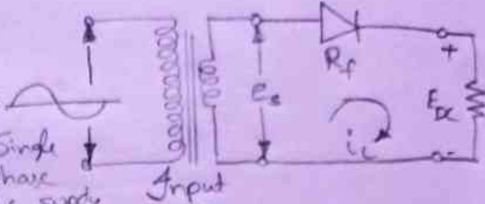
Half Wave Rectifier :-

In half wave Rectifier, rectifying element conducts only during positive half cycle of input a.c supply. The negative half cycle of a.c supply are eliminated from the output

this Rectifier circuit consists of Resistive load, rectifying element i.e p-n junction diode, and the Source of a.c voltage, all connected in Series. The Circuit diagram shown in fig. usually the Rectifier circuits are operated from ac main supply. To obtain the desired d.c Voltage across the load, the ac Voltage is applied to rectifier circuit using suitable step-up (↳ Secondary winding more) or step down (↳ primary winding more) transformer, mostly a step down one with necessary turns ratio



Half wave rectifier

⇒ The Input Voltage to the half wave rectifier circuit is a Sinusodial Voltage, having a frequency which is the supply frequency, 50HZ equal winding : centre tapped.

Operation of the Circuit

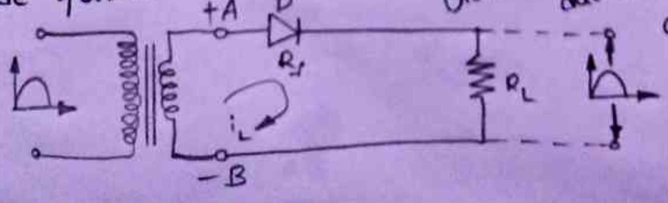
→ During the positive half cycle of Secondary ac voltage, terminal (A) becomes positive w.r.t terminal (B). The diode is forward biased and the Current flows in the Circuit in the clockwise direction. The Current will flow for almost full positive half cycle. This Current is also flowing through Load Resistance R_L hence denoted as i_L, the Load Current. Reverse bias lo output raadhu due to open circuit.

forward bias lo output +ve half cycle vachuw

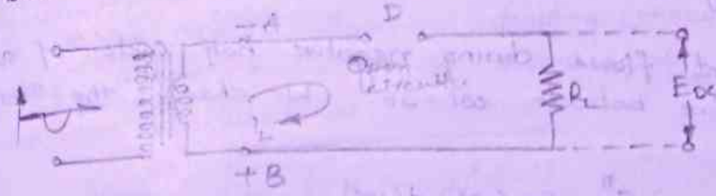
During negative half cycle when terminal (A) is negative w.r.t terminal (B), diode becomes reverse biased. Hence no Current flows in the Circuit. Thus the Circuit Current which is also the load Current, is in the form of half Sinusoidal pulses

a) Diode forward biased

Diode on condition due to forward bias at positive half cycle

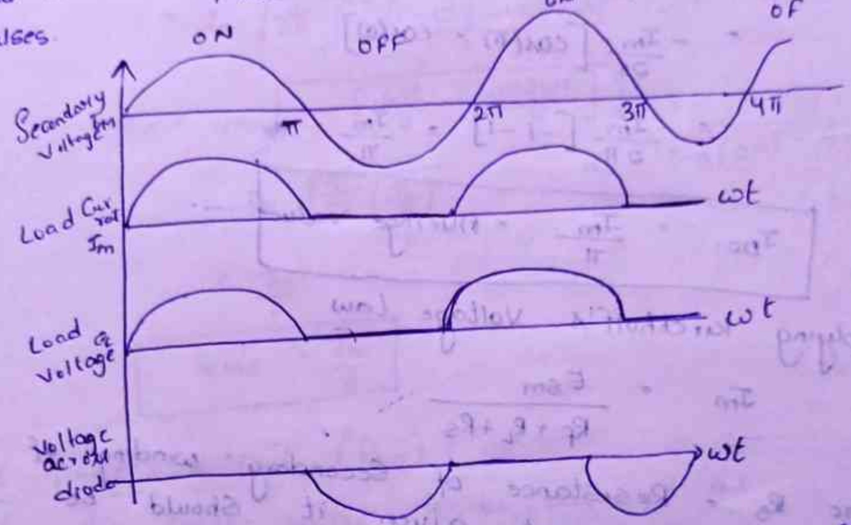


b) Diode Reverse biased :



Diode off Condition due to Reverse bias at Negative cycle

The load voltage, being the product of load current and load resistance, will also be in the form of half sinusoidal pulses



The d.c output waveform is expected to be a straight line but the half wave Rectifier output in the form of positive sinusoidal pulses

Average D.C Load Current (I_{DC})

The Average or d.c values of alternating current is obtained by integration.

