Unit - II

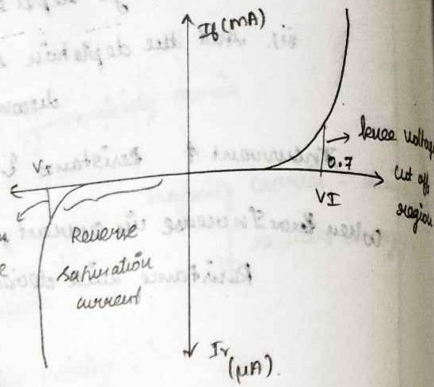
7 - Regulated power supply

Ammeter → In series.

Voltmeter → In parallel.

Barrier potential for Si = 0.7eV

Ge = 0.3eV.



Forward bias → current due to majority carriers.

Reverse bias → current due to minority carriers.

Minority carriers are generated due to temperature which are known as thermally generated carriers.

Reverse saturation current → current flow due to minority carriers in reverse bias.

Static Resistance = $\frac{V}{I}$,

Dynamic Resistance = $\frac{\Delta V}{\Delta I}$ (current ↑; voltage ↓).

Application of Diode,

1). Rectifiers

2). clippers

3). Clampers

4). Voltage Regulator.

5). Modulation / demodulation.

Pre - requisities

Diode → unidirectional device (current flow in one direction).

$\int \sin x\,dx = -\cos x + c$.

$\sin 180° = 0$ $\sin 360° = 0$

$\int \cos x\,dx = \sin x + c$.

$\cos 180° = -1$ $\cos 360° = 1$.

$\sin^2\theta = \frac{1}{2}[1-\cos 2\theta]$. (or) $\frac{1-\cos 2\theta}{2}$

$\cos^2\theta = \frac{1}{2}[1+\cos 2\theta]$. (or) $\frac{1+\cos 2\theta}{2}$.

Block diagram of Linear Power supply.

AC $\rightarrow$ Transformer $\rightarrow$ Rectifier $\rightarrow$ Filter $\rightarrow$ Regulator $\rightarrow$ Load.

Rectifier,

AC input $\rightarrow$ Rectifier $\rightarrow$ DC output

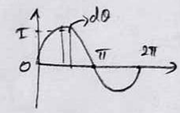
DC $\rightarrow$ 0Hz (0 frequency).

Rectifier — Half wave
— Full wave — Bridge
— centre tap.

AC $\rightarrow$ Magnitude and Direction of the signal keeps on changing.

To represent DC output.

Average value (or) Average value mean $= \dfrac{\text{Area under a half cycle}}{\text{Base length}}$



$I = I_m \sin\theta$.

Area $= \int_0^{\pi} I \, d\theta$.

Area $= I \int_0^{\pi} d\theta$

$\cos\pi = -1$

$\cos 0 = 1$.

$= I[\pi - 0] = I\pi$. $\boxed{\text{Area} = I\pi}$

Area $= \int_0^{\pi} I_m \sin\theta \, d\theta$.

$= I_m \int_0^{\pi} \sin\theta d\theta = I_m [-\cos\theta]_0^{\pi}$

$= I_m [-\cos(\pi) + \cos(0)]$

$360^\circ = 2\pi$

$180^\circ = \pi$.

$= I_m[-(-1) + 1] = I_m(2)$. $\boxed{\text{Area} = 2I_m}$

$\boxed{\text{Mean (or) Average value} = \dfrac{2I_m}{\pi}}$ For DC output.

RMS value, 1). component of AC.

2). Taken for one full cycle.

3). Given AC voltage output must be equivalent, to the output produced by DC voltage.

$$\text{RMS value} = \sqrt{\frac{\text{square area under one full cycle}}{\text{Base length}}}$$

$$\text{Area} = \int_0^{2\pi} I^2 d\theta = \int_0^{2\pi} (I_m \sin\theta)^2 d\theta$$

$$= \int_0^{2\pi} I_m^2 \sin^2\theta \, d\theta$$

$$I^2_m \int_0^{2\pi} \left[\frac{1-\cos 2\theta}{2}\right] d\theta = \frac{I^2 m}{2}\left[\theta - \frac{\sin 2\theta}{2}\right]_0^{2\pi}$$

$$= \frac{I^2 m}{2}\left[(2\pi - 0) - \frac{1}{2}(\sin 2(2\pi) - \sin(0))\right] = \frac{I^2 m}{2}[2\pi - 0].$$

$$= \pi I^2 m.$$

$$\text{Area} = \pi I^2 m.$$

$$\text{RMS} = \sqrt{\frac{I^2_m \pi}{2\pi}}$$

$$\boxed{\text{RMS} = \frac{I_m}{\sqrt{2}}}$$

$\sin 2\pi = 0$.

$$I_{RMS} = 0.707\, I_m.$$

$$V_{rms} = 0.707\, V_m.$$

Ripple factor → Amount of AC produced from DC output.

$$\gamma = \frac{\text{RMS value of AC Component}}{\text{Average (DC) value of output}}$$

$$I_L = I_{ac} + I_{dc}$$

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

$$I^2_{rms} = I^2_{dc} + I^2_{r\,rms}$$ → AC component

$$\gamma = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1} \text{ (ripple factor).}$$

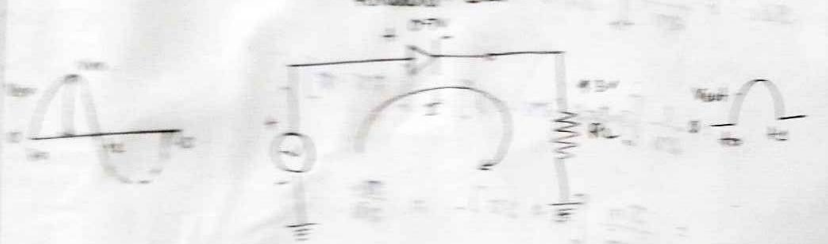
Half wave Rectifier.

