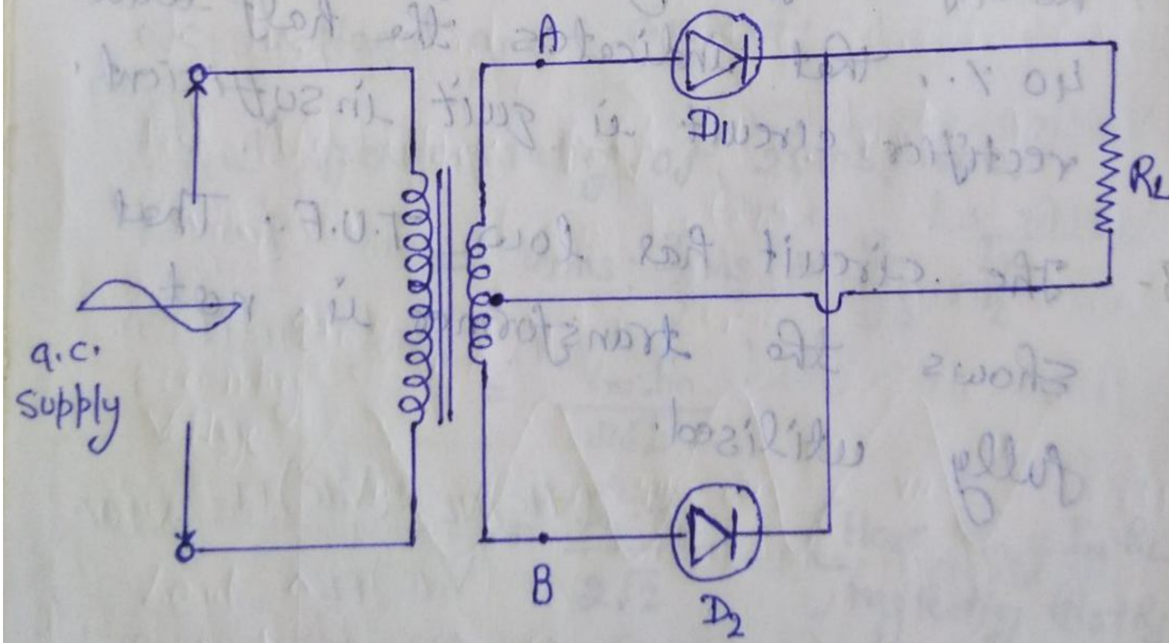
Full Wave Rectifier :→

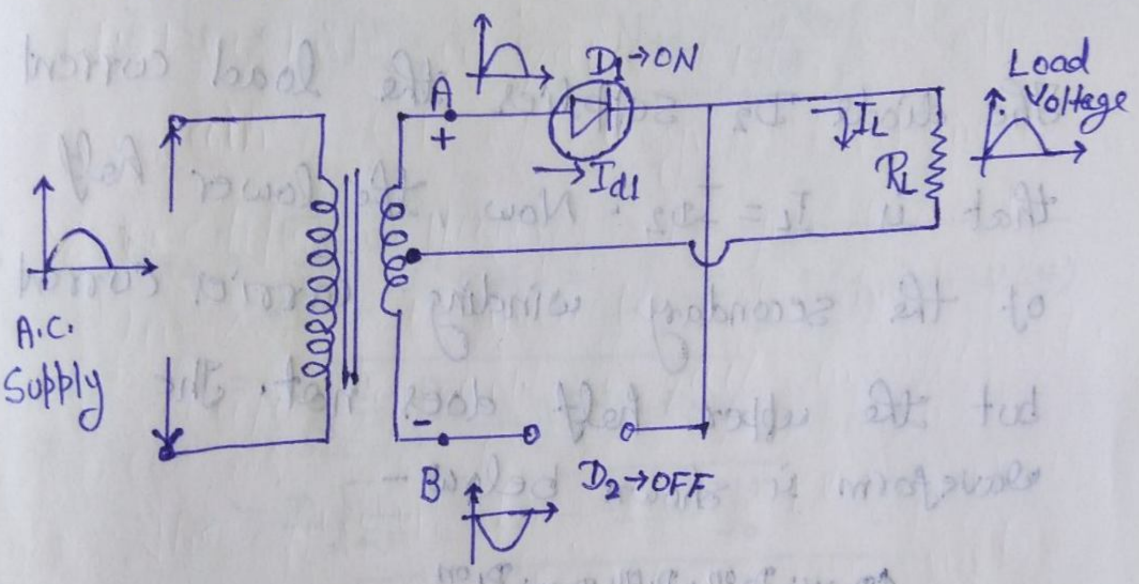
The full wave rectifier conducts during
both cycles of input a.c. supply.
In order to rectify both the half
cycles of a.c. input, two diodes are
used in this circuit. The diodes
feed a common load R_L with the
help of a center tap transformer.
The full wave rectifier ckt. is shown
in following fig.