For finding out the average value of an alternating waveform, we have to determine the area under the curve over one complete cycle i.e from 0 to 2π and then dividing it by the base i.e 2π

Mathematically current waveform can be described as

$i_L = I_m \sin\omega t$ for $0 \le \omega t \le \pi$

$i_L = 0$ for $\pi \le \omega t \le 2\pi$

I_m = peak value of load current

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

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

⇒ As no current flows during negative half cycle of a.c input voltage, i.e between $\omega t = 2\pi$, we change the limits for integration

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

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

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

$$= -\frac{I_m}{2\pi}\left[-1-1\right] = \frac{I_m}{\pi}$$

$$\therefore \boxed{I_{DC} = \frac{I_m}{\pi} = \text{Average value}}$$

Applying Kirchhoff's Voltage Law

$$I_m = \frac{E_{sm}}{R_f + R_L + R_S}$$

where R_S = Resistance of Secondary winding of transformer. If R_S is not given it should be neglected while calculating I_m

<u>Average</u> <u>D.C</u> <u>Load</u> <u>Voltage</u> (E_{DC})

It is the product of average D.C load current and the load Resistance R_L.

$$E_{DC} = I_{DC} R_L$$

Substituting value of I_{DC} $\qquad I_{DC} = \frac{I_m}{\pi}$

$$E_{DC} = \frac{I_m}{\pi} R_L$$

$$= \frac{E_{sm}}{(R_f + R_L + R_S)\pi} R_L$$

R.M.S Value of Load Current

The R.M.S means squaring, finding mean and then finding square root. Hence R.M.S value of load current can be obtained as,

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

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

$\cos 2\theta = 1 - 2\sin^2\theta$

$2\sin^2\theta = 1 - \cos 2\theta$

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

$$= I_m\sqrt{\frac{1}{2\pi}\left\{\frac{\omega t}{2} - \frac{\sin 2\omega t}{4}\right\}_0^{\pi}}$$

as $\sin(2\pi) = \sin(0) = 0$

$$= I_m\sqrt{\frac{1}{2\pi}\left(\frac{\pi}{2}\right)}$$

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

$$\boxed{I_{RMS} = \frac{I_m}{2}}$$

D.C power output (P_{DC})

The d.c power output can be obtained as

$$P_{DC} = E_{DC} \cdot I_{DC} = I_{DC}^2 R_L$$

$E_{DC} = I_{DC} R_L$

$P_{DC} = I_{DC} \cdot I_{DC} R_L$

$= I_{DC}^2 R_L$

$$\text{D.C power output} = I_{DC}^2 R_L$$

$$= \left[\frac{I_m}{\pi}\right]^2 R_L$$

$$= \frac{I_m^2}{\pi^2} R_L$$

$V = IR$

$I = \frac{V}{R}$

$$P_{DC} = \frac{I_m^2}{\pi^2} R_L$$

$$I_m = \frac{E_{sm}}{R_f + R_L + R_S}$$

$$P_{DC} = \frac{E_{sm}^2 R_L}{\pi^2 [R_f + R_L + R_S]^2}$$

A.C power Input (P_{AC})

The power input taken from the secondary of transformer is the power supplied to the resistances namely load resistance R_L, the diode resistance R_f and winding resistance. The a.c power is given by

$$P_{AC} = I^2_{RMS} [R_L + R_f + R_s]$$

but $I_{RMS} = \frac{I_m}{2}$

$$P_{AC} = \frac{I^2_m}{4} [R_L + R_f + R_s]$$

Rectifier efficiency (η)

The Rectifier efficiency is defined as the ratio of output d.c power to input a.c power

$$\eta = \frac{\text{D.C output power}}{\text{A.C input power}}$$

$$= \frac{P_{DC}}{P_{AC}}$$

$$\eta = \frac{\frac{I^2_m}{\pi^2} R_L}{\frac{I^2_m}{4}[R_f + R_L + R_s]} = \frac{(4/\pi^2) R_L}{R_f + R_L + R_s}$$

$$\eta = \frac{0.406}{1 + \left(\frac{R_f + R_s}{R_L}\right)}$$

If $(R_f + R_s) << R_L$ as mentioned earlier, we get the maximum theoretical efficiency half wave rectifier as

$$\% \eta_{max} = 0.406 \times 100$$
$$= 40.6 \%$$

Thus in half wave rectifier, maximum 40.6 % a.c power gets converted to d.c power in the load. if the efficiency of Rectifier is 40% then what happens to the remaining 60% power; It is present interms of ripples in the output which is fluctuating component present in the output

Key point :- Thus more the rectifier efficiency, less are the tripple contents in the output

Ripple factor (γ)

It is seen that the output of half wave rectifier is not pure d.c but a pulsating d.c. The output contains pulsating components called ripples. ideally there should not be any ripples in the rectifier output. The measure of such ripples present in the output is with the help of a factor called ripple factor denoted by γ. It tells how smooth is the output.