- → Working Principle
- → I/P and O/P waveform
- → Positive half cycle
- → Negative half cycle
- → Ripple factor
- → Average value
- → RMS value
- → Form and peak factor
- → Transformer and utilization factor

$$\boxed{V_{dc} \text{ or Average value} = \frac{I_m}{\pi}}$$

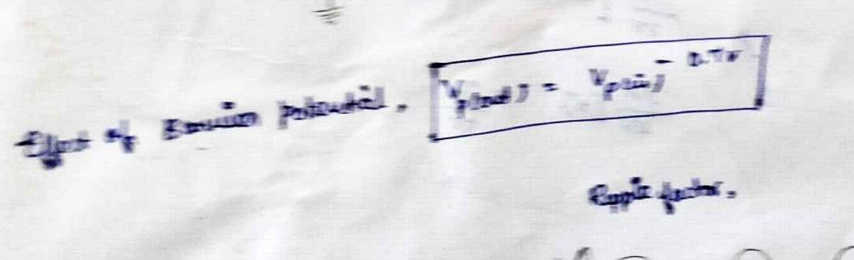
$$r = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}$$

Forward - Bias (Conduct current)



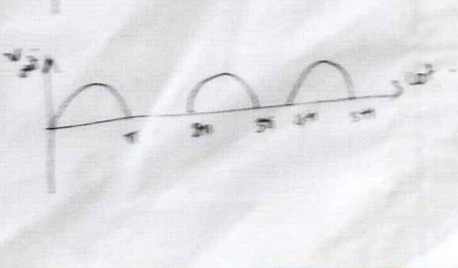
Output pulses can be obtained on the output.

Reverse - Bias (doesn't conduct current)



Effect of Barrier potential. $\boxed{V_{p(out)} = V_{p(in)} - 0.7V}$

Ripple factor.



$$\text{RMS value} = \sqrt{\frac{\text{squared Area under one cycle}}{\text{Base length.}}}$$

$$\text{Area} = \int_0^{2\pi} I^2 d\theta$$

$$= \int_0^{2\pi} (I_m \sin\theta)^2 d\theta$$

$$= \int_0^{2\pi} I_m^2 \sin^2\theta \, d\theta = I_m^2 \int_0^{2\pi} \left[\frac{1-\cos 2\theta}{2}\right] d\theta$$

$$= \frac{I_m^2}{2} \int_0^{2\pi} d\theta - \int_0^{2\pi} (\cos 2\theta) d\theta$$

$$= \frac{I_m^2}{2} \left[\theta\right]_0^{2\pi} - \left[\frac{\sin 2\theta}{2}\right]_0^{2\pi}$$

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

$$\text{Area} = \frac{I_m^2}{2}(2\pi)$$

$$\sqrt{\frac{I_m^2}{2}} = \frac{I_m}{\sqrt{2}} \qquad \text{RMS} = \frac{I_m}{\sqrt{2}}$$

$$\boxed{\text{Root mean square value} = \frac{I_m}{\sqrt{2}}}$$

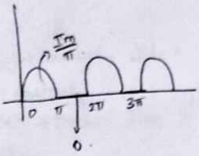
Rectifier :- AC to DC   high voltage → Transformer → low voltage.
↓
220V (household)

Ripple factor.

Average value, $I = I_m \sin\theta$.

$$Area = \int_0^{2\pi} \frac{I\,d\theta}{2\pi}$$

$$Area = \int_0^{\pi} \frac{I\,d\theta}{2\pi} + \boxed{\int_{\pi}^{2\pi} \frac{I\,d\theta}{2\pi}}\ 0$$

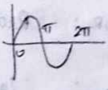


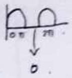
$$= \frac{I_m}{2\pi}\int_0^{\pi} \sin\theta\,d\theta.$$

$$= \frac{I_m}{2\pi}\left[-\cos\theta\right]_0^{\pi} = \frac{I_m}{2\pi}\left[-\cos\pi + \cos 0\right].$$

$$\frac{I_m}{2\pi}\left[1+1\right] = \frac{I_m}{2\pi}(2).$$

$$Area = \frac{I_m}{\pi}\ ,\quad I_{dc} = \frac{I_m}{\pi}.$$





RMS value of half wave,

$$I_{rms} = \sqrt{\frac{\text{squared Area under One Cycle}}{\text{Base length.}}}$$

Since negative half cycle is zero, baselength from π to 2π becomes zero.

$I = I_m \sin\theta$

$$I_{rms} = \sqrt{\frac{\int_0^{2\pi}(I_m\sin\theta)^2\,d\theta}{2\pi}} = \sqrt{\int_0^{\pi}\frac{(I_m\sin\theta)^2 d\theta}{2\pi} + \underbrace{\int_{\pi}^{2\pi}\frac{(I_m\sin\theta)^2}{2\pi}d\theta}_{0}}$$

$$I_{rms} = \sqrt{\frac{I_m^2}{2\pi}}\cdot\sqrt{\int_0^{\pi}\sin^2\theta\,d\theta}.$$

$$\sqrt{\frac{I_m^2}{2\pi}}\cdot\sqrt{\int_0^{\pi}\left[\frac{1-\cos 2\theta}{2}\right]d\theta} = \sqrt{\frac{I_m^2}{2\pi}}\sqrt{\left(\frac{\theta}{2}\right)_0^{\pi} - \frac{1}{2}\left[\frac{\sin 2\theta}{2}\right]_0^{\pi}}$$

$$= \sqrt{\frac{I_m^2}{2\pi}}\cdot\sqrt{\frac{\pi}{2}-\frac{0}{2}} = \sqrt{\frac{I_m^2}{2\pi}}\cdot\sqrt{\frac{\pi}{2}} \Rightarrow \sqrt{\frac{I_m^2}{4}} = \frac{\sqrt{I_m^2}}{2}.$$

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

Ripple factor for half-wave rectifier,

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

SWJMS

SMJWS.

average

$I_{rms} = \frac{I_m}{2}$, $I_{dc} = \frac{I_m}{\pi}$.

