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Electronics Assignment - 1

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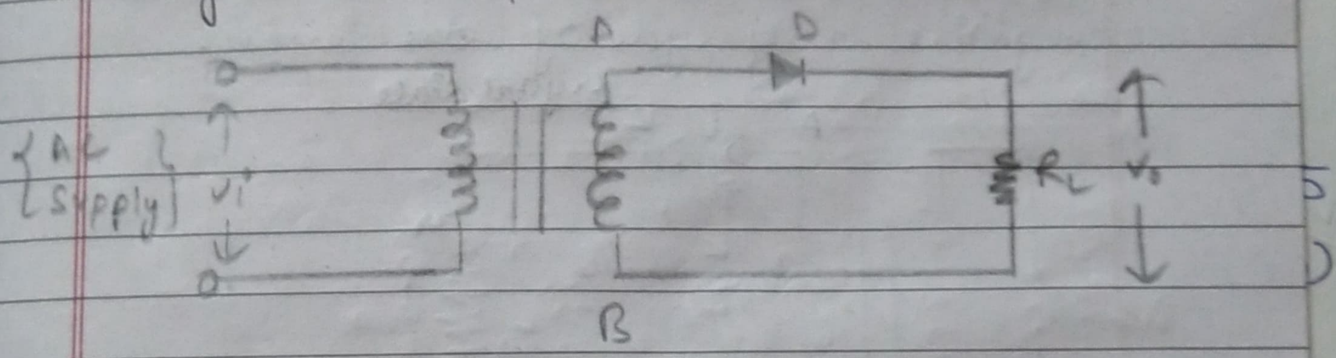
Half wave rectifier.



Characteristics :-

(i) Single diode is used in half wave rectifier
(ii) When a.c supply is applied to the input, only positive half cycle appears across the load, whereas, the negative half cycle is suppressed.
(iii) Step down transformer is used.

Working :- When a.c supply is switched on, the alternating voltage (V_{in}), as shown in fig. (A), appears across the terminal AB at secondary winding. During positive half cycle, the terminal A is positive w.r.t B and the crystal diode is forward biased. Therefore, it conducts current 'i' flows through the load resistor R_L. This current varies in magnitude. Thus, a positive half cycle of output negative $V_{out} = iR_L$ appears across the load resistor (R_L).

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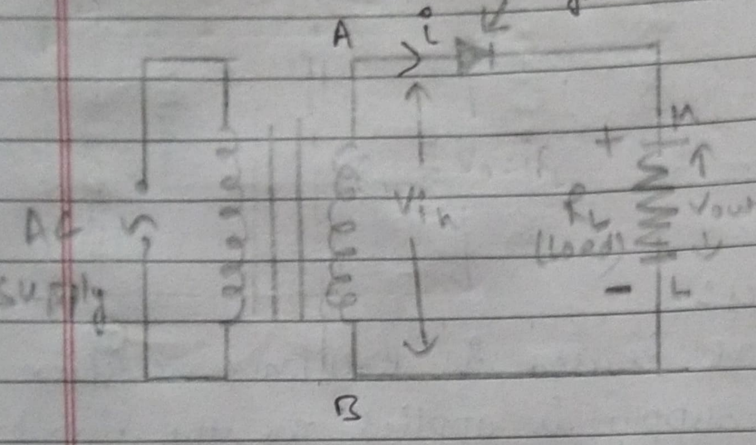
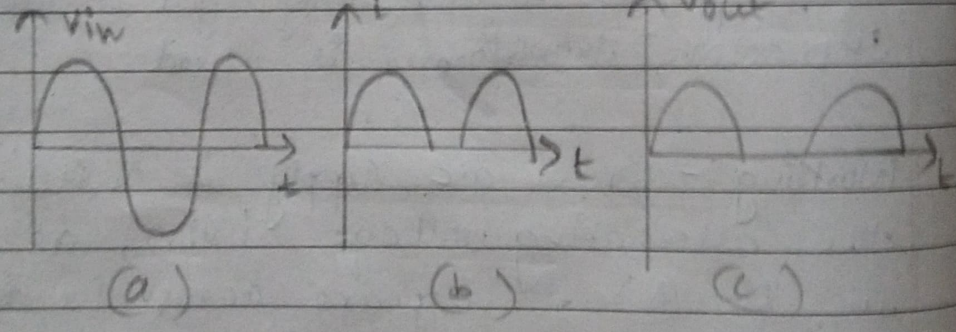
During negative half cycle, the terminal A is negative wrt B and the crystal diode is reverse biased. Under this condition, the diode does not conduct and no current flows through the circuit. Therefore, no voltage appears across the load resistor R_L in the negative half cycle of the input.



