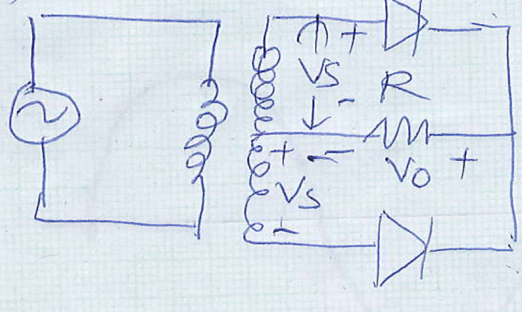
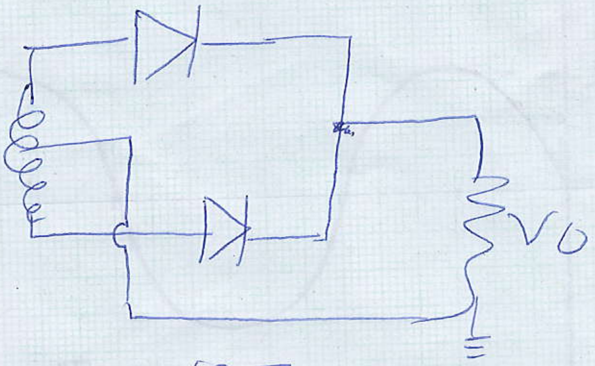
LECTURE 07/10/2020

(2) FULL WAVE RECTIFIER

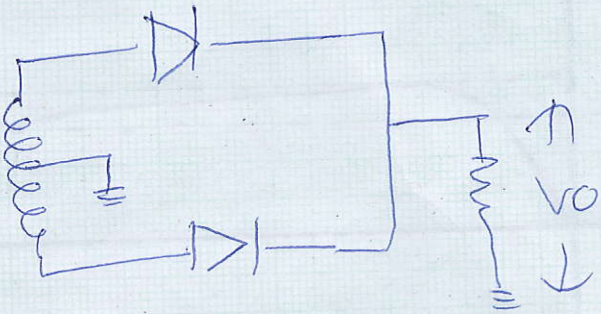
A full wave rectifier is a circuit which allows a unidirectional current to flow through the load during the entire input cycle

(a) CENTRE-TAPPED FULL WAVE RECTIFIER





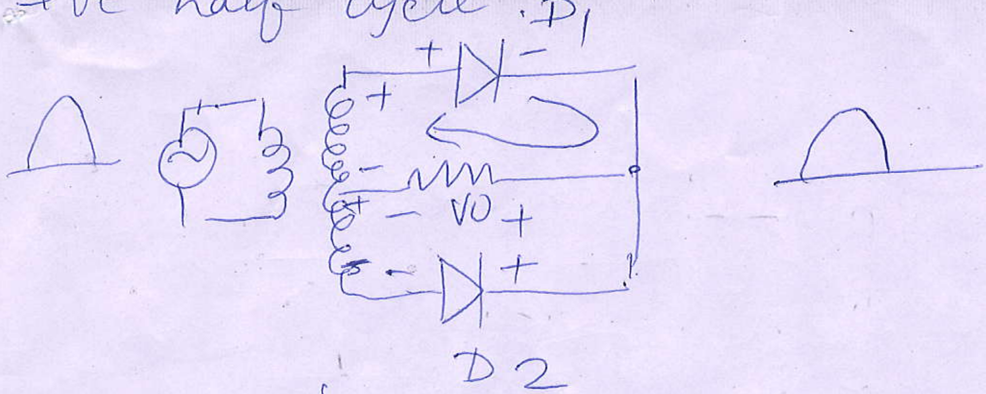
$\boxed{OR}$



Construction: The circuit uses 2 diodes which are connected to the centre-tapped secondary winding of the transformer. The input signal is applied to the primary winding of the transformer. The center tap is taken as the ground or zero voltage reference point. The voltage between the center tap and either ~~to~~ end of the secondary winding is half of the secondary voltage. $V_S = \frac{V_2}{2}$

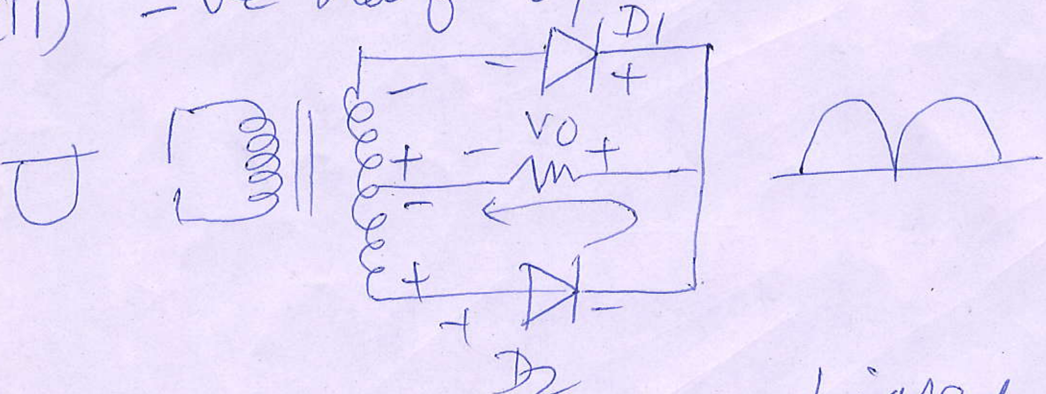
Working:

(i) +ve half cycle:



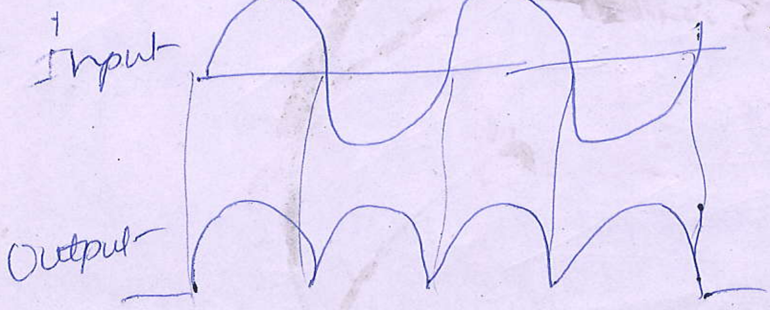
Diode D_1 is forward biased and diode D_2 is reverse biased. As a result D_1 conducts and D_2 is OFF. D_1 supplies the load current.

(ii) -ve half cycle:



Diode D_1 is reverse biased and D_2 is forward biased. D_1 is OFF and D_2 conducts. D_2 supplies load current.

During both cycles the current flowing through the load is in same direction.



PARAMETERS

(1) AVERAGE OR D.C. VALUE OF O/P VOLTAGE

V_{dc} = Area under the curve over half cycle / Base

$$= \int_0^\pi \frac{v\,d\theta}{\pi} = \int_0^\pi \frac{V_m \sin\theta\, d\theta}{\pi}$$

$$= \frac{V_m}{\pi}\left(-\cos\theta\right)_0^\pi = \frac{V_m}{\pi}\left(+1-(-1)\right)$$

$$= \frac{2V_m}{\pi} = 0.636\, V_m$$

(2) Average or d.c. value of load current

$$I_{dc} = \frac{V_{dc}}{R_L} = \frac{2V_m}{\pi R_L} = \frac{2I_m}{\pi} = 0.636\, V_m$$

(3) RMS VALUE OF LOAD CURRENT.

$$I_{rms} = \sqrt{\frac{2}{2\pi}\int_0^\pi i^2\, d\theta}$$

$$= \sqrt{\frac{1}{\pi}\int_0^\pi I_m^2 \sin^2\theta\, d\theta}$$

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

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

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

$$= \sqrt{\frac{I_m^2}{2\pi}\times\pi} = \sqrt{\frac{I_m^2}{2}} = \frac{I_m}{\sqrt{2}}$$

(4) RIPPLE FACTOR

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

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

$$= \sqrt{\frac{I_m^2}{2} \times \frac{\pi^2}{4I_m^2} - 1} = \sqrt{\frac{\pi^2}{8} - 1}$$

$$= 0.482$$

(5) RATIO OF RECTIFICATION

$$\eta = \frac{I_{dc}^2 R_L}{I_{rms}^2 (R_f + R_L)}$$

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

$$= \frac{4I_m^2}{\pi^2} \times \frac{R_L}{I_m^2} \times \frac{2}{R_f + R_L}$$

$$= \frac{8}{\pi^2} \frac{R}{R_f + R_L} = \frac{0.812}{1 + \frac{R_f}{R_L}}$$

$$R_L >> R_f$$

$$\therefore \eta = 0.812$$

(6) Peak Inverse voltage rating of diode
Voltage across reverse biased diode
= voltage across half the secondary
+ voltage across R_L
$= V_m + V_m = 2V_m$.
$\therefore$ P.I.V. of diode $= 2V_m$.

(7) Form Factor

$$F = \frac{I_{rms}}{I_{dc}} = \frac{I_m/\sqrt{2}}{2I_m/\pi} = \frac{\pi}{2\sqrt{2}}$$