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

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

$\frac{1}{2} \times \frac{\pi}{1} = \left(\frac{\pi}{2}\right)^2$

$$\sqrt{\frac{\pi^2}{4} - 1} = \sqrt{\frac{3.14 \times 3.14}{4} - 1}.$$

$$= \sqrt{\frac{9.8596}{4} - 1}. = \sqrt{2.4649 - 1}$$

$$= \sqrt{1.4649}$$

$$\boxed{\gamma = 1.21}$$

Ripple factor high AC component will also be high.

HWR ; Rectifis half of the cycle.

Efficiency, (gain).

$$\eta = \frac{\text{dc output power}}{\text{AC input power}} = \frac{P_{dc}}{P_{ac}}.$$

$P = VI$. $\boxed{P = \frac{V^2}{R}}$

$V = IR$.

$P = (IR)I$.

$\boxed{P = I^2 R}$

$$\frac{\frac{(V_{dc})^2}{R_L}}{\frac{(V_{rms})^2}{R_L}} = \frac{\left(\frac{V_m}{\pi}\right)^2}{\left(\frac{V_m}{2}\right)^2}. \quad \frac{\frac{(I_{dc})^2}{R_L}}{\frac{(I_{rms})^2}{R_L}} = \frac{\left(\frac{I_m}{\pi}\right)^2}{\left(\frac{I_m}{2}\right)^2}.$$

$$\frac{4}{\pi^2} = 0.406 = 40.6\%.$$

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

$\left(\frac{V_m}{\pi}\right)^2 \times \left(\frac{2}{V_m}\right)^2.$

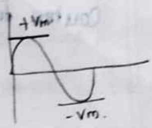
$= \frac{4}{\pi}.$

conversion efficiency is low because we are not gonna take the another half cycle.

Ripple factor refers to the no. of ripples in them more the ripple factor value.

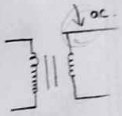
$\boxed{\text{Form factor or Ripple factor.}}$

Peak Inverse Voltage,



Maximum reverse voltage - Vm.

Transformer utilization factor.



$$TUF = \frac{\text{dc power delivered to the load}}{\text{ac rating of the transformer secondary}}.$$

$$= \frac{P_{dc}}{P_{ac\ rated}}.$$

(dc) → Average, $I_{dc} = \frac{I_m}{\pi}$
↳ (output).
(AC) → RMS, $I_{rms} = \frac{I_m}{2}$.
(input)

$$TUF = \frac{\frac{I^2m}{\pi^2} R_L}{\frac{V_m}{\sqrt{2}} \times \frac{I_m}{2}} = \frac{\frac{V^2m}{\pi^2} \cdot \frac{1}{R_L}}{\frac{V_m}{\sqrt{2}} \frac{V_m}{2R_L}.} = \frac{2\sqrt{2}}{\pi^2} = 0.287.$$

$$\left(\frac{V^2m}{\pi^2} \times \frac{1}{R_L}\right) \times \left(\frac{2}{V_m} \times \frac{2R_L}{V_m}\right).$$
$$= \frac{4}{\pi^2}$$

$$\boxed{TUF = 0.287}$$

Form Factor, → (smoothness of the waveform).

∴ Form factor ↑ waveform is not smooth it has more ripple factor.

$$\text{Form factor} = \frac{\text{rms value}}{\text{average value}}.$$

$$= \frac{V_m/2}{V_m/\pi} = \frac{V_m}{2} \times \frac{\pi}{V_m} = \frac{\pi}{2}. = 1.57.$$

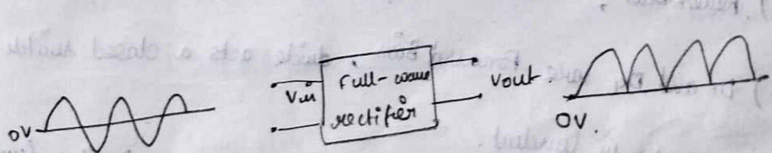
$$\boxed{\text{Form factor} = 1.57}$$

Peak factor,

$$\text{Peak factor} = \frac{\text{Peak value}}{\text{rms value}} = \frac{V_m}{V_m/2} = 2.$$

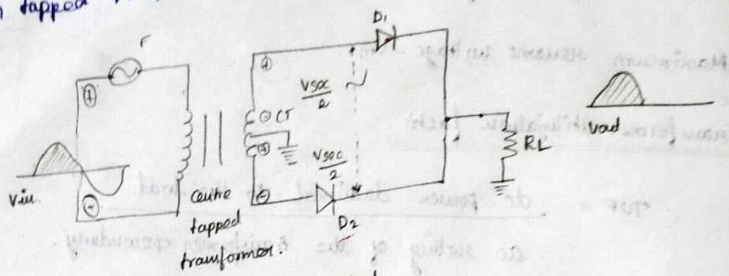
$$\boxed{\text{Peak factor} = 2}$$

Full wave rectifier, rectifies both the positive / Negative cycle.



Pulsating dc.

Centre tapped FWR, consists of two diode.



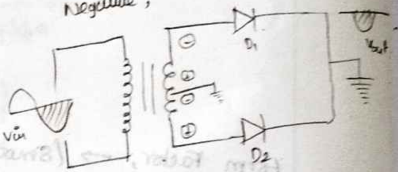
Positive half cycle → D_1 conducts

Case (i), Positive half cycle,

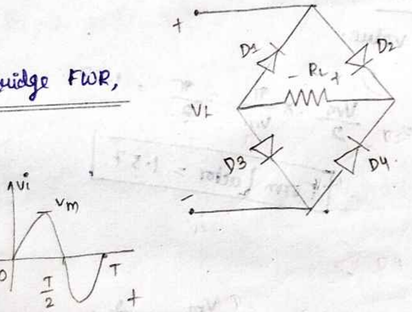
(i). D_1 is Forward biased. (D_1 acts as closed switch and
(ii). D_2 is Reverse biased. output can be driven through the load resistance).