Key point :- Smaller the ripple factor closer is the output to a pure d.c

The ripple factor expresses how much successful the circuit is, in obtaining pure d.c from a.c input

Definition :-

Mathematically ripple factor is defined as the ratio of R.M.S value of the a.c component in the output to the average or d.c component present in the output

$$\text{Ripple factor } \gamma = \frac{\text{R.M.S value of a.c component of output}}{\text{Average or d.c component of output}}$$

Now the output current is composed of a.c component as well as d.c component

Let I_{ac} = r.m.s value of a.c component present in output

I_{DC} = d.c component present in output

I_{RMS} = R.M.S value of total output current

$$I_{RMS} = \sqrt{I_{ac}^2 + I_{DC}^2}$$

$$I_{ac} = \sqrt{I_{RMS}^2 - I_{DC}^2}$$

$$\text{Ripple factor} = \frac{I_{ac}}{I_{DC}} \quad \text{--- as per definition}$$

$$\gamma = \frac{\sqrt{I_{RMS}^2 - I_{DC}^2}}{I_{DC}}$$

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

This is the general expression for ripple factor and can be used for any rectifier circuit

Now for a half wave circuit.

$$I_{RMS} = \frac{I_m}{2} \quad \text{while} \quad I_{DC} = \frac{I_m}{\pi}.$$

$$\gamma = \sqrt{\left(\frac{\left(\frac{I_m}{2}\right)}{\left(\frac{I_m}{\pi}\right)}\right)^2 - 1}$$

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

$$= \sqrt{1.4674}$$

$$\boxed{\gamma = 1.211}$$

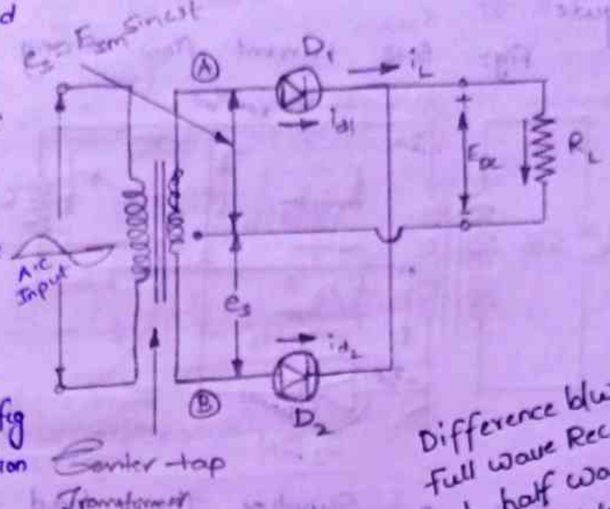
This indicates that the ripple contents in the output are 1.211 times the d.c component 1.211% of dc component.

__Key point__ :-

The Ripple factor for half wave Rectifier is very high which indicates that the half wave circuit is a poor converter of a.c to d.c

Full wave Rectifier

The full wave Rectifier Conducts during both positive and negative half cycles of input a.c supply. In order to rectify both the half cycles of ac input two diodes are used in the Circuit. The diodes feed a Common load R_L with the help of a centre transformer. The a.c voltage is applied through a Suitable power transformer with proper turns ratio.



⇒ The full wave rectifier Circuit is shown in the fig

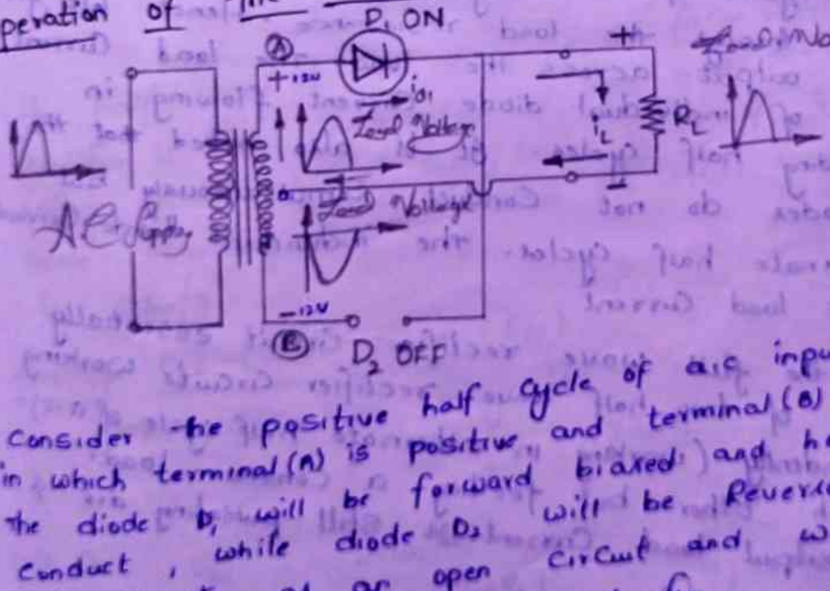
⇒ for the proper operation of the Circuit, a Centre tap on the Secondary winding of the transformer is essential

