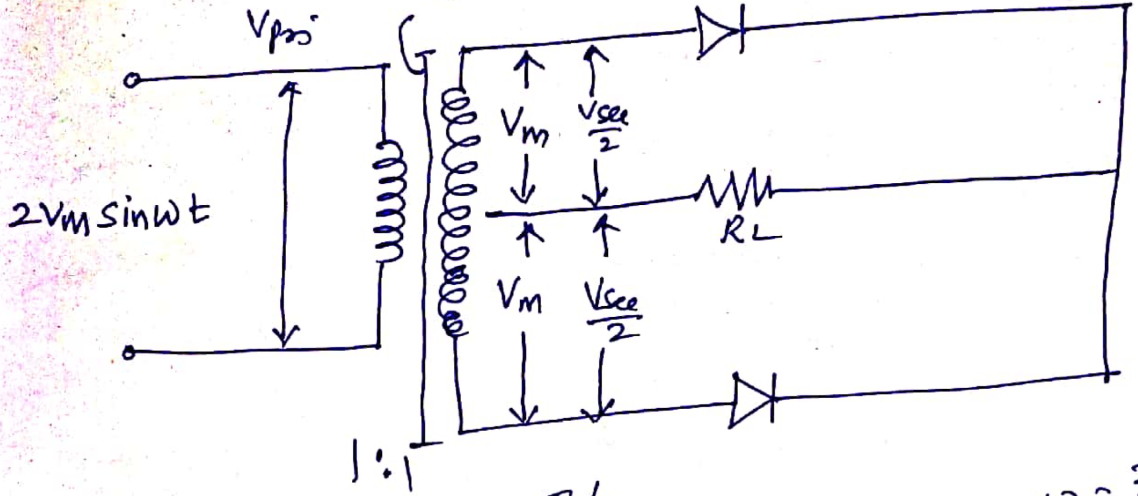
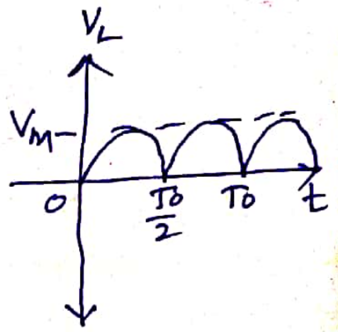
Centre tapped Full wave Rectifier





$$\omega = \frac{2\pi}{T_0}$$

$$V_{avg} = \frac{1}{T_0/2}\int_0^{T_0/2} V_m \sin\omega t \, dt$$

$$= \frac{2}{T_0} \cdot V_m \cdot \left[-\cos\frac{2\pi}{T_0}t\right]_0^{T_0/2} \times \frac{T_0}{2\pi}$$

$$= \frac{2V_m}{T_0}\left[-\cos\frac{2\pi}{\cancel{T_0}}\times\frac{\cancel{T_0}}{\cancel{2}} - \left[-\cos\frac{2\pi}{T_0}(0)\right]\right]\times\frac{T_0}{2\pi}$$

$$= \frac{2V_m}{\cancel{T_0}}\left[\cancel{2}\right]\frac{\cancel{T_0}}{\cancel{2}\pi} = \frac{2V_m}{\pi}$$

$$\boxed{V_{avg} = \frac{2V_m}{\pi}}$$

~~Primary~~

HF

$$\boxed{\begin{aligned} V_{sec} &= V_m \sin\omega t \\ V_{avg} &= \frac{V_m}{\pi}\end{aligned}}$$

$$V_{rms} = \sqrt{\frac{1}{T_0/2}\int_0^{T_0/2} V_m^2 \sin^2\omega t \, dt} = \sqrt{\frac{2}{T_0}\int_0^{T_0/2} V_m^2 \sin^2\frac{2\pi}{T_0}t}$$