Case (ii), Negative half cycle,

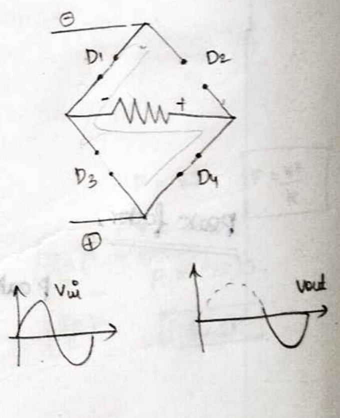
(i). D_2 is Forward Biased.
(ii). D_1 is Reverse Biased.



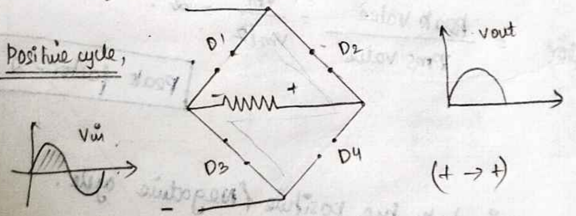
Bridge FWR,



Negative cycle,



Positive cycle,



(− to +). Reverse bias, diode act as open switch and does not conduct.

(− to −) D_1 and D_4 are Forward bias, diode acts a closed switch and thus results in Conduct.

D_2 and D_4 are short circuit, (current flows).

Case (i), positive halfcycle, D_1 and D_3 are Forward Biased, (no current flow)

Case (ii), Negative half cycle, D_2 and D_3 are Forward Biased (no current flow).

D_1 and D_4 are short circuited (which current flows).

Problem: 2.

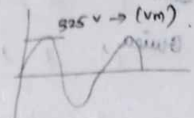
A HWR. having a resistive load of 1000 Ω, rectifies an alternating voltage of 325 V peak value and the diode has a forward resistance of 100 Ω.

Calculate, a). peak, average, and rms values of current.

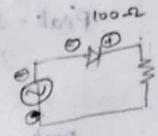
b). dc power output.

c). ac input power.

d). efficiency of the rectifier.



Given,



Average, $\frac{I_m}{\pi}$ Peak, $= \frac{\text{Peak value}}{\text{Rms.}} = \frac{V_m}{V_m/2}$

rms, $\frac{I_m}{2}$

$= \frac{325}{I_m/2}$, $325 \times \frac{2}{I_m}$

efficiency, $\eta = \frac{\text{dc output}}{\text{Ac input}}$

$\frac{325}{325/2} \times \frac{325 \times 2}{325} = \underline{\underline{2}}$

$\boxed{\text{Peak value} = 2}$

$V_m = \frac{I_m}{R}$ AV $= \frac{325}{\pi}$, rms, $\frac{325}{2} = 162.5$.

$\frac{325}{1000} = I_m$

$0.325 = I_m$

162.5 $\frac{325}{2}$

positive half cycle, (Forward bias)

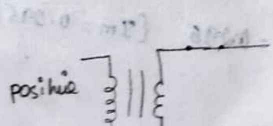
→ D_1 and D_3 are open circuited through which no current flow occurs.

→ D_2 and D_4 are short circuited through which current flow occurs.

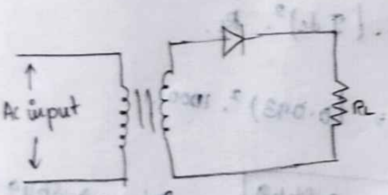
Negative half cycle, (Reverse bias)

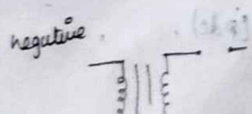
→ D_1 and D_4 are short circuited through which the current flow occurs.

→ D_2 and D_3 are open circuited through which current flow does not occur.



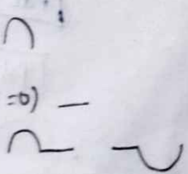
→ In a Forward bias condition, when the diode is conductivity then it can replaces by its resistance.



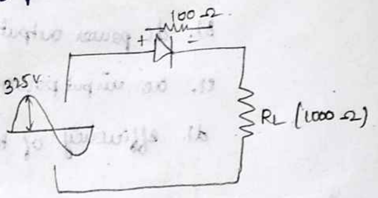


1). Positive - short circuit.

2). negative - open circuit (v = 0)



Q. A Hook, having a resistive load of $1000\,\Omega$, rectifies an alternating voltage of 325V peak value and the diode has a forward resistance of $100\,\Omega$. calculate, a). peak, average and rms value of the current. b). dc power output. c). ac input power. d). efficiency of the rectifier



Soln.

Given,

$$\text{Peak} = \frac{\text{dc output}}{\text{AC input}} = \frac{V_m}{\cdot}$$

$$\text{Peak} = \frac{\text{Peak value}}{\text{rms value}} = \frac{V_m}{V_m/2} = 2.$$

efficiency, $\eta = \frac{P_{dc}}{P_{ac}}$.

(dc) Average $= \frac{I_m}{\pi}$

(AC) rms $= \frac{I_m}{2}$.

$V_m = 325V$

$r_f = 100\,\Omega$.

$R_L = 1000\,\Omega$.

$R_T = 1000 + 100$,

$\boxed{R_T = 1100\,\Omega}$

Ohm's law,

$V = IR.$

$V_m = I_m R.$

$\frac{V_m}{R} = I_m.$

$V_m = 325V$, $R_T = 1100$

$\frac{325}{1100} = I_m.$

$\boxed{0.295A = I_m}$

$I_m = 0.295$ (peak).

a). (i). Average, $\frac{I_m}{\pi} = \frac{0.295}{3.14} = 0.093.$ (I_{dc})

$I_{dc} = 0.093A$

(ii). rms, $\frac{I_m}{2} = \frac{0.295}{2} = 0.1475.$ (I_{ac}).

$I_{ac} = 0.1475$ A.

(iii). Peak, $\frac{I_m}{V_m/2} = 0.295$ $(I_m = 0.295)$.

b). dc power output, (P_{dc}).