Difference b/w Full wave Rectifier and half wave

(full wave) Negative cycle - +ve cycle is at output and Central tapped

(Half wave) Negative Cycle - 0V +ve cycle -

operation of the Circuit

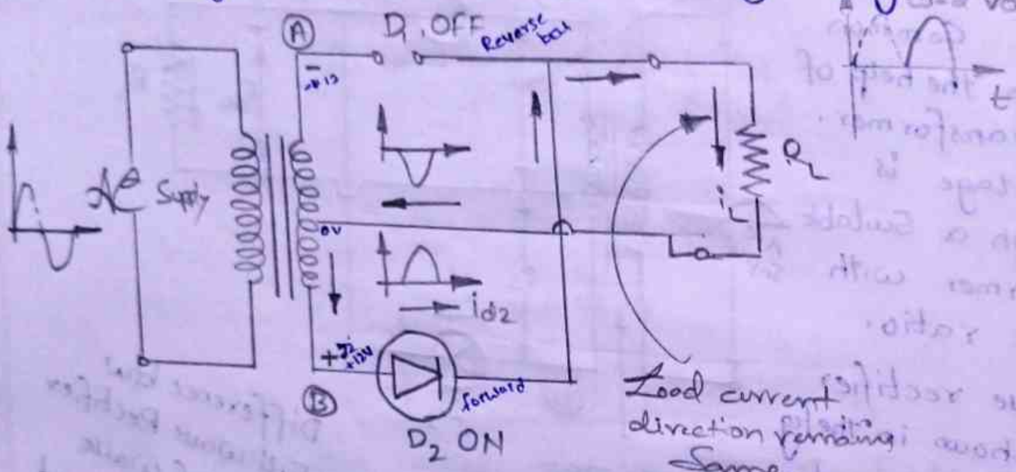


Consider the positive half cycle of a.c input voltage in which terminal (A) is positive and terminal (B) negative. the diode D_1 will be forward biased and hence will conduct, while diode D_2 will be Reverse biased and will act as an open Circuit and will not Conduct. this is illustrated in the fig.

⇒ The diode D_1 supplies the load Current, i.e $i_L = i_{d1}$. This Current is flowing through upper half of Secondary winding while the lower half of Secondary winding of the transformer carries no Current since diode D_2 is reverse biased and act as an open Circuit.

In the next half cycle of a.c voltage, polarity reverses and terminal (A) becomes negative and (B) positive. The diode D_2 conducts being forward biased, while D_1 does not, being reverse biased as shown in figure

Fig:- 5.12 Current flow during negative half cycle

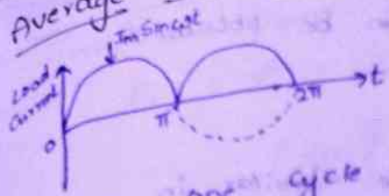


The diode D_2 supplies the load current i.e $i_L = i_{d2}$. Now the lower half of the secondary winding carries the current but the upper half does not.

⇒ It is noted that the load current flows in both the half cycles of a.c voltage and in the same direction through the load resistance. Hence we get rectified output across the load. The load current is sum of individual diode current flowing in corresponding half cycles. It is also noted that the two diodes do not conduct simultaneously but in alternate half cycles. the individual diode currents and the load current

⇒ Thus the full wave rectifier circuit essentially consists of two half wave rectifier circuits working independently (working in alternate half cycle of a.c) of each other but feeding a common load. The output load current is still pulsating d.c & not pure d.c

Average D.C Load Current (I_{DC})



Consider one cycle of the load current i_L from 0 to π to obtain the average value which is d.c value of load current.

$i_L = I_m \sin\omega t \qquad 0 \le \omega t \le \pi$

$$I_{av} = I_{DC} = \frac{1}{\pi}\int_0^{\pi} i_L \, d(\omega t)$$

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

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

$$= \frac{I_m}{\pi}\left[-\cos\pi - (-\cos 0)\right]$$

$$= \frac{I_m}{\pi}\left(+1 - (-1)\right]$$

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

for half wave it is I_m/π and full wave rectifier is the combination of two half wave circuits acting alternatively in two half cycles of input. Hence obviously the d.c value for full wave circuit is $2I_m/\pi$.

Average D.C Load Voltage (E_{DC})

The d.c load voltage is

$$E_{DC} = I_{DC} R_L = \frac{2I_m R_L}{\pi}$$

Sub I_m,
$$E_{DC} = \frac{2E_{sm} R_L}{\pi[R_f + R_s + R_L]} = \frac{2E_{sm}}{\pi\left[1 + \frac{R_f + R_s}{R_L}\right]}$$

But as R_f and $R_s << R_L$

hence $\frac{R_f + R_s}{R_L} << 1$

$$E_{DC} = \frac{2E_{sm}}{\pi}$$

R.M.S Load Current (I_{RMS})

The R.M.S value of Current can be obtained.

$$\therefore I_{RMS} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} i_L^2 \, d(\omega t)}$$

Since two half wave rectifier are Similar in operation we can write.

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

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

$$I_{R.M.S} = I_m\sqrt{\frac{1}{2\pi}\left[[\omega t]_0^{\pi} - \left(\frac{\sin 2\omega t}{2}\right)_0^{\pi}\right]}$$

$$= I_m\sqrt{\frac{1}{2\pi}[\pi - 0]}$$

$$= I_m\sqrt{\frac{1}{2\pi}.(\pi)}$$

$$I.RMS = \frac{I_m}{\sqrt{2}}$$

R.M.S value of the Load Voltage

As the load is resistive, the r.m.s value of the Load Voltage

$$E_{L(RMS)} = I_{R.M.S} \cdot R_L = \frac{I_m}{\sqrt{2}} R_L$$

D.C power output (P_{DC})

$$\text{D.c power output} = E_{DC} I_{DC} = I_{DC}^2 R_L$$

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

$$P_{DC} = \frac{4}{\pi^2} I_m^2 R_L$$

Sub I_m, we get;

$$P_{DC} = \frac{4}{\pi^2} \frac{E_{sm}^2}{(R_S+R_f+R_L)^2} \times R_L$$

power input (P_{AC})

