Half wave Rectifier, Full wave Rectifier, Bridge Rectifier

Classification

Crystal Diode Rectifiers

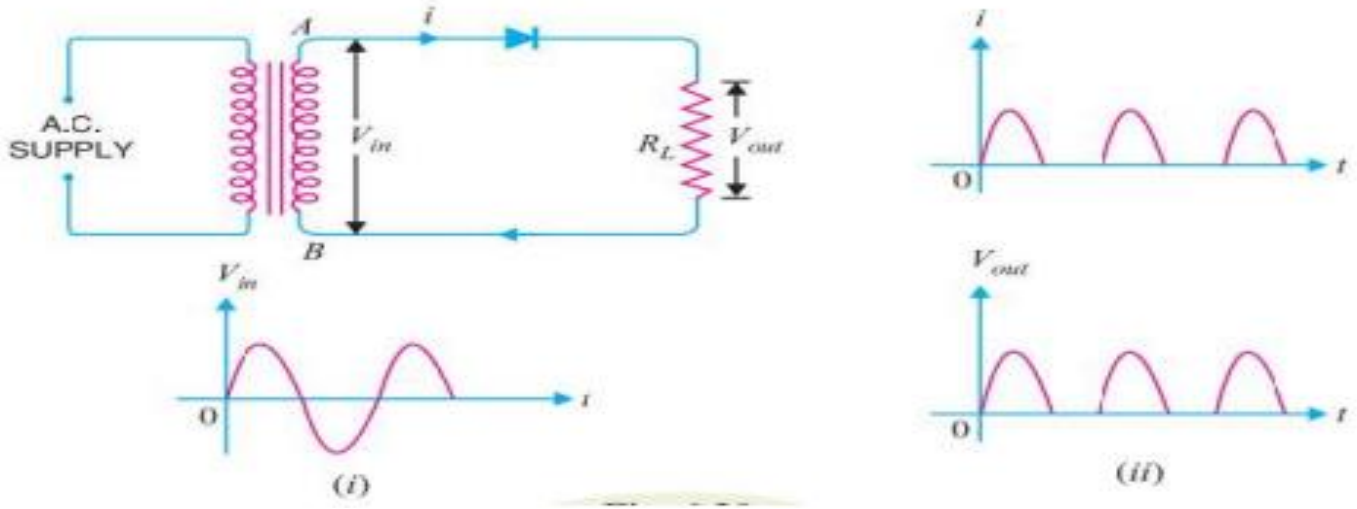
- Rectifier: Rectifier is that circuit, that converts ac to dc.

- The following two types of rectifier circuit can be used:

I. Half wave rectifier
II. Full wave rectifier

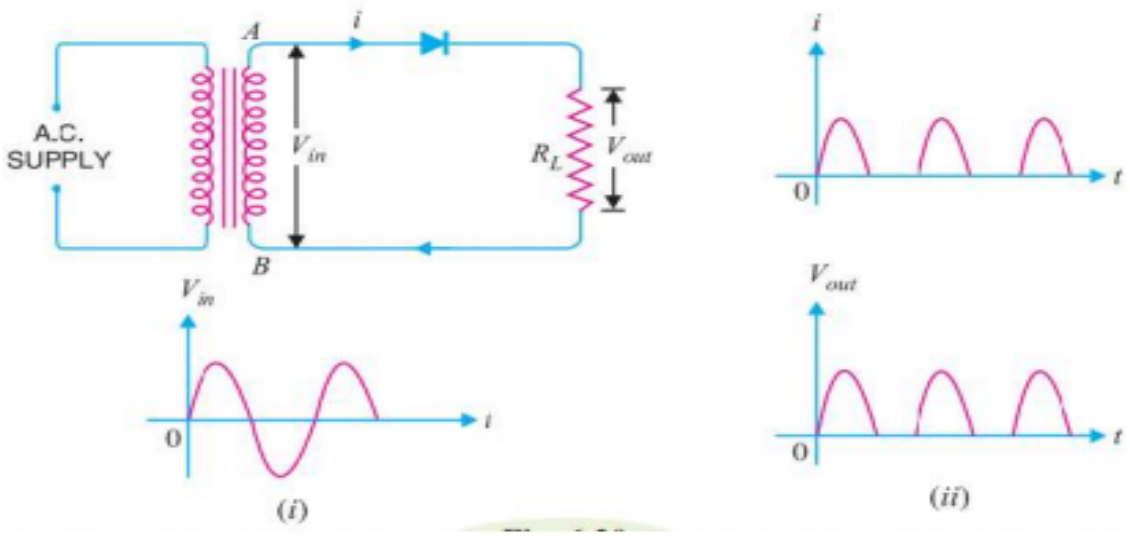
Half wave Rectifier

- The process of removing one-half the input signal to establish a dc level is called *half-wave rectification*.
- In Half wave rectification, the rectifier conducts current during positive half cycle of input ac signal only.
- Negative half cycle is suppressed.