$P_{dc} = (I_{dc})^2 . R_L.$

$= (0.093)^2 . 1000.$

$\boxed{\cancel{P_{dc} = 0.8649}}$

~~Pdc = 0.8649 W.~~

$\boxed{P_{dc} = 8.649\,W}$

2). Ac input power,

$$P_{ac} = (I_{rms})^2 \cdot (R_f + R_L).$$

$$= (0.1475)^2 \cdot (1100).$$

$$\boxed{P_{ac} = 23.93W}$$

3). efficiency,

$$\eta = \frac{P_{dc}}{P_{ac}} = \frac{\cancel{0.8649}}{23.93} \cdot \frac{8.649}{23.93}$$

$\cancel{\boxed{\eta = 0.03}} \cancel{= 36.8\%}$ $\boxed{\eta = 37.6\%}$

21). A HWR is used to supply 24V dc to $R_L = 500\Omega$ and the diode has a forward resistance, $r_f = 50\Omega$. Calculate the maximum value of ac voltage required at input.

Soln. max value of AC voltage = V_m.

$R_L = 500\Omega$.

$R_f = 50\Omega$.

$V_{dc} = 24V$.

$V_m = I_m \cdot R$.

$V_m = I_m(R_L + R_f)$.

$$V_{dc} = \frac{V_m}{\pi}.$$

$24 \times \pi = V_m$.

$$\boxed{V_m = 75.36V}$$

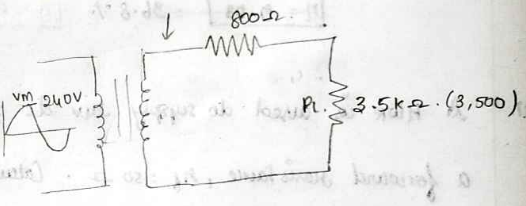
3). An HWR has a load of 3.5 kΩ. If the diode resistance and secondary coil resistance together have a resistance of 800 Ω and the input voltage has a signal voltage of peak value of 240 V, calculate,

a). peak, average, rms values of current flowing.

b). dc power output

c). Ac power input.

d). efficiency of the rectifier.



Given,

$V_m = 240\,V$.

$R_f = 800\,\Omega$.

$R_L = 3.5\,k\Omega$

$= 3.5 \times 1000 = 3500\,\Omega$.

$V = IR$.

$R_T = R_L + R_f$.

$= 3500 + 800$.

$R_T = 4300$.

$V = IR$

$R_f + R_L$

$\frac{V_m}{R} = I_m \Rightarrow \frac{240}{4300} = 0.055A$

(i). Peak, I_m, $\frac{240}{4300} = 0.055A$.

(ii). rms, $\frac{I_m}{2} = \frac{0.055}{2} = 0.027\,A$.

(iii). Average, $\frac{I_m}{\pi} = \frac{0.055}{3.14} = 0.0177\,A$

(iv). dc power output, $P_{dc} = (I_{dc})^2 . R_L$.

$= (0.0177)^2 . 3500$.

$P_{dc} = 1.09\,W$.

(v). ac power input, $P_{ac} = (I_{rms})^2 . 4300$.

$= (0.027)^2 . 4300$.

$P_{ac} = 3.25\,W$.

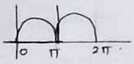
(vi). efficiency, $\frac{P_{dc}}{P_{ac}} = \frac{1.09}{3.25} = 0.335 \times 100$

$\eta = 33.5\,\%$.

Ripple factor full wave Rectifier.

Average value.

Mean (or) Average value $= \dfrac{\text{Area under a half cycle.}}{\text{Base length.}}$



$I = I_m \sin\theta.$

$\text{Area} = \int_0^{\pi} I \cdot d\theta.$

Average, $A = \int_0^{\pi} \dfrac{I_m \sin\theta \, d\theta}{\pi}$

$= \dfrac{I_m}{\pi} \int_0^{\pi} \sin\theta \, d\theta = \dfrac{I_m}{\pi} [-\cos\theta].$

$\dfrac{I_m}{\pi} [-\cos(\pi) + \cos(0)]$

$\dfrac{I_m}{\pi} (2).$

$$\boxed{\text{Average},\ I_{dc} = \frac{2I_m}{\pi}}$$

$\text{Area} = \int_0^{\pi} I_m \sin\theta \, d\theta.$

$I_m \int_0^{\pi} \sin\theta \, d\theta.$

$I_m (-\cos\theta)_0^{\pi}$

$I_m [-\cos(\pi) + \cos(0)].$

$I_m [-(-1) + 1] = I_m (2).$

$$\boxed{\text{Area} = 2I_m.}$$

RMS value,

RMS value $= \sqrt{\dfrac{\text{squared area under one cycle}}{\text{Base length.}}}$

$\text{Area} = \int_0^{\pi} I^2 . d\theta.$

$\text{Area} = \int_0^{\pi} I_m^2 \sin^2 d\theta.$

$= I_m^2 \int_0^{\pi} \sin^2\theta \, d\theta.$

$= I^2 m^2 \int_0^{\pi} \left[\dfrac{1 - \cos 2\theta}{2}\right] d\theta.$

$= I^2 m \left[\dfrac{\theta}{2} - \dfrac{\sin 2\theta}{4}\right]_0^{\pi}$

$I^2 m \left[\dfrac{\pi - 0}{2} - \left[\dfrac{\sin 2(\pi)}{4} - \dfrac{\sin 2(0)}{4}\right]\right].$

$I^2 m \times \dfrac{\pi}{2}.$

$$\boxed{\text{Area} = \frac{I_m^2 \pi}{2}.}$$

RMS value, $\sqrt{\dfrac{\frac{I^2 m \pi}{2}}{\pi}} = \sqrt{\dfrac{I^2 m}{2}}.$

RMS value $= \dfrac{I_m}{\sqrt{2}}.$

$$\boxed{\text{RMS value } (I_{ac}) = \frac{I_m}{\sqrt{2}}}$$

Ripple factor of full wave rectifier.

$$I_{dc} = \frac{2I_m}{\pi}, \quad I_{rms} = \frac{I_m}{\sqrt{2}}.$$

$$\frac{2\sqrt{2}\times 2\sqrt{2}}{4\times 2} = 8$$

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

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

$$= \sqrt{\left(\frac{\pi}{2\sqrt{2}}\right)^2 - 1} = \sqrt{\frac{\pi^2}{8} - 1}.$$

230v - rms (ac)

$$\sqrt{\frac{9.85}{8} - 1} = \sqrt{0.232} = 0.482.$$

$$\boxed{\gamma = 0.48}$$

Comparing with HWR,

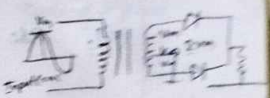
Peak Inverse - Maximum reverse voltage. voltage.