Waveform



Ripple factor

$$RF = \frac{\text{rms value of ac component of O/P}}{\text{dc value}}$$

$$V_{rms}^2 = V_{(ac)rms}^2 + V_{dc}^2$$

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

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$$RF = \frac{\sqrt{V_{rms}^2 - V_{dc}^2}}{V_{dc}}$$

$$RF = \frac{\cancel{V_{dc}}\sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1}}{\cancel{V_{dc}}}$$

$$RF = \sqrt{(F.F)^2 - 1}$$ F.F → form factor.

$$F.F = \frac{V_{rms}}{V_{avg}} = \frac{V_m/2}{V_m/\pi} = \frac{\pi}{2} = 1.57$$

$$RF = \sqrt{(1.57)^2 - 1}$$

$$\boxed{RF = 1.21}$$

Efficiency:-

$$\eta\% = \frac{O/P\ DC\ Power}{I/P\ AC\ Power} \times 100\ \%$$

$$= \frac{I_{dc}^2 \cdot R}{I_{rms}^2 \cdot R} \times 100\%$$

$$= \frac{I_m^2/\pi^2}{I_m^2/4} \times 100\% = \frac{4}{\pi^2} \times 100\%$$

$$\left(\begin{array}{l} I_{dc} = I_m/\pi \\ I_{rms} = I_m/2 \end{array}\right) \quad \boxed{\eta\% = 40.56\%}$$

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% regulation.

~~% regulation = Vdc (no load) - Vdc (full load)~~

$$\% \text{ regulation} = \frac{V_{dc}(\text{no load}) - V_{dc}(\text{full load})}{V_{dc}(\text{full load})} \times 100$$

$$V_{dc}(\text{no load}) = V_m/\pi$$

$$V_{dc}(\text{full load}) = I_{dc} \times R_L = \frac{I_m}{\pi} \times R_L$$

$$= \frac{V_m R_L}{\pi(R_L + R_s + R_f)} \qquad \left\{ I_m = \frac{V_m}{R_L + R_s + R_f} \right\}$$

On putting these values in eqn.

$$\% \text{ regulation} = \frac{\frac{V_m}{\pi} - \frac{V_m R_L}{\pi(R_L + R_s + R_f)}}{\frac{V_m R_L}{\pi(R_L + R_s + R_f)}} \times 100\%$$

$$= \frac{\cancel{\frac{V_m}{\pi}}\left(1 - \frac{R_L}{R_L + R_f + R_s}\right)}{\cancel{\frac{V_m}{\pi}} \frac{R_L}{(R_L + R_f + R_s)}} \times 100\%$$

$$\Rightarrow \frac{R_L + R_s + R_f - R_L}{R_L} \times 100\%$$

$$\left[\% \text{ regulation} = \frac{R_s + R_f}{R_L} \times 100\% \right]$$

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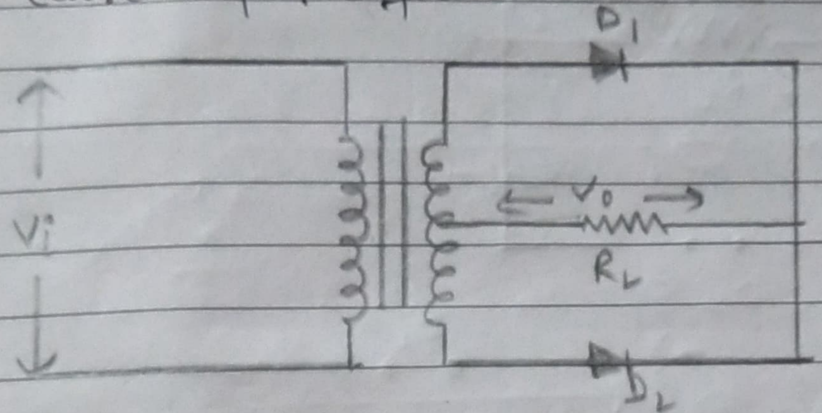
full wave rectifier :-

→ Centre top rectifier.