The a.c power input is given by

$$P_{AC} = I^2_{RMS}(R_f + R_S + R_L)$$

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

$$P_{AC} = \frac{I^2_m (R_f + R_S + R_L)}{2}$$

Substituting value of I_m we get,

$$P_{AC} = \frac{E^2_{sm}}{(R_f + R_S + R_L)^2} \times \frac{1}{2} \times (R_f + R_S + R_L)$$

$$P_{AC} = \frac{E^2_{sm}}{2(R_f + R_S + R_L)}$$

Rectifier efficiency (η)

$$\eta = \frac{P_{DC} \text{ output}}{P_{AC} \text{ input}}$$

$$\eta = \frac{\frac{4}{\pi^2} I^2_m R_L}{\frac{I^2_m (R_f + R_S + R_L)}{2}}$$

$$\eta = \frac{8R_L}{\pi^2 (R_f + R_S + R_L)}$$

But if $R_f + R_S << R_L$, neglecting it from denominator

$$\eta = \frac{8R_L}{\pi^2 (R_L)} = \frac{8}{\pi^2}$$

$$\% \eta_{max} = \frac{8}{\pi^2} \times 100 = 81.2\%$$

→ This is the maximum theoretical efficiency of full wave rectifier.

Ripple factor (γ)

As derived earlier in case of half wave rectifier the ripple factor is given by as expression

$$\text{Ripple factor} = \sqrt{\left(\frac{I_{RMS}}{I_{DC}}\right)^2 - 1}$$

for full wave $I_{RMS} = \frac{I_m}{\sqrt{2}}$

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

Substituting the above eqn

$$\text{Ripple factor} = \sqrt{\left[\frac{I_m/\sqrt{2}}{2I_m/\pi}\right]^2 - 1}$$

$$= \sqrt{\frac{\pi^2}{8} - 1}$$

$$\text{Ripple factor} = \gamma = 0.48$$

Key point :- This indicates that the ripple contents in the output component which is much less that for the half wave circuit

/ Bridge Rectifier :-

The bridge rectifier circuits are mainly used as

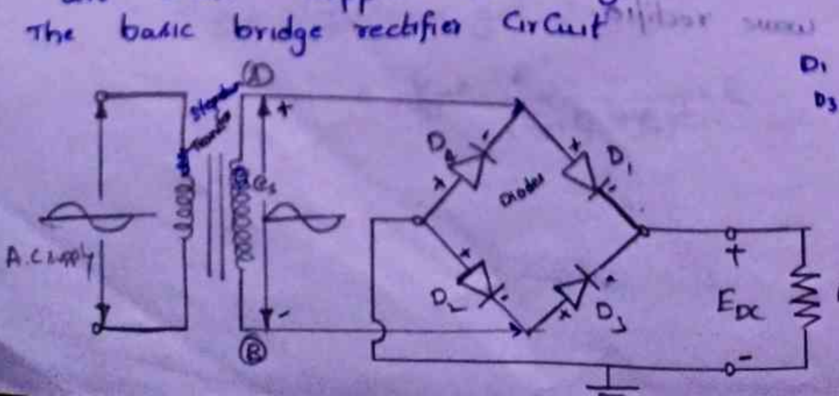
a) A power rectifier circuit for converting a.c power to d.c power, and

b) A rectifying system in rectifier type a.c, meters, such as a.c. voltmeter; in which the a.c voltage under measurement is first converted into d.c and measured with conventional moving meter. In this system, the rectifying elements are either copper oxide type or selenium type