> full wave rectifier got some reduced value, as compared to HWR, and has less AC component.

Comparison b/w HWR and FWR :-

	HWR	Center tapped	Bridge Rectifier.
no. of diodes.	1	2	4
Max efficiency	40.6	81.2	81.2.
Vdc	$\frac{V_m}{\pi}$	$\frac{2V_m}{\pi}$	$\frac{2V_m}{\pi}$.
Ripple factor.	1.21	0.48	0.48
PIV	Vm	2Vm	Vm.
TUF	0.287.	0.693	0.812
Form factor	1.57	1.11	1.11.
Peak factor.	2	$\sqrt{2}$	$\sqrt{2}$.

1). An 230V, 60Hz voltage is applied to the primary 5:1 centred tapped step down transformer used in a FWR have a load 900 Ω, diode resistance + secondary coil together has a R of 100 Ω. determine,



1). DC voltage across the load. (Vdc) → voltage

2). DC current flowing through the load (Idc).

3). DC power delivered to the load.

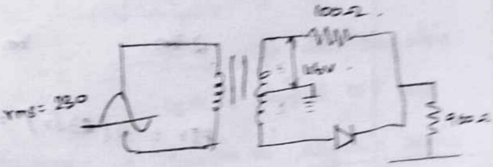
4). Peak inverse voltage across each diode.

5). Ripple voltage.

6). Efficiency.

$V_{dc} \rightarrow$ voltage

$I_{dc} \rightarrow$ current



Given, $V_{rms} = 230V$.

$r_f = 900\Omega$.

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

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

$\frac{N_1}{N_2} = \frac{V_1}{V_2}$ → Pri-volt, → Sec volt (N₁ → Pri turn, N₂ → Sec turn)

$\frac{2V_m}{\sqrt{2}} = 46V$.

$\frac{5}{1} = \frac{230}{V_2} = \frac{230}{5} = 46$.

$\frac{V_m}{\sqrt{2}} = \frac{46}{2} = 23$ $\boxed{V_m = 23\sqrt{2}}$

$\frac{5}{230} = V_2$. $\boxed{V_2 = 46V}$

$\boxed{V_m = 23\sqrt{2}}$

$\underline{V_{rms} = 46V}$

$V_2 = (\text{sec in rms})$.

$\underline{V_{rms} = 46V}$

$V_{dc} = \frac{2I_m}{\pi}$ (or) $\frac{2V_m}{\pi}$.

(i). $V_{dc} = \frac{2V_m}{\pi}$

$= \frac{2(23\sqrt{2})}{3.14} = \frac{65.05}{3.14}$

$V = IR$.

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

$R = R_1 + R_2$

$I = \frac{V}{R_1 + R_2}$.

$\boxed{V_{dc} = 20.71V}$

(ii). $I_{dc} = \frac{V_{dc}}{\underbrace{R_s + r_f}_{100} + \underbrace{R_L}_{900}}$

$I_{dc} = \frac{V_{dc}}{1000\Omega}$. $= \frac{20.71}{1000} = \frac{20.7}{10^3} = 20.7 \times 10^{-3} A$. (or) $20.7 mA$.

$\boxed{I_{dc} = 20.7 mA}$.

(iii). Pdc,

$V = IR$.
$V_{dc} = I_{dc} R$
$\frac{V_{dc}}{I_{dc}} = R$

$$P_{dc} = \frac{V_{dc}}{I_{dc}}$$

$P_{dc} = I^2_{dc} R$.
$P_{dc} = \frac{V^2_{dc}}{R}$.

$$P_{dc} = I^2_{dc} R.$$

$$P_{dc} = (20.7 \times 10^{-3})^2 (900) \Rightarrow (4.28 \times 10^{-4}) 900.$$

$$\boxed{P_{dc} = 0.385}$$

(iv). Peak inverse voltage,

$$2V_m. \qquad V_m = 23\sqrt{2}.$$

$$PIV = 2(23\sqrt{2}) = 65.05 \qquad \boxed{PIV = 65.05}$$

(v). Ripple voltage,

$$\sqrt{(V_{rms})^2 - (V_{dc})^2}.$$

$$\sqrt{(46)^2 - (20.7)^2} = \sqrt{2116 - 428.9}$$

$$= \sqrt{1687.4}$$

$$= 41.07$$

(vi). Efficiency,

$$\eta = \frac{\text{dc output}}{\text{ac input}} = \frac{\left(\frac{(V_{dc})^2}{R_L}\right)}{\left(\frac{(V_{ac})^2}{R_L}\right)} = \frac{(V_{dc})^2}{(V_{ac})^2} = \left(\frac{V_{dc}}{V_{ac}}\right)^2.$$

$$= \frac{(20.7)^2}{(46)^2} = \frac{428.9}{2116} = 0.202.$$

$$\boxed{\eta = 0.202}$$

$$\eta = 0.202 \times 100$$

$$\boxed{\eta = 20.2\%}$$

①. clipper :- it clips the positive or negative region of the applied signal. In electronic circuit.

Depending on the Orientation of the diode.

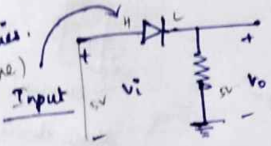
Types of clippers,
- (i). Series
- (ii). Parallel.

[wave shaping circuit (or) limiters] → For clippers

Series, Diode is in series with load / source. → it can do in any wave form

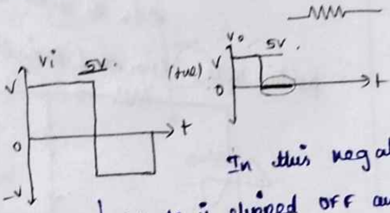
Series.