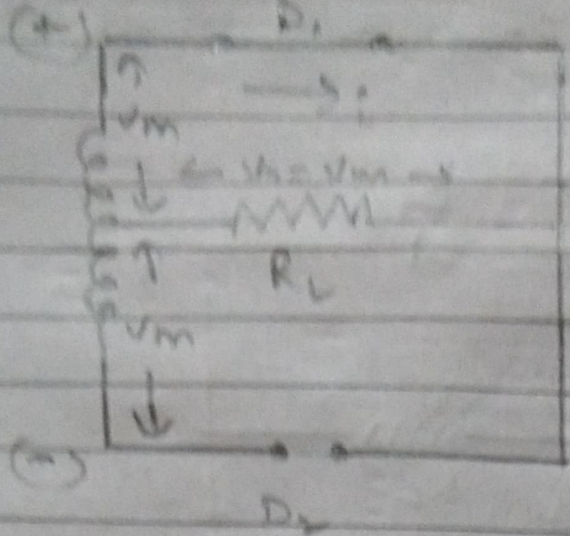
Characteristics:-

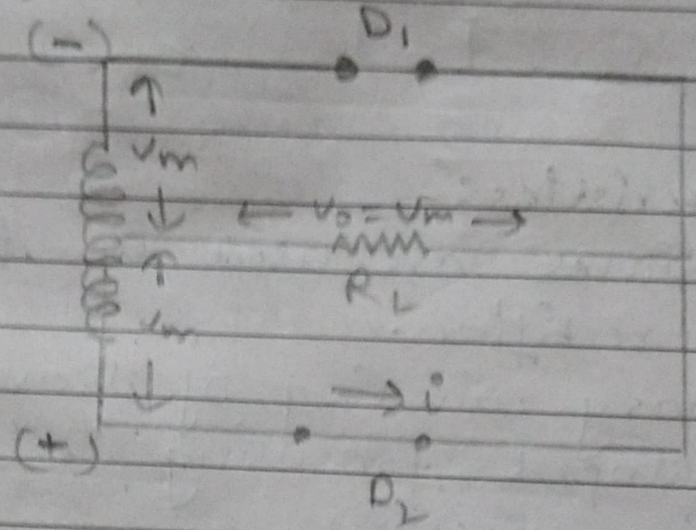
→ Two diodes are used in full wave centre toped rectifier.

→ Secondary winding of transformer is centre toped for using TUF (Transformer Utilisation factor).

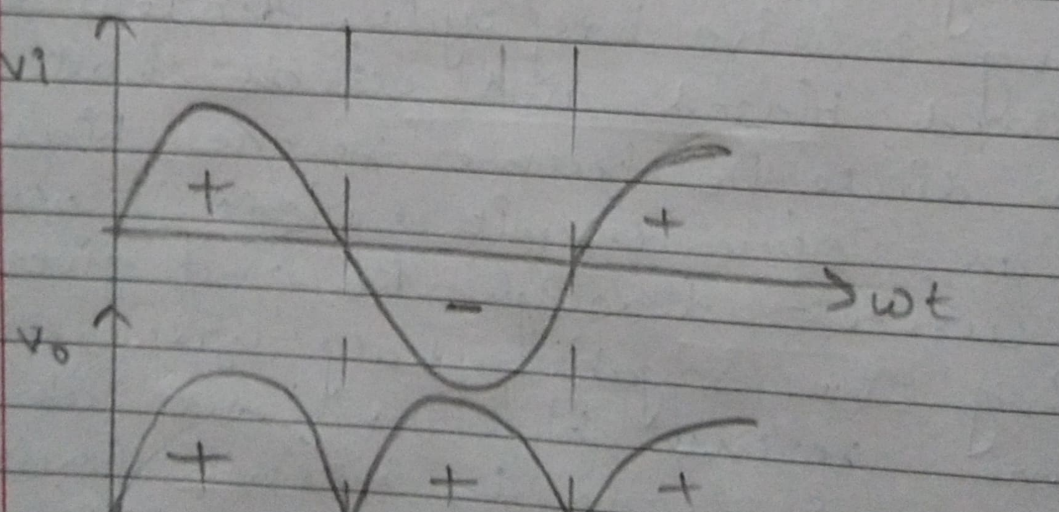
Working:-

During positive half cycle, diode D become forward biased and act as short circuit and diode D_2 become reverse bias and act as open circuit. Diode D_1 conduct the current through R_L and gives O/P. During the negative half cycle, diode D_1 become reverse bias and act as open circuit and diode D_2 become forward bias and act as short circuit diode D_2 conducts the current through load resistance R_L and gives output.





Waveform.



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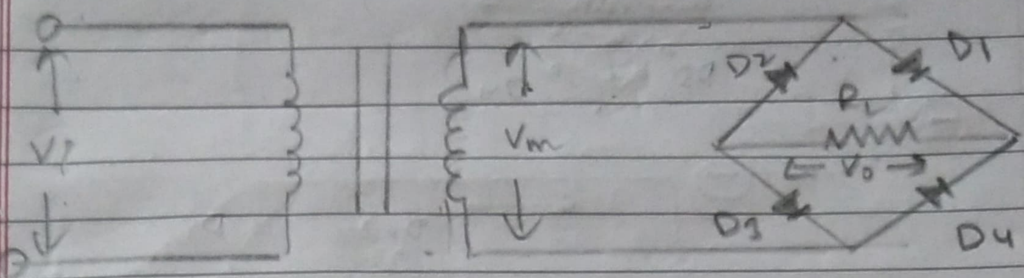
Bridge Rectifier.