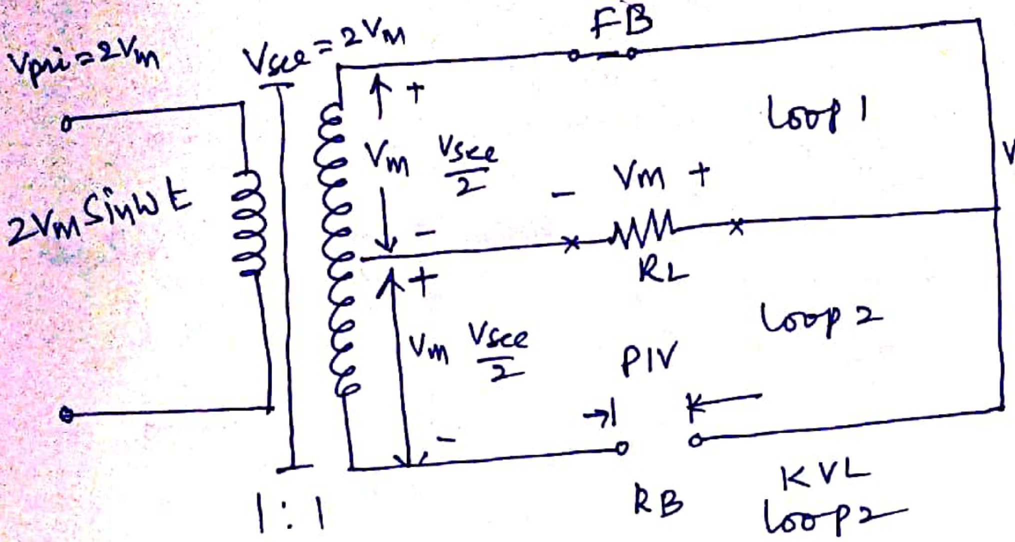
$$= \sqrt{\frac{\cancel{2}}{\cancel{T_0}}\cdot V_m^2 \cdot \cancel{\frac{\cancel{2}}{2}}\int_0^{T_0/2}\frac{1-\cos\frac{4\pi}{T_0}t}{2}\,dt}$$

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

$$= \sqrt{\frac{2}{T_0}\cdot\frac{V_m^2}{2}\left\{[t]_0^{T_0/2} - \underbrace{\left[\sin\frac{4\pi}{T_0}\right]_0^{T_0/2}\times\frac{T_0}{4\pi}}_{0}\right\}} = \sqrt{\frac{\cancel{2}}{\cancel{T_0}}\cdot\frac{V_m^2}{2}\cdot\frac{\cancel{T_0}}{\cancel{2}}}$$

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

Peak Inverse voltage of Full wave Rectifier



KVL
loop ①

$V_{RL} = V_m =$

$V_{RL} = V_m$.

KVL
loop 2

$$PIV = V_m + V_{RL} = \frac{V_{sec}}{2} + \frac{V_{sec}}{2}$$

$$= 2V_m = V_{sec}$$

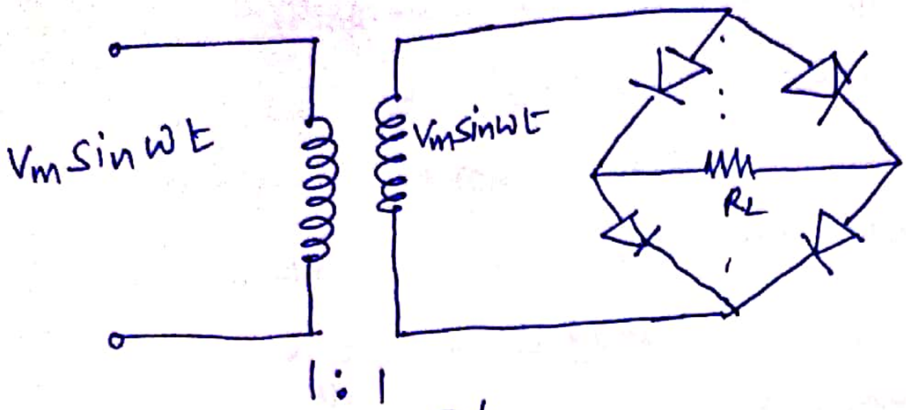
$$PIV = 2V_m$$

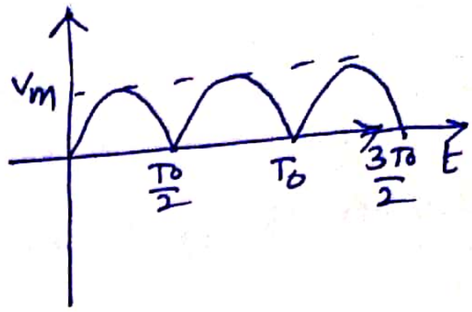
Efficiency $\quad \eta = \frac{P_{dc}}{P_{ac}} = \frac{V_{avg} \cdot I_{avg}}{V_{rms} \cdot I_{rms}} = \frac{V_{avg}^2 / R_L}{V_{rms}^2 / R_L} =$

$$= \frac{4V_m^{\cancel{2}}}{\pi^2} \times \frac{2}{\cancel{V_m^2}} = \frac{8}{\pi^2} = 0.81$$