Half wave Rectifier

- AC voltage across secondary terminals AB changes its polarity after each half cycle.



- During negative half cycle terminal A is negative so diode is reversed biased and conducts no current.
- So, current flows through diode during positive half cycle only.
- In this way current flows through load RL in one direction

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Half wave Rectifier

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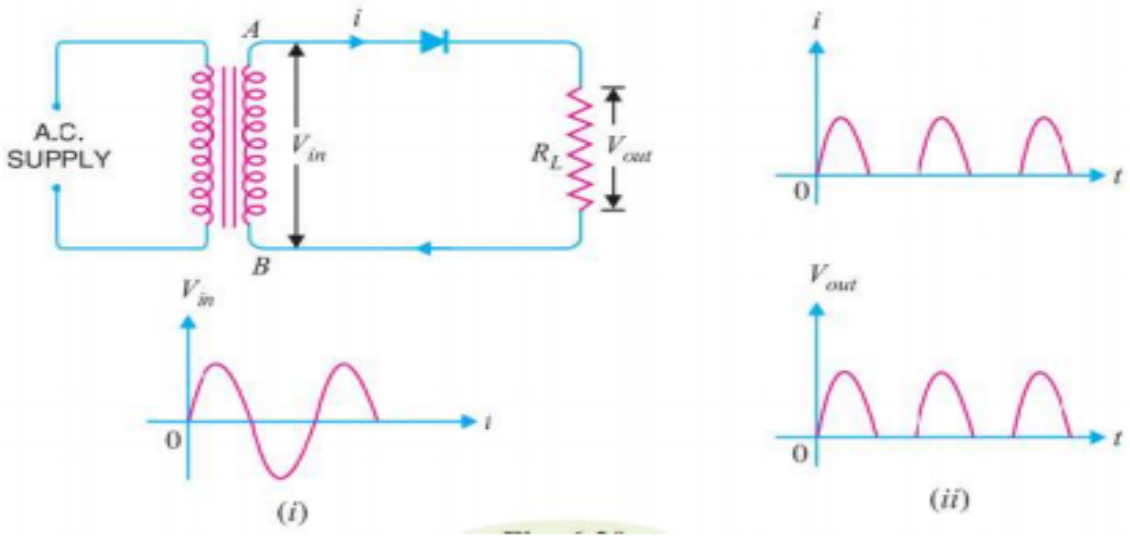

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Half wave Rectifier

- Disadvantage of Half wave rectifier:

  - The pulsating current in output contains ac components whose frequency is equal to supply frequency so filtering is needed.

  - The ac supply delivers power during half cycle only so output is low.

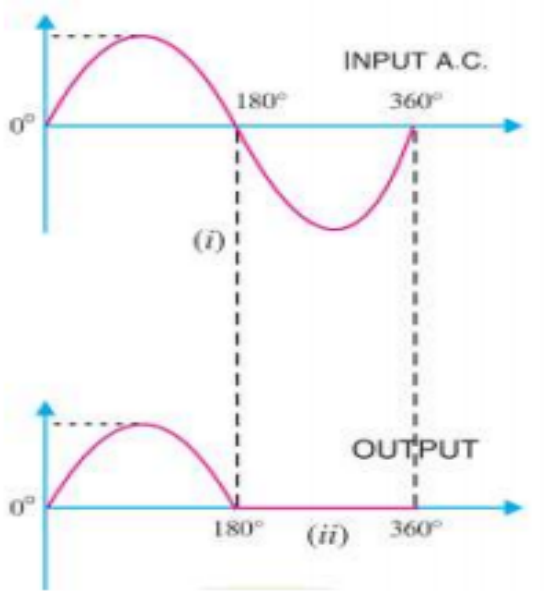
Half wave Rectifier

- Output frequency of HWR:

➢ Output frequency of HWR is equal to input frequency.