The basic bridge rectifier circuit

D_1, D_2 - F.B
D_3, D_4 - R.B

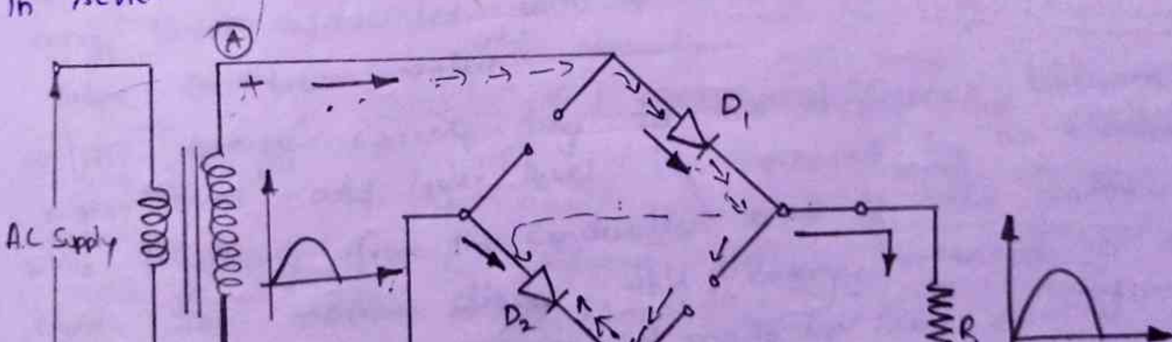
primary winding / Secondary winding



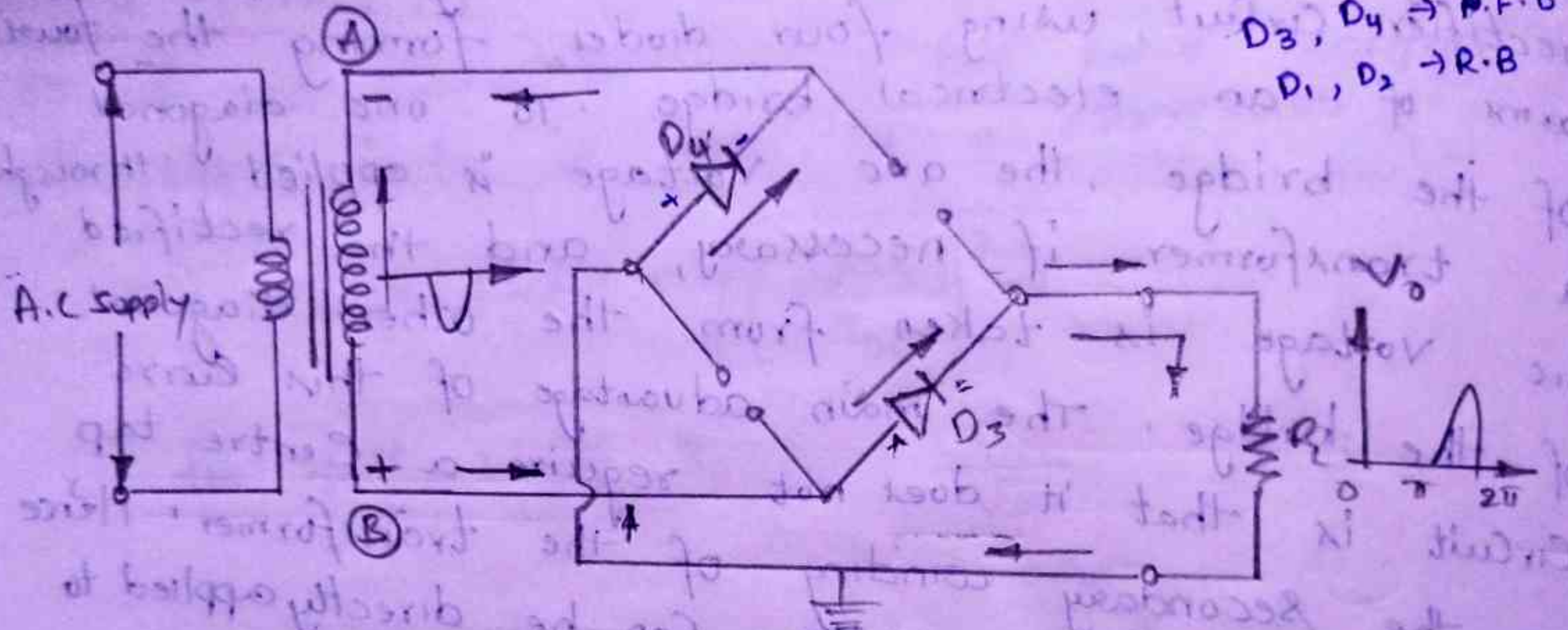
The bridge rectifier Circuit is essentially a full-wave rectifier Circuit, using four diodes, forming the four arms of an electrical bridge. To one diagonal of the bridge, the a.c Voltage is applied through a transformer if necessary, and the rectified d.c voltage is taken from the other diagonal of the bridge. The main advantage of this Circuit is that it does not require a Centre tap on the Secondary winding of the transformer. Hence wherever possible, a.c Voltage Can be directly applied to the bridge.

Operation of the Circuit :-

Consider the positive half of ac input voltage. The point A of Secondary becomes positive. The diode D_1 and D_2 will be forward biased while D_3 & D_4 reverse biased. The two diodes D_1 and D_2 conduct and the Current flows in series with the load



In the next half cycle, when the polarity of a.c Voltage reverses hence point B becomes positive diodes D_3 and D_4 are forward biased, while D_1 and D_2 reverse biased. Now the diodes D_3 and D_4 conduct in series with the load and the Current flows



A
B
A.C supply
D_4
D_3
R_L
V_0
0
π
2π
$D_3, D_4 \rightarrow$ F.B
$D_1, D_2 \rightarrow$ R.B

Filters - when there is a need of constant voltage or current we may use a rectifier and a filter.

- A rectifier converts AC to pulsating DC.
- A filter circuit removes the AC components of rectified output and allows only the DC component to reach the load.
- filters are made of resistors, inductors and capacitors.

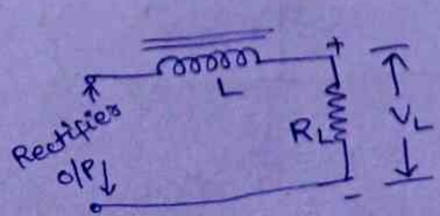
⇒ A capacitor allows AC and blocks DC.

⇒ An Inductor allows DC and blocks AC.

Based on these properties of these passive elements, we can construct different types of filters.