$$\eta = 81\%$$

Bridge Rectifier

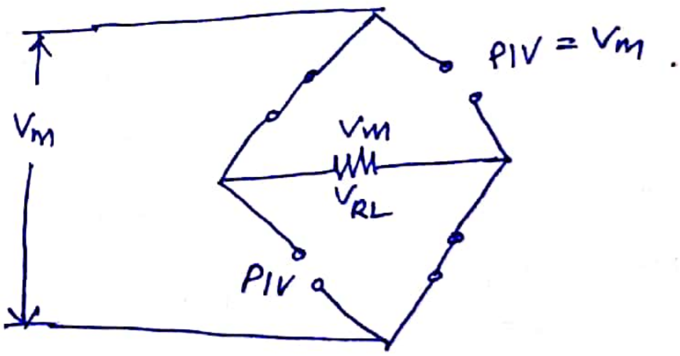




$$V_{avg} = \frac{1}{T_0/2}\int_0^{T_0/2} V_m \sin\frac{2\pi}{T_0}t = \frac{2V_m}{\pi} \qquad I_{dc} = \frac{2I_m}{\pi}$$

$$V_{rms} = \sqrt{\frac{1}{T_0/2}\int_0^{T_0/2} V_m^2 \sin^2\frac{2\pi}{T_0}t} = \frac{V_m}{\sqrt{2}} \qquad I_{rms} = \frac{I_m}{\sqrt{2}}$$

PIV = Vm.



Basic Electronics Engineering

Numerical Questions

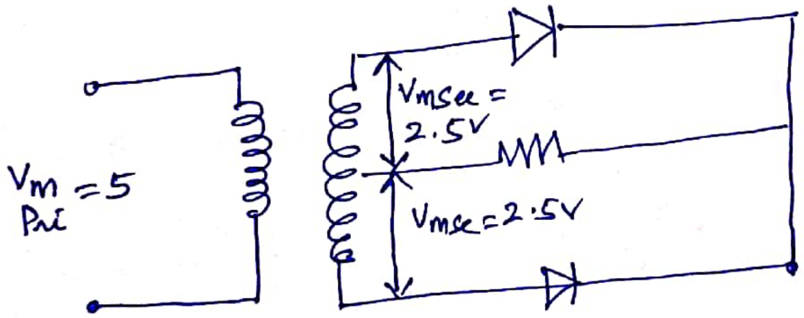
SPPU

(1) For a full wave Rectifier applied input voltage is 5 sinωt. calculate average output voltage, RMS voltage and PIV of diode used for both centre tapped and Bridge rectifiers

(i) Centre tapped Full wave Rectifier :

$I/P = 5\sin\omega t$

~~2Vm = 5~~



$V_{avg} = \frac{2V_{msec}}{\pi} = \frac{5}{\pi} = 1.59V$

$V_{rms} = \frac{V_{msec}}{\sqrt{2}} = \frac{2.5}{\sqrt{2}} = 1.7677$

$PIV = \frac{V_{msec}}{2} + \frac{V_{msec}}{2} = V_{msec} = \cancel{2.5V}$

$\boxed{PIV = 5V}$

OR Consider i/p as

$2V_m = 5$

$V_{avg} = \frac{5}{\pi}$

$V_{rms} =$

(ii) Bridge Rectifier $\Rightarrow V_m = 5$

$V_{avg} = \frac{2V_M}{\pi} = \frac{10}{\pi} = \cancel{1.59V}\ \frac{10}{\pi} = 3.18$

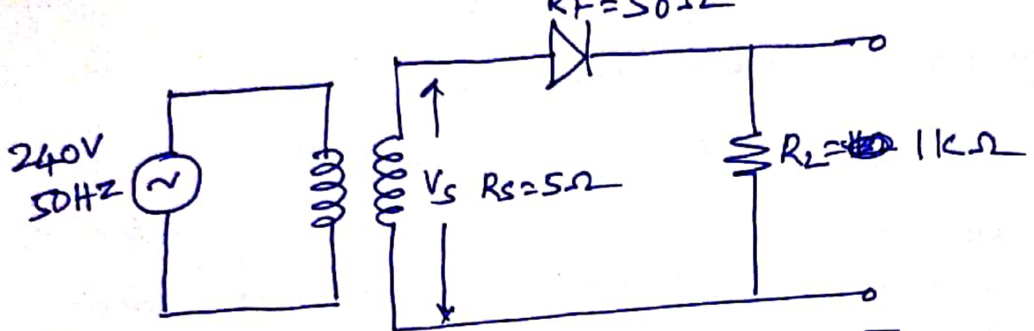
$V_{rms} = \frac{5}{\sqrt{2}} = 3.5355$

$PIV = 5V$

Q2 For the half wave Rectifier circuit of following figure. the resistance of the transformer secondary is 5Ω, forward resistance of the diode $R_F = 50Ω$ and the load resistance is 1 kΩ. Calculate the following