➢ This means when input ac completes one cycle, rectified wave also completes one cycle.

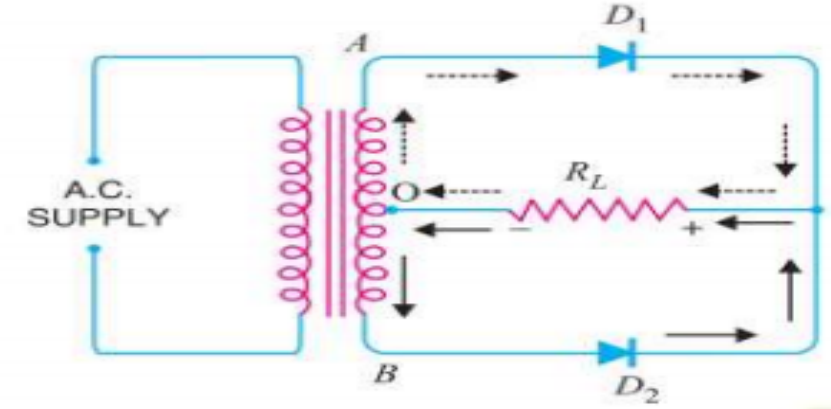
$$f_{out} = f_{in}$$

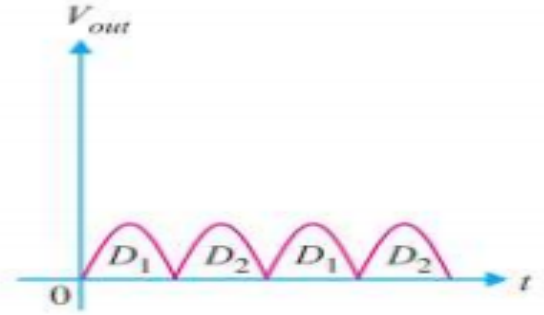


Full-Wave Rectifier

- In Full wave rectification current flow through the load in same direction for both half cycle of input ac.
- This can be achieved with two diodes working alternatively.
- For one half cycle one diode supplies current to load and for next half cycle another diode works.

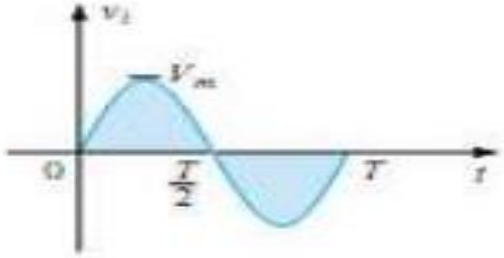
Centre Tap Full Wave Rectifier

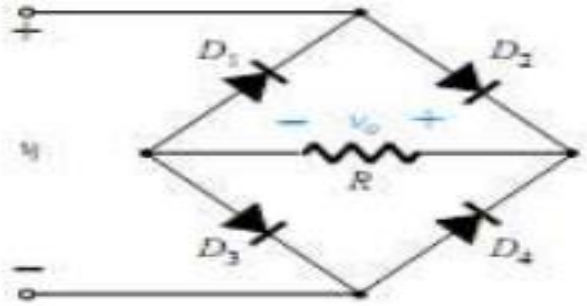




- Circuit has two diodes D1 , D2 and a centre tap transformer.
- During positive half cycle Diode D1 conducts and during negative half cycle Diode D2 conducts.
- It can be seen that current through load RL is in the same direction for both cycle.