They are
1) L filters (or) Inductor (or) choke filter
2) C filters (or) shunt capacitor filter
3) LC filters (or) L-section filters
4) CLC (or) π - section filters

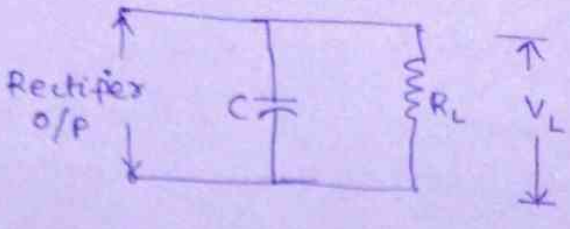
i) **L - filter (choke - filter)** -
- This is also called an Inductor filter (or) choke filter.
- This filter consists of an Inductor in series in between the rectified input and the load resistance R_L.
- The rectified input (rectifier output) consists of AC as well as DC components.
- when the rectified input passes through the inductor filter, the inductor blocks AC and allows DC. will reaches the load.



The ripple factor for a full wave rectifier with Inductor filter

$$\gamma = \frac{R_L}{3\sqrt{2}\,\omega L}$$

2) C-filter (capacitor- shunt filter) -



A capacitor allow AC and blocks DC. Hence a capacitor should be connected in parallel & shunt to the rectifier output then the AC components are reached to the ground and only DC will reach the R_L (load).

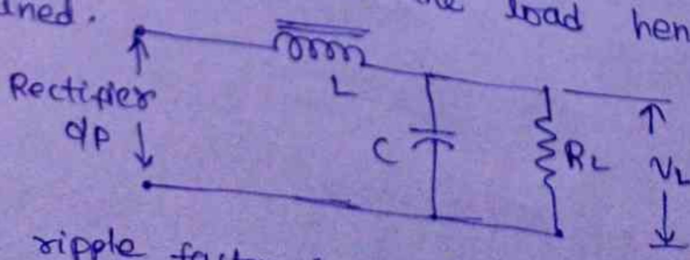
The ripple factor for a full-wave rectifier with a capacitor filter is $\gamma = \frac{1}{4\sqrt{3} f C R_L}$

3) LC - filter -

In L-filters and C-filters we use L, C singly, however they cannot block AC completely.

Hence an Inductor is connected in series and capacitor is connected in parallel in a single circuit.

The series Inductor allow the DC component, if any AC component exists it will be by passed by the shunt capacitor so, DC current passes to the load hence the DC voltage is obtained.

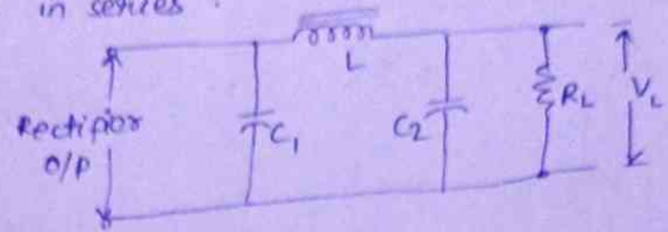


The ripple factor is $\gamma = \frac{1}{6\sqrt{2}\, \omega^2 C L}$

4) CLC filter -

This filter is also called π - section filter.

- It consists of two capacitors in shunt and one inductor in between them in series.



- we can see this CLC filter as the output of a C_1 - filter (C_1) will be given as input to the LC filter (LC_2).

- The ripples (AC components) are much more blocked in the CLC filter.

$$r = \frac{\sqrt{2}}{8\omega^3 C_1 C_2 L R_L}$$

Regulators - a voltage regulator gives a constant DC voltage at its output irrespective of the input voltage fluctuations (or) changes in the load current.

There are 3 types of voltage regulators

- 1) fixed voltage regulators
- 2) adjustable voltage regulators
- 3) switching regulators.

A zener diode is the basic element in the design of voltage Regulators.

we have two types of regulators

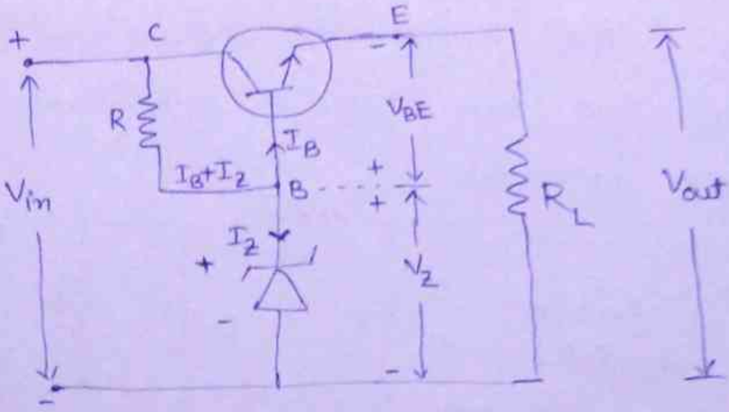
① Discrete transistor regulators

② IC voltage regulators.

Transistor voltage regulators 2 types -

1. Transistor Series voltage regulator
2. Transistor shunt voltage regulator.

1) Transistor Series Voltage Regulator -



- In transistor series voltage regulator, the transistor is connected in series with the Rectifier and filter.
- The transistor acts as a control element and it's connected in series with the load (R_L).

Hence it's referred as Transistor series voltage Regulator.