(i) Average load current and load voltage

(ii) RMS load current and load voltage



Given Primary 4:1

$V_{rms} = 240$

$V_m = 240 \times \sqrt{2}$

$V_{m\,secondary} = \frac{240\sqrt{2}}{4} = 60\sqrt{2} = 84.85V$

$V_{rms\,secondary} = \frac{240}{4}$

I_m & I_{rms} are loop currents

$$I_m = \frac{V_m}{R_s + R_f + R_L} = \frac{84.85}{55} = 80.49mA.$$

$V_{rms} = \frac{V_m}{2}$; $I_{rms} = \frac{I_m}{2}$ for Half wave Rectifier

$I_{rms} = 40.24mA.$

$$I_{dc} = \frac{I_m}{\pi} = \frac{80.49}{\pi} = 25.62mA.$$

Rms voltage Across load = $I_{rms} \times R_L = 40.24mA \times 1kΩ$

$V_{Rms\,L} = 40.24V.$

Average / DC voltage Across load = $25.62mA \times 1kΩ = 25.62V$

* (i) $V_{avg} = 25.62V$; $I_{avg} = 25.62mA.$
* (ii) $V_{rms} =$ ~~40.16~~ $40.24V$; $I_{rms} = 40.24mA.$

Q3 A bridge rectifier is applied with the input from a step down transformer having turns ratio 8:1 and input 230V, 50HZ. If the load is 2KΩ, diode forward resistance is 1Ω, Secondary (series source) resistance is 10Ω calculate (i) I_{dc} (Average current) and V_{dc} (Average voltage) Across load

(ii) V_{rms} and I_{rms} Across load

(iii) Rectifier Efficiency

Given

V_{rms} primary $= 230V$

V_{rms} secondary $= \frac{230}{8}$

$R_L = 2K$
$R_S = 10\Omega$
$R_f = 1\Omega$

→ V_m secondary $= \frac{230}{8} \times \sqrt{2} = 40.65V$

→ $I_m = \frac{V_{m\,sec}}{2R_f + R_L + R_s} = \frac{40.65}{2012} = 20.2mA.$

$\cancel{V_{avg} = V_{dc}} = \cancel{\frac{2V_m}{\pi}} = \cancel{\frac{2\times 40.65}{\pi}} = \cancel{25.87V}.$

$I_{dc} = \cancel{\frac{2I_m}{2\pi}} = \cancel{/2012} = \frac{2I_m}{\pi} = \frac{20.2\times10^{-3}\times2}{\pi}$

→ $I_{dc} = 12.85mA.$

→ $V_{dc} = I_{dc} \times R_L = 12.85mA \times 2k\Omega = 40.4V.$

→ $I_{rms} = \frac{I_m}{\sqrt{2}} = 14.28mA.$

→ $V_{rms} = 28.56V$

→ Efficiency $= \frac{(12.85)^2\times(10^{-3})^2\times R_L}{(14.28\times10^{-3})^2} = 80.9\%$
$= 0.809$

Q4: A full wave rectifier is fed from a transformer with a centre tap. The rms voltage from one end to centre tap at secondary is 30V. If the forward diode resistance is 2Ω and that of Half Part Secondary resistance is 8Ω calculate the following for ~~load~~ 1KΩ load

$R_L = 1K$
$R_f = 2\Omega$
$R_s = 8\Omega$

(i) I_{dc}, I_{rms}

(ii) V_{dc}, V_{rms} across the load

(iii) Power available at secondary and Power delivered to the load

(iv) Rectifier Efficiency.

Given: $\frac{V_{rms\,sec}}{2} = 30V$ $\quad \frac{\cancel{V_{sec}}}{2}$

$V_{rms\,sec} = 30 \times 2 = 60V.$

$$V_{m\,sec} = \underline{60 \times \sqrt{2}} = 60 \times \sqrt{2}$$

$$I_m = \frac{60 \times \sqrt{2}}{R_f + R_s + R_L} = \frac{84.85}{2 + 8 + 1000} = \frac{84.85}{1010}$$

$$\boxed{I_m = 84.01\,mA.}$$

$$I_{dc} = \frac{2I_m}{\pi} = 53.48\,mA:$$

Load

$V_{dc} = 53.48\,mA \times 1K$

$\boxed{V_{dc_L} = 53.48V.}$

$$I_{rms} = \frac{I_m}{\sqrt{2}} = 56.57\,mA.$$

$\boxed{I_{rms} = \cancel{59.57\,mA}\ 59.4}$

V_{rms} across load $= 5\cancel{9}.57\,mA \times 1K\Omega$

$\boxed{V_{rm\,sL} = \cancel{59.57}V.\ 59.4V}$

$$\text{Efficiency} = \frac{P_{dc}}{P_{AC}} = \frac{\text{Power delivered to load}}{\text{Power at Secondary}} =$$

$$= \frac{(53.48)^2 \cancel{R_L} \times (10^{-3})^2 \times \underset{R_L}{1000}}{(\cancel{59.57}\,59.4 \times 10^{-3})^2 \underset{R_f + R_s + R_L}{(1010)}} \times 100\% = \cancel{88.48}\ 79.80\%.$$

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