(+ve)



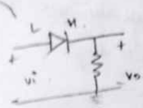
Case (i).

(+ve)



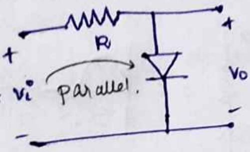
In this negative cycle is clipped OFF and known as Negative series clipper.

(-ve) diode act as open switch and does not conduct

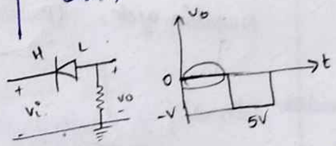


Series clipper.

Parallel, Diode in a branch parallel to the load.



Case (ii).



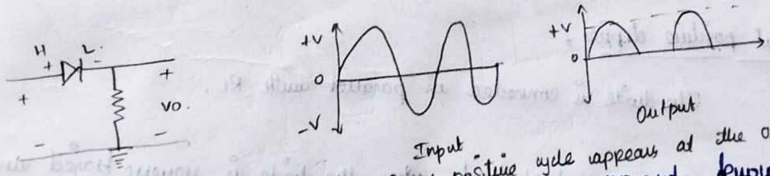
In this case, the positive cycle is clipped OFF and known as positive series clipper.

(i). diode conduct → act like closed switch.

(ii). diode does not conduct → act like open switch.

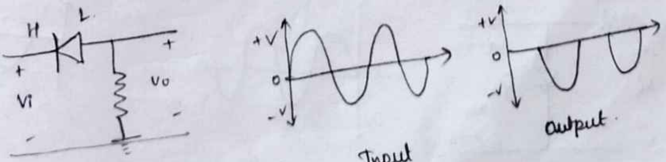
Case (i), In this negative cycle is clipped off and known as negative series clipper (Forward bias).

↓ current flows the diode.



Positive half cycle is allowed at output. a series of positive cycle appears at the output

Case (ii), In this case, the positive cycle is clipped OFF and known as positive series clipper. (reverse bias).

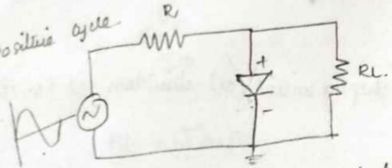


The diode D is reverse biased during the positive cycle.

During RB, no current flow through the diode, so positive half cycle is blocked at the output.

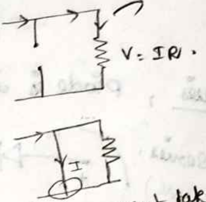
Parallel clipper (or) Shunt clipper.

Open circuit → voltage will be high. current is low.



Current always take least resistance path.

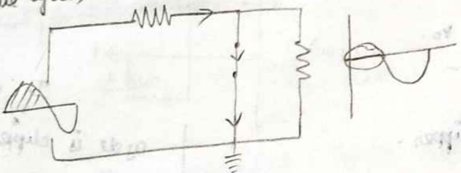
Forward bias → diode conducts → acts as closed switch



→ Voltage will be high.

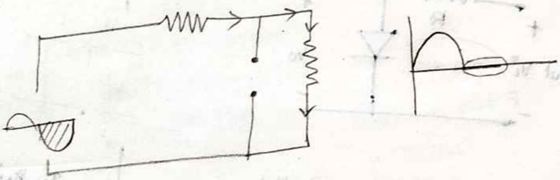
↳ current take path in there direction and voltage will be zero and current will high

positive cycle, (Forward Biased)



In this case, voltage will be zero.

Negative cycle, (Reverse Biased)



In this voltage will be high.

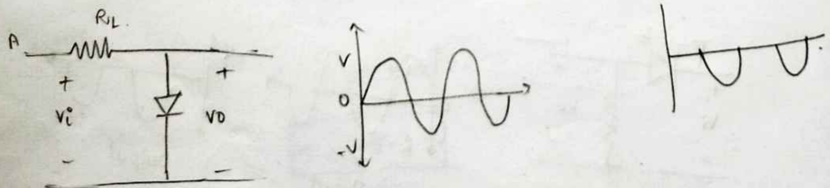
Forward Bias → diode conducts → acts as closed switch.

Reverse Bias → diode does not conduct → acts as open switch

Shunt positive clipper,

The diode is connected in parallel with RL.

passes. Input signal to output load, when the diode is reverse biased and blocks the input signal when the diode is forward biased.



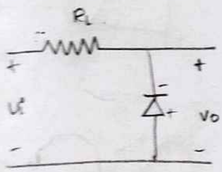
Parallel positive clipper.

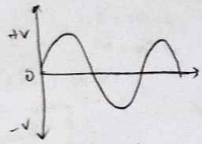
Shunt positive clipper,

(i). positive half cycle the diode is forward biased (no current) → no output generated.

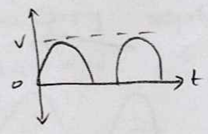
(ii). negative half cycle, the diode is reverse biased (current flow) → negative half cycle generated.

Shunt negative clipper.





Input



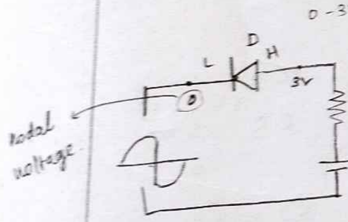
output

(i) Positive half cycle the diode is reverse biased and positive half cycle is generated.

(ii) negative half cycle the diode is forward bias and no current flow (no output).

→ Bias - Applying an external DC supply.

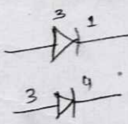
$0 - 3V = -3$



3v (Biasing voltage).
an extra DC current.

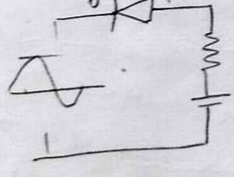
The difference of potential between two different point is known as the potential difference.

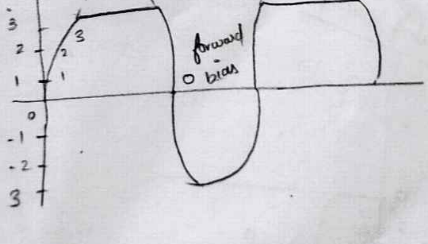
If the diode has high positive value and low negative value, then it is forward biased.