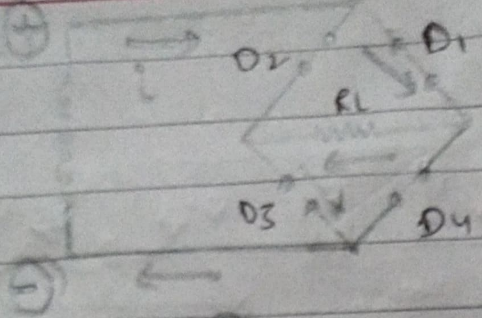


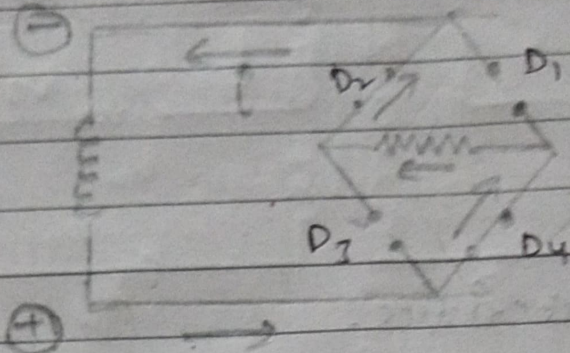
Characteristics.

→ 4 diodes are used in bridge rectifier.
→ Bridge rectifier offers full wave rectification.
→ Bridge combination of diode is connected with secondary winding of transformer.

Working:- During positive half cycle, diode D_1 and D_3 become forward bias and D_2, D_4 become reverse bias. Diode D_1 and D_3 act as short circuit and passes the current through R_L. Diode D_2 and D_4 act as open circuit and do not conduct the current.

During the negative half cycle, D_2 & D_4 act as forward bias and D_1 and D_3 become reverse bias. Diode D_2 and D_4 act as short circuit and D_1, D_3 act as open circuit. D_2 and D_4 conduct the current through R_L.





Ripple factor

$$Rf = \sqrt{(F.F)^2 - 1}$$

$$F.F = \frac{V_{rms}}{V_{avg}} = \frac{V_m/\sqrt{2}}{2V_m/\pi} = \frac{\pi}{2\sqrt{2}} = 1.11$$

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

$$(RF = 0.48)$$

Efficiency

$$\eta\% = \frac{O/P\ DC\ Power}{I/P\ AC\ Power} \times 100$$

$$= \frac{I_{dc}^2 R}{I_{rms}^2 R} \times 100\ \%$$

$$= \frac{4\ I_m^2/\pi^2}{I_m^2/2} \times 100\ \%$$

$$\left\{ \begin{array}{l} I_{dc} = 2I_m/\pi \\ I_{rms} = I_m/\sqrt{2} \end{array} \right\}$$

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

$$= \boxed{\eta\% = 81.13\%}$$

% Regulation

$$\%\ \text{regulation} = \frac{V_{dc}(\text{no load}) - V_{dc}(\text{full load})}{V_{dc}(\text{full load})} \times 100\%$$

$$V_{dc}\ (\text{no load}) = \frac{2V_m}{\pi}$$

$$V_{dc}\ (\text{full load}) = \frac{2V_m}{\pi} \cdot \frac{R_L}{R_S + R_L + R_f}$$

$$\%\ \text{regulation} = \frac{\frac{2V_m}{\pi} - \frac{2V_m}{\pi}\left\{\frac{R_L}{R_S + R_L + R_f}\right\}}{\frac{2V_m}{\pi} \cdot \frac{R_L}{R_S + R_L + R_f}}$$

$$= \frac{\frac{2V_m}{\pi}\left\{1 - \frac{R_L}{R_S + R_L + R_f}\right\}}{\frac{2V_m}{\pi} \cdot \frac{R_L}{R_L + R_S + R_f}}$$

$$\boxed{\%\ \text{Regulation} = \frac{R_f + R_S}{R_L} \times 100\%}$$

→ Comparative study of half wave, centre tap and bridge rectifier.

	Half wave	Centre Tap	Bridge
Ripple factor	1.21	0.48	0.48
Efficiency	40.6%	81.13%	81.13%
% regulation	0%	0%	0%