- The output voltage $V_{out} = V_Z - V_{BE}$

operation -

from the above output voltage equation it's evident that any increase or decrease in the output voltage causes increase or decrease in the V_{BE}, since V_Z is always constant.

case-1: If V_{out} increases ($V_{out} \uparrow$)

$\Rightarrow$ V_{BE} decreases ($V_{BE} \downarrow$)

then $\Rightarrow$ I_B decreases ($I_B \downarrow$)

then $\Rightarrow$ I_C decreases ($I_C \downarrow$)

($\because$ I/P current decreases then o/p current decreases)

$\because$ Transistor is a current controlled device)

if I_C decreases, then V_{CE} increases

This increase in the V_{CE} regulates the V_{out} (o/p) case-2 - if V_{out} decreases ($V_{out} \downarrow$)

then V_{BE} increases

then I_B increases

the I_c increases (∵ I/p current increases then o/p current also increases) in transistors.

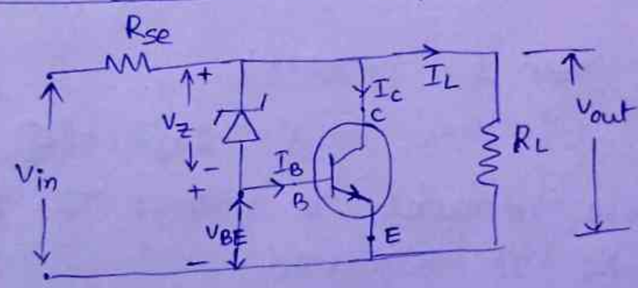
if I_c ~~is~~ increases then

V_{CE} decreases.

the decrease in the V_{CE} will regulate the output voltage V_{out}.

Thus the transistor series voltage regulator maintains constant output voltage with respect to the changes i.e either increase or decrease in the input voltage.

2) Transistor shunt voltage Regulator -



- In this regulator the transistor is connected as a control element in shunt or parallel with the rectifier and filter.

R_L (load) is connected in parallel to the transistor.

- Here R_{se} is connected as current limiting resistance

for a transistor shunt voltage regulator o/p voltage

$$V_{out} = V_z + V_{BE}$$

the input current $I = I_c + I_L$ (Since parallel connection)

- from the above o/p voltage equation

the increase or decrease in the Vout will cause increase & decrease in V_{BE}, Since V_Z is Constant.

Case-1 - if V_{out} increases,

$\Rightarrow V_{BE}$ increases,

$\Rightarrow I_B$ increases

$\Rightarrow I_C$ increases (as transistor is current controlled device)

(i/p ∝ o/p)

$\Rightarrow I_L$ decreases ($\because I = \uparrow I_C + I_L \downarrow$)

as small amount of current flows through the load which restores the value of output voltage V_{out}. thus decreases in I_L will regulate V_{out} (Constant).

Case-2 - if V_{out} decreases,

$\Rightarrow V_{BE}$ decreases,

$\Rightarrow I_B$ decreases,

$\Rightarrow I_C$ decreases ($\because$ transistor is current controlled device

$\Rightarrow$ i/p ∝ o/p)

then I_L increases

($\because I = \downarrow I_C + I_L \uparrow$)

as I_L gets increases it restores the V_{out} Value to make it regulated.

Thus the increase and decreases in the voltage will be regulated by Shunt voltage regulator.

→ Three terminal fixed voltage IC Regulators -

it has 3 terminals namely 1) un-regulated voltage (V_{in})

2) regulated voltage (V_o)

3) common & ground.

Basically there are two types of three terminal fixed voltage regulators IC's.

→ 78XX series - Positive Regulators

→ 79XX series - negative Regulators

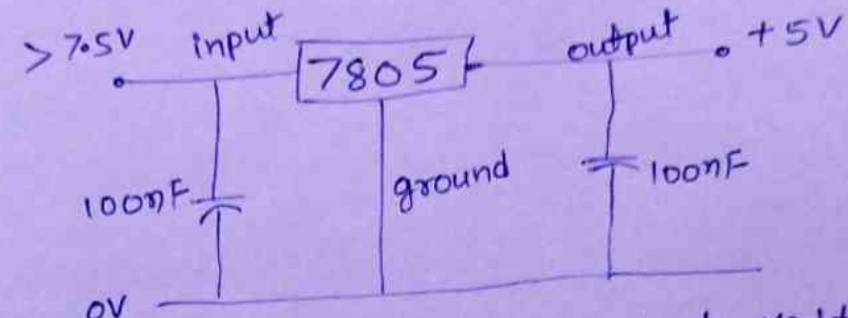
1) 78XX Voltage Regulators -

→ This is a positive voltage regulator. where the first two digits '78' indicates the output voltage is +Ve.

→ the second two digits 'XX' indicates the o/p voltage value.

ex: 7805 (+5V) ; 7812 (+12V), 7815 (+15V)

ex)



it's range is 7.5V to 35V unregulated voltage can be regulated to +5V output voltage.

2) 79XX - negative voltage regulators -

→ This is a negative voltage regulator. where the first two digits '79' indicates the output voltage is -ve and the second two digits 'XX' indicates the the o/p voltage value.

ex: 7905 (-5V); 7912(-12V); 7915 (-15V)