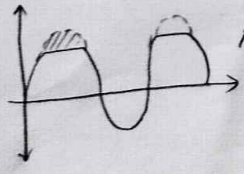


(Forward biased) → closed switch

(Reverse biased) → Open switch

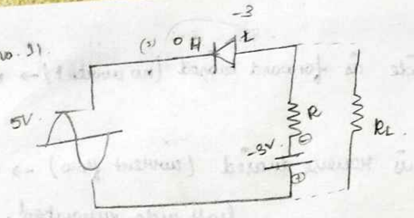


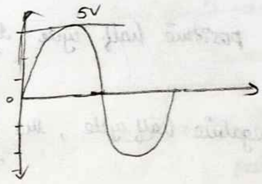


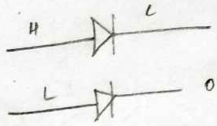


series
Positive clipper.

Ques. 1)

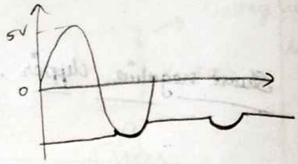


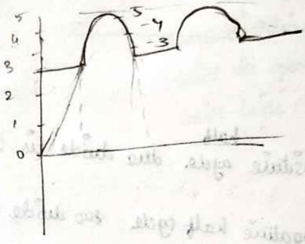




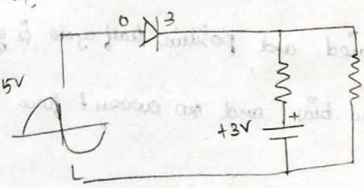
ON (Forward / closed)

OFF (Reverse / Open)





Ques. 2)



Anode has to be more positive than the cathode.

3 2 → (FB)

1 -2 → (RB).

-2

6 - 3

5 - 3 → FB

4 - 3

2 - 3 RB

1 - 3

0 - 3

(FB). ← -3

-4 - 3 → RB

-5 - 3 → RB.

F.B - + +

R.B - + ~~+~~

$V_o = V_i - V_m$.

$V_i = 0 \quad = 0 - 5 = -5$

$V_i = 3 \quad = 3 - 5 = -2$

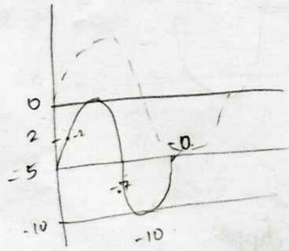
$V_i = 5 \quad = 5 - 5 = 0$

$V_i = -2 \quad = -2 - 5 = -7$.

$V_0 = -5 \quad = -5 - 10 = -10$.

$V = -10 \quad = -10 - (-10) = 0$.

Negative clamper:



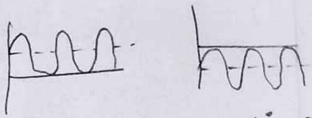
CLAMPERS :

→ Diode upward - positive clamper.
→ Diode downward - Negative clamper

1). Its an electronic device, which can pull either upwards or downwards without changing the shape of the wave by an external DC is applied.

2). It is also known as DC restorer.

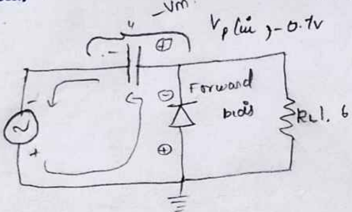
3). Two types, positive clamper
Negative clamper.



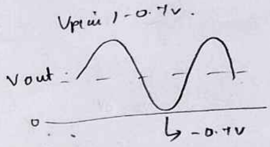
positive clamper   Negative clamper.

Clamper Circuit.

$6 = 10 - 4$
$V_o = V_i - V_R$



(i).



positive clamper.

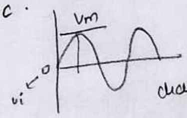
$V_i = +ve$, $D = RB$
$V_i = -ve$, $D = FB$.

→ positive half cycle - Reverse bias.

→ Negative half cycle - Forward bias - closed switch - current always choose the least resistant path. → [capacitor charge to the Negative maximum] -Vm.

$$V_o = V_i - \underbrace{(-V_m)}_{DC}$$

$$\boxed{V_o = V_i + V_m}$$



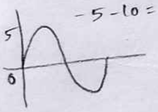
charges to
Negative HC = $-V_m$

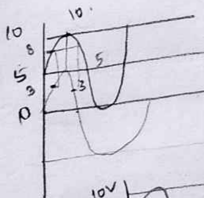
$V_o = 0+5$

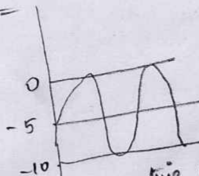
$V_i + V_m$

$V_o = V_i - V_m$.
$V_o = V_i - (-V_m)$
$\boxed{V_o = V_i + V_m}$ → constant. (input given)

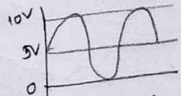
$0+5 = 5$
$5+5 = 10$
$5-5 = 0$
$-5-10 = -10$.







Negative clamper

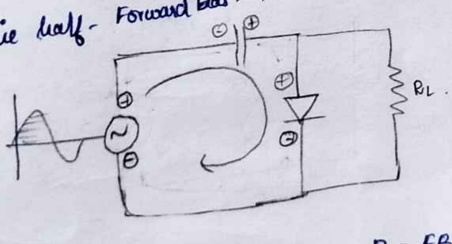


positive clamper.

$V_i = 0$, $V_o = 0+5 = 5$.
$V_i = 3$, $V_o = 3+5 = 8$.
$V_i = 5$, $V_o = 5+5 = 10$.
$V_i = -2$, $V_o = -2+5 = 3$.
$V_o = -5$, $V_o = -5+5 = 0$.

(ii). Negative clamper.

Positive half - Forward bias. +Vm



$V_i = +ve$, $D = FB$ (current flows)

Capacitor charges to the positive Vm, $\boxed{V_o = V_i - V_m}$