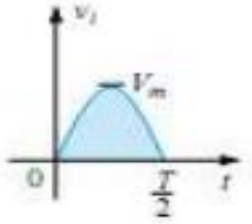
Full Wave Bridge Rectifier

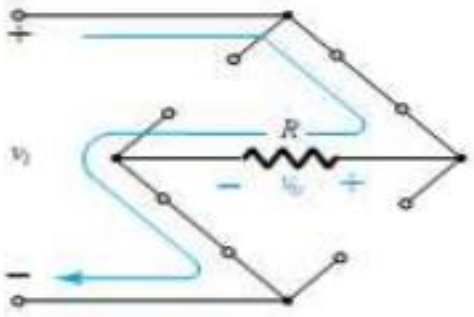


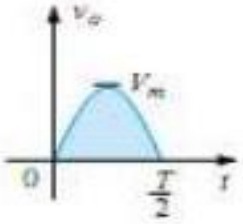


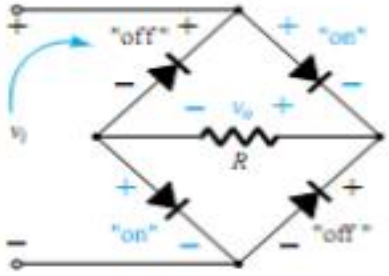
- Need for centre tapped PT is eliminated.
- Consists of 4 diodes instead of 2.

Full Wave Bridge Rectifier



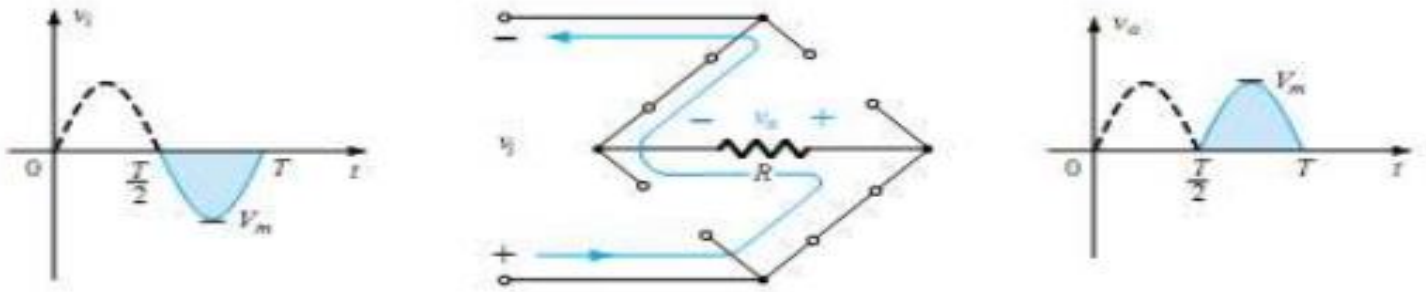






- During period t=0 to t=T/2 D2 and D3 are conducting while D1 and D4 are in the “off” state.

Full Wave Bridge Rectifier



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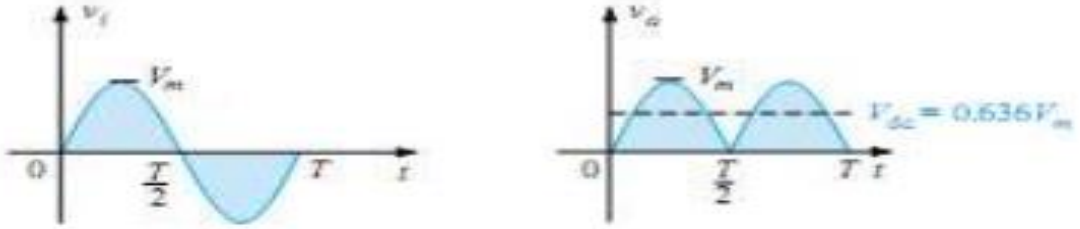
Full Wave Bridge Rectifier

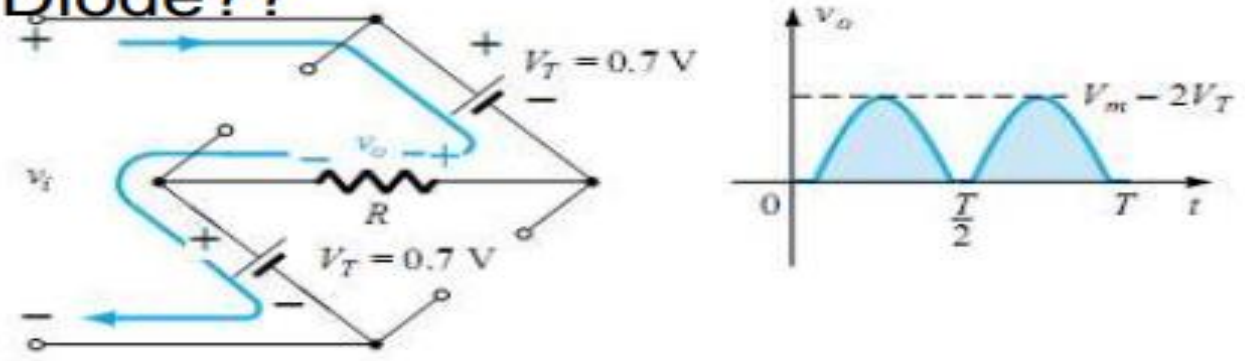


- Over one full cycle the input and output voltages will appear as shown in Fig.