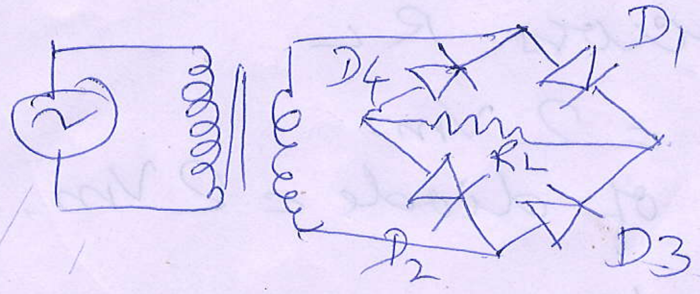
$F = 1.11$

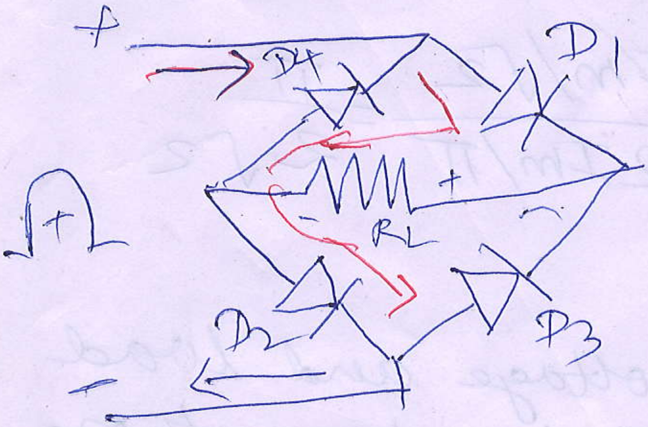
Advantages
(1) The d.c. output voltage and load current values are twice than those of a half wave rectifier,
(2) The ripple factor is much less than (0.482) that of a Half wave rectifier (1.21)
(3) The efficiency is twice that of a Half wave rectifier

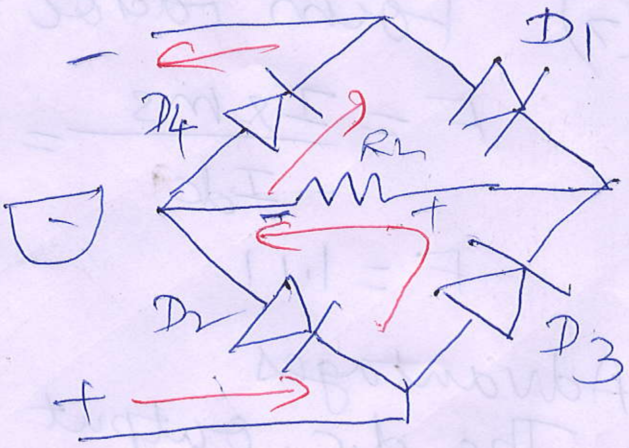
Disadvantages:
(1) The output voltage is half of the sec. voltage.
(2) The P.I.V. rating of a diode is twice that of the diode used in half wave rectifier.
(3) Expensive to manufacture a centre-tapped

transforma which produces equal voltages on each half of the secondary winding

(b) FULL WAVE BRIDGE RECTIFIER







Working:

(i) + ve half cycle

Diodes D_1 & D_2 are forward biased and conduct some current due to which a voltage is developed across R_L. D3 and D4 are reverse biased

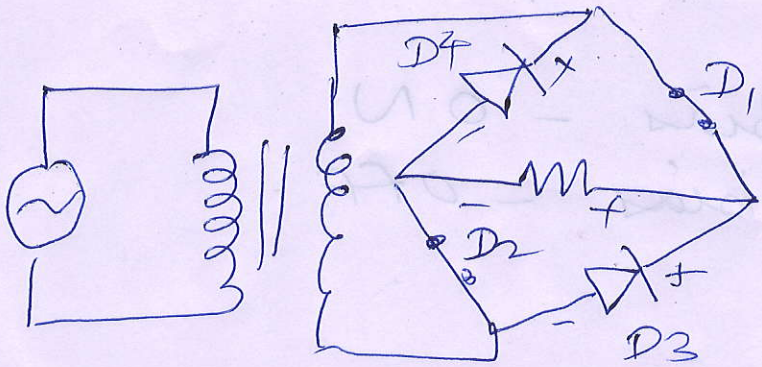
(ii) - ve half cycle:

Diodes D_3 and D_4 are forward biased & conduct current in the same direction through R_L as during +ve half cycle, D_1 & D_2 are reverse biased.

As a result a full rectified output voltage is developed across R_L

All the parameters of Bridge rectifier are same as full wave center tapped rectifier

PIV rating of diode in Bridge rectifier



Here D_1 & D_2 are forward biased, whereas D_3 & D_4 are reverse biased and have maximum reverse bias voltage equal to the maximum secondary voltage V_m + voltage across R_L (max V_m)

∴ Across each diode D_4 & D_3

The voltage is $= \frac{2V_m}{2} = V_m$.

∴ The P.I.V. rating of diode $= V_m$.

Advantages of Bridge rectifier

1. The transformer is less costly as it is required to provide only half the voltage of an equivalent center tapped rectifier

2. No center tap is required on transformer
3. P.I.V. rating of diode is less.

Disadvantages

1. Uses 4 diodes

Diode has an important application as a switch.

(1) Forward bias – ON
(2) Reverse bias – OFF

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