Full Wave Rectifier

circuit operation →

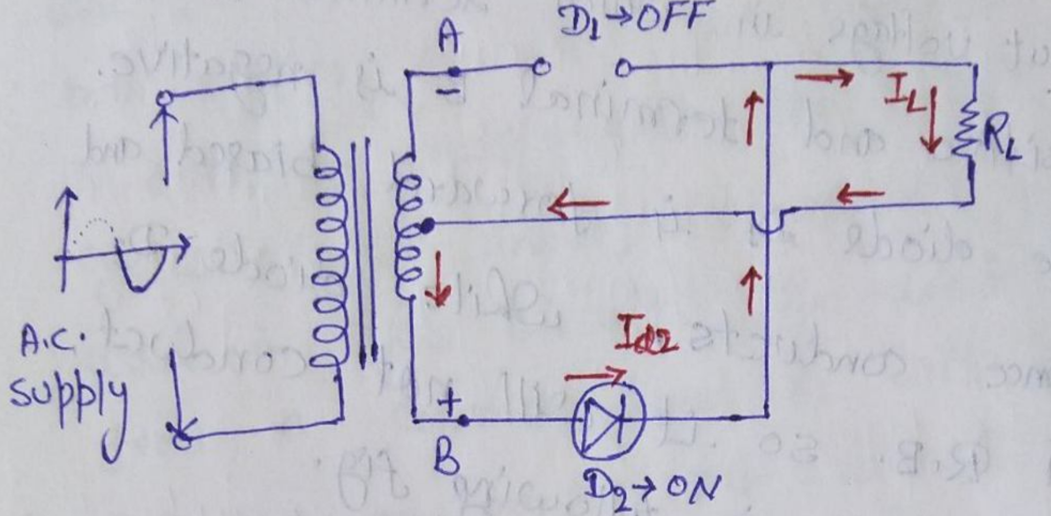
Consider positive half cycle of a.c. input voltage in which terminal A is positive and terminal B is negative. The diode D_1 is forward biased and hence conducts, while diode D_2 is R.B. so it will not conduct, as shown in following fig.



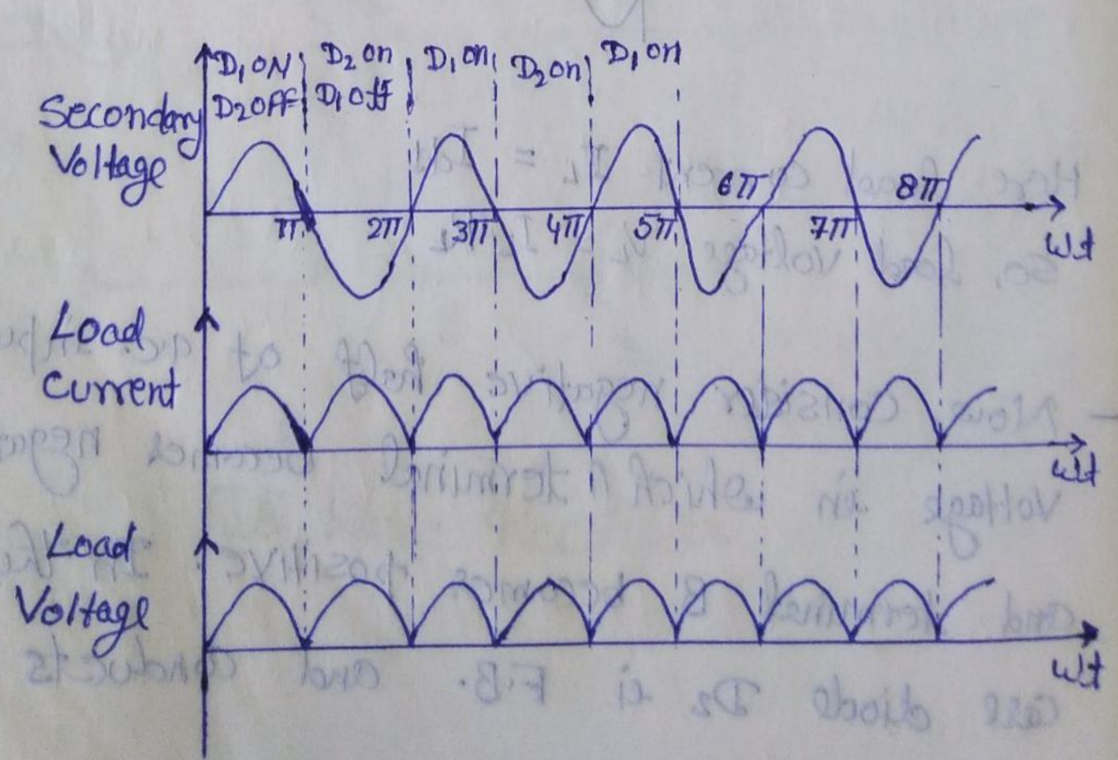
Here load current $I_L = I_{d1}$

So, load voltage $V_L = I_L \cdot R_L$

- Now, consider negative half of a.c. input voltage in which A terminal becomes negative and terminal B becomes positive. In this case diode D_2 is F.B. and conducts while diode D_1 is reverse biased and does not conduct, shown below -



