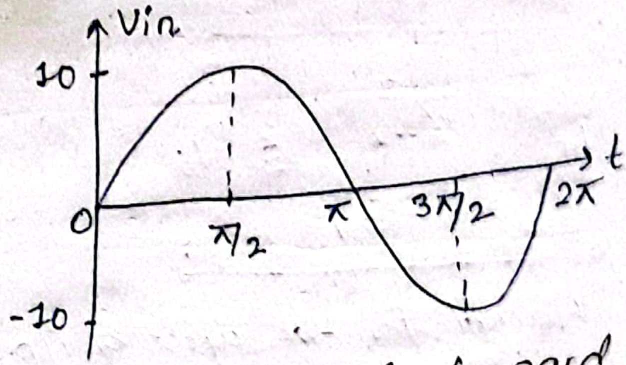
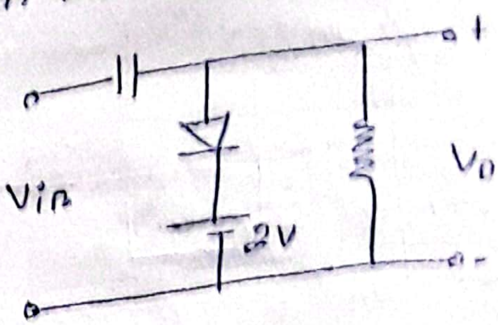


fig: o/p waveform.

⑤ Draw o/p waveform (Assume ideal diode)



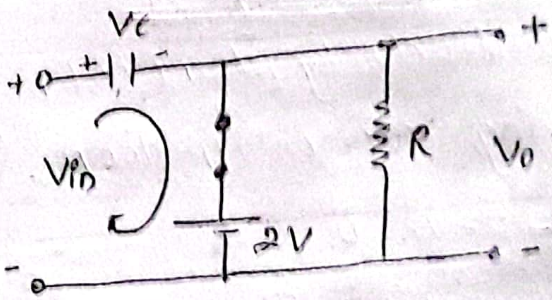


soln Here, diode is forward biased for +ve cycle of i/p

i) for +ve cycle of i/p

Replace diode by short ckt.

Applying KVL at i/p loop,



$V_{in} - V_c - 2 = 0$

$V_{in} - 2 = V_c$

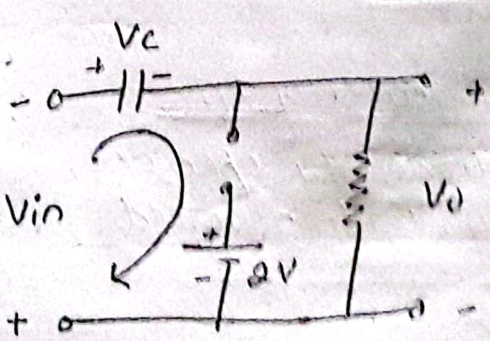
$\Rightarrow V_c = V_{in} - 2 = 10 - 2 = 8\,V$

