Rectifier Circuit
Lecture 5

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Rectification:

Let us now come to the most popular application of diode i.e. rectification. It is conversion of alternating current to direct current. This involves a device that only allows one way flow of electric charge. The simplest kind of rectifier circuit is the half wave rectifier circuit.

Half wave Rectifier Circuit:

It is the simplest form of rectifier and requires only one diode for the construction of half wave rectifier circuit. This circuit consists three main components; a diode, a transformer and a resistive load. It is defined as a type of rectifier that allows only one half cycle of an AC voltage wave form to pass while blocking the other half cycle.

The efficiency of half wave circuit is

$$\rho = \frac{Output\ DC\ Power}{Input\ AC\ power} = \frac{P_{DC}}{P_{AC}} = 40.6\% \rightarrow (i)$$

The Ripple Factor

$$\gamma = \sqrt{(\frac{V_{RMS}}{V_{DC}})^2 - 1} = 1.21 \rightarrow (ii)$$

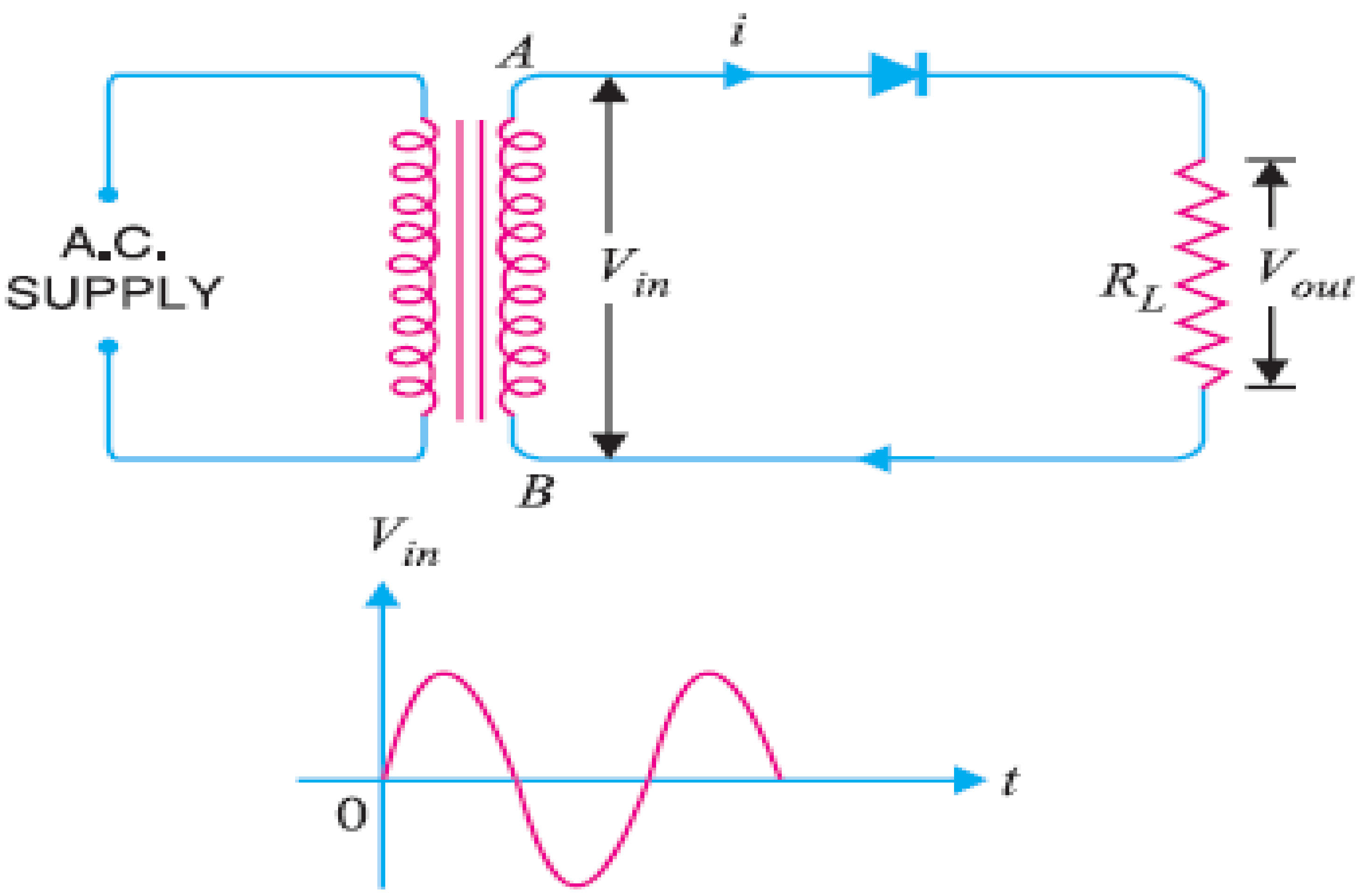

Fig 1

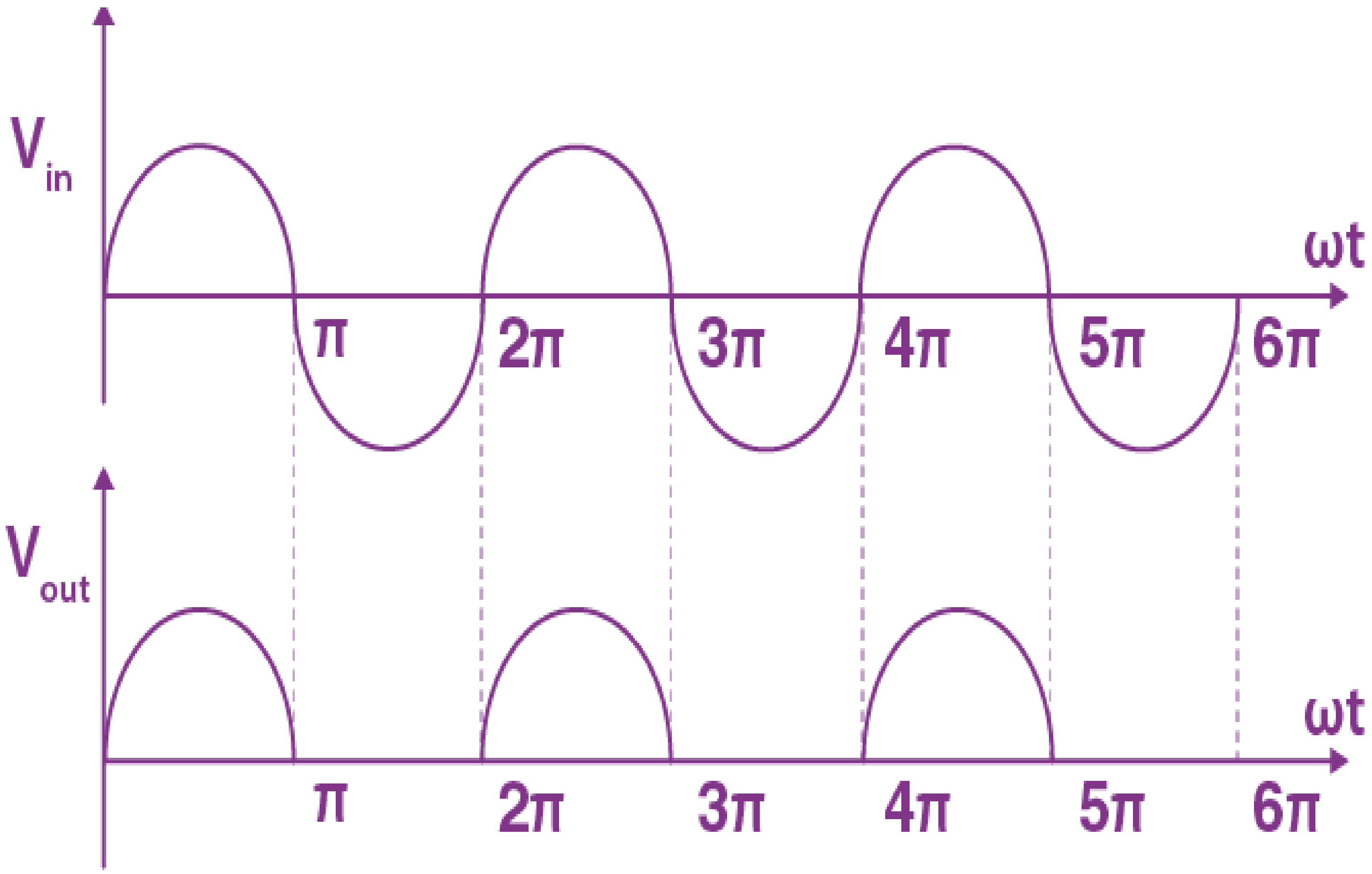

Fig 2

The form factor is

$$Form\ Factor = \frac{RMS\ value}{Avarage\ Value}$$

The application of half wave circuit are as follows

- Signal demodulation purpose
- Rectification of signal
- Signal peak application

The disadvantage of half wave rectifier circuit are

- Power Loss
- Low input voltage
- Output contains lot of ripples

Full Wave Rectifier Circuit:

A full wave rectifier circuit is defined as a rectifier that converts the complete cycle of alternating current into pulsating DC. Significant power lost while using half wave rectifier is not feasible in application that needs a smooth and steady supply. Therefore full wave rectifier circuit is used. A full wave rectifier utilize the full cycle. The lower efficiency of half wave rectifier can be overcome by the full wave rectifier. In this method a centre taped transformer is used. This circuit consist of a step down transformer and two diodes that are connected and centre taped. The output voltage is obtained across the load resistance. The input AC supplied to the full wave rectifier is very high.