$$V_{dc} = 2*(0.318V_m) = 0.636V_m$$

Full Wave Bridge Rectifier

What happens if we use silicon Diode instead of ideal Diode??



$$V_{dc} \cong 0.636\left(V_m - 2V_T\right)$$

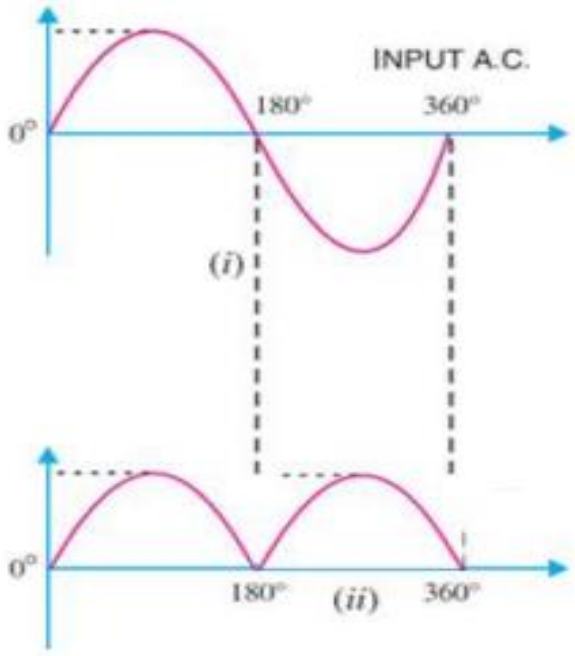
Full wave Rectifier

- Output frequency of FWR:

➢ Output frequency of FWR is equal to double of input frequency.

➢ This means when input ac completes one cycle, rectified wave completes two cycle.

$$f_{out} = 2f_{in}$$



Full Wave Bridge Rectifier

- Advantage:
  I. Need for centre tap Xformer is eliminated.
  II. PIV is one half of that of centre tap circuit.
  III. Output is twice than that of centre tap circuit.

Disadvantage

I. Requires 4 diodes.
II. Internal resistance voltage drop is twice than that of Centre Tap Circuit.

Ripple factor

The ripple factor is the ratio between the RMS value of the AC voltage (on the input side) and the DC voltage (on the output side) of the rectifier.

The formula for ripple factor is:

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

Which can also be rearranged to equal:

$$Ripple\ factor(r) = \frac{(I_{rms}^2 - I_{dc}^2)}{I_{dc}} = 1.21$$

The ripple factor of half wave rectifier is equal to 1.21 (i.e. $\gamma = 1.21$).

Note that for us to construct a good rectifier, we want to keep the ripple factor as low as possible. This is why we use capacitors and inductors as filters to reduce the ripples in the circuit.

Efficiency

Efficiency of Half Wave Rectifier

Rectifier efficiency (η) is the ratio between the output DC power and the input AC power. The formula for the efficieny is equal to:

$$\eta = \frac{P_{dc}}{P_{ac}}$$

The efficiency of a half wave rectifier is equal to 40.6% (i.e. η_{max} = 40.6%)

Efficiency & Peak inverse voltage

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Peak Inverse Voltage of Half Wave Rectifier

Peak Inverse Voltage (PIV) is the maximum voltage that the diode can withstand during reverse bias condition. If a voltage is applied more than the PIV, the diode will be destroyed.

Comparison between Half wave and full wave rectifiers

Comparison of Half wave Rectifiers and Full wave Rectifiers

S. No	Particulars	Half-wave	Centre-tap	Bridge type
1	No. of diodes	1	2	4
2	Transformer necessary	no	yes	no
3	Max. efficiency	40.6%	81.2%	81.2%
4	Ripple factor	1.21	0.48	0.48
5	Output frequency	f_{in}	$2f_{in}$	$2f_{in}$
6	Peak inverse voltage	V_m	$2V_m$	V_m