$\boxed{\therefore V_c = 8\,V}$

ii) for -ve cycle of i/p

diode is reversed biased and replace it by open circuit

Applying KVL,



$-V_{in} - V_c - V_o = 0$

$\Rightarrow V_o = -V_{in} - V_c$

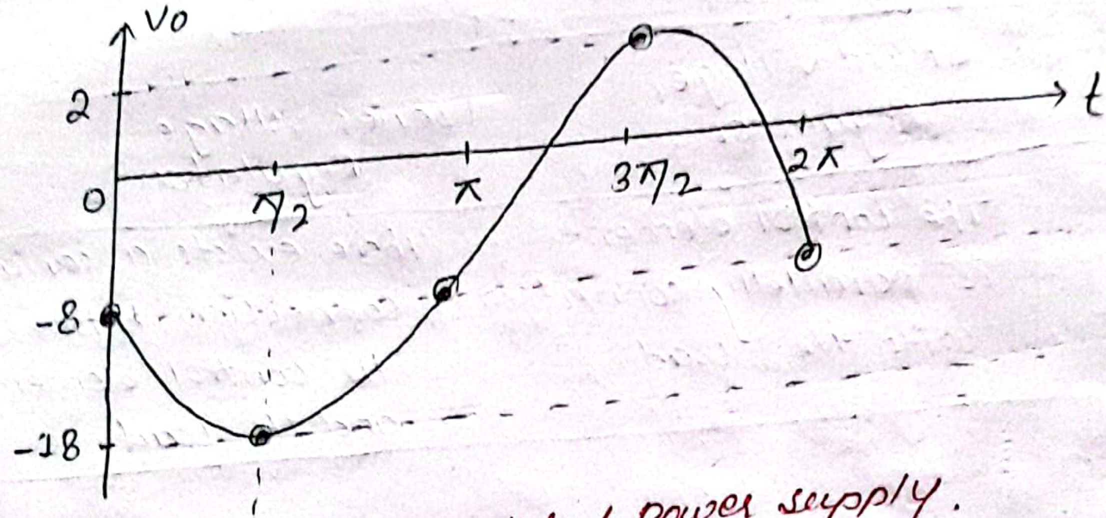
$\Rightarrow \boxed{V_o = -V_{in} - 8}$ — ①

[Vo मा हेर्दा every point मा Vin vary गर्दै गएर Vin को value direct 10V नराखेको]

Now,

t	0	π/2	π	3π/2	2π
Vin	0	10	0	-10	0
Vo	-8	-18	-8	2	-8

Thus, o/p waveform is.



#. Regulated and unregulated power supply.

1. unregulated Power supply.

An unregulated power supply is a system that transforms input voltage into direct current voltage without regulating one constant voltage.

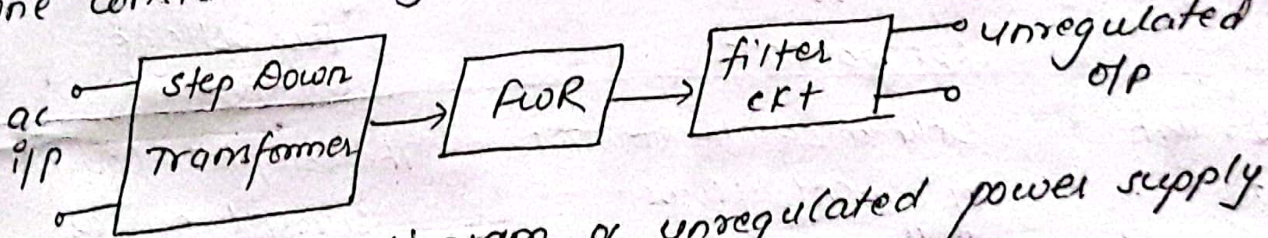


fig: Block diagram of unregulated power supply.

2. Regulated power supply

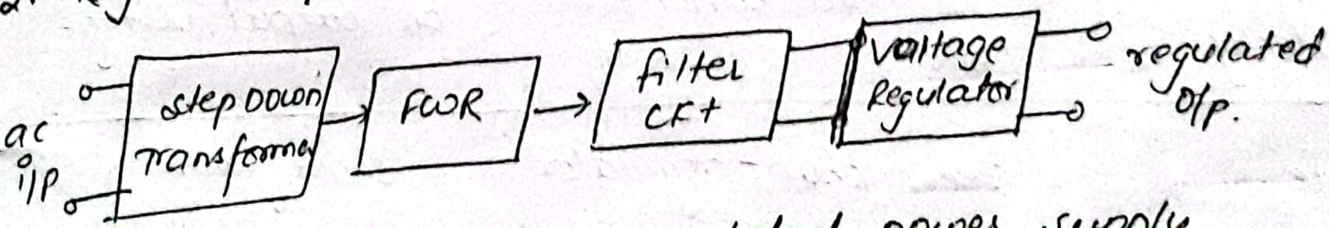


fig: Block diagram of regulated power supply.