The diode D_2 supplies the load current that is $I_L = I_{D2}$. Now, the lower half of the secondary winding carries current but the upper half does not. The waveform is shown below -



d.c. Value -

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

$$= \frac{I_m}{\pi}\left[-\cos\omega t\right]_0^{\pi} = -\frac{I_m}{\pi}\left[\cos\pi - \cos 0\right]$$

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

$$\therefore \boxed{I_{dc} = \frac{2I_m}{\pi}}$$

The d.c. load voltage, $V_{dc} = I_{dc} \cdot R_L = \frac{2I_m}{\pi} \cdot R_L$

$$\Rightarrow V_{dc} = \frac{2V_m}{\pi(R_s + R_f + R_L)} \cdot R_L$$

But $(R_s + R_L) << R_L$

$$\therefore V_{dc} = \frac{2V_m}{\pi R_L} \cdot R_L \Rightarrow \boxed{V_{dc} = \frac{2V_m}{\pi}}$$

rms load current (I_{rms}) →

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

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

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

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

$$= I_m\sqrt{\frac{1}{2\pi}\left[(\pi - 0) - (0-0)\right]}$$

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

rms value of load voltage

$$V_{rms} = I_{rms} \cdot R_L = \frac{I_m}{\sqrt{2}} \cdot R_L = \frac{V_m}{\sqrt{2}(R_s + R_f + R_L)} \cdot R_L$$

If $(R_s + R_L) << R_L$ then

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

dc power output →

$$P_{dc} = I_{dc}^2 \cdot R_L = \left(\frac{2I_m}{\pi}\right)^2 \cdot R_L = \frac{4}{\pi^2} \cdot I_m^2 \cdot R_L$$

ac power Input (P_{ac}) →

$$P_{ac} = I_{rms}^2 (R_s + R_f + R_L) = \left(\frac{I_m}{\sqrt{2}}\right)^2 (R_s + R_f + R_L)$$

$$= \frac{I_m^2}{2} (R_s + R_f + R_L)$$

Rectifier Efficiency → $\eta = \frac{P_{dc}}{P_{ac}}$

$$\therefore \eta = \frac{\frac{4}{\pi^2} I_m^2 \cdot R_L}{\frac{I_m^2}{2}(R_s + R_f + R_L)} = \frac{8}{\pi^2} \cdot \frac{R_L}{(R_L + R_f + R_L)}$$

$$\Rightarrow \eta = \frac{8}{\pi^2} \cdot \frac{1}{1 + \frac{(R_f + R_s)}{R_L}} = \frac{0.812}{1 + \frac{R_f + R_s}{R_L}}$$

If $(R_s + R_f) << R_L$ then max. theoretical efficiency is-

$$\eta = 0.812 \Rightarrow \boxed{\%\eta = 81.2\ \%}$$

Ripple factor →

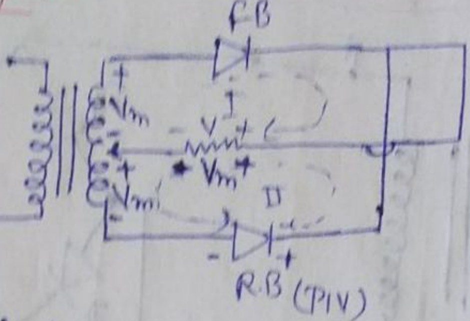
Form factor, $f = \frac{I_{rms}}{I_{dc}} = \frac{I_m/\sqrt{2}}{2I_m/\pi} = \frac{\pi}{2\sqrt{2}} = 1.11$

$\therefore$ Ripple factor $r = \sqrt{f^2 - 1}$

$\therefore r = \sqrt{(1.11)^2 - 1}$

$$\boxed{r = 0.48}$$

Peak Inverse Voltage :→



Apply KVL in I loop

$$V_m - V = 0 \Rightarrow V = V_m$$

Now apply KVL in II loop

$$V_m + V_m - PIV = 0$$

$$\Rightarrow \boxed{PIV = 2V_m}$$

Transformer Utilization Factor (T.U.F.) →

~~TUF = 0.812~~ $\boxed{TUF = 0.693}$

Advantages →

1- The d.c. load voltage and current are more than HWR
2- No d.c. current through transformer windings, hence no possibility of saturation.
3- TUF is better as transformer losses are less
4- The efficiency is higher
5- The large d.c. power output.
6- The ripple factor is less.

Disadvantages →

1- The PIV rating of diode is higher
2- Higher PIV diodes are larger in size and costlier
3- The cost of centre tap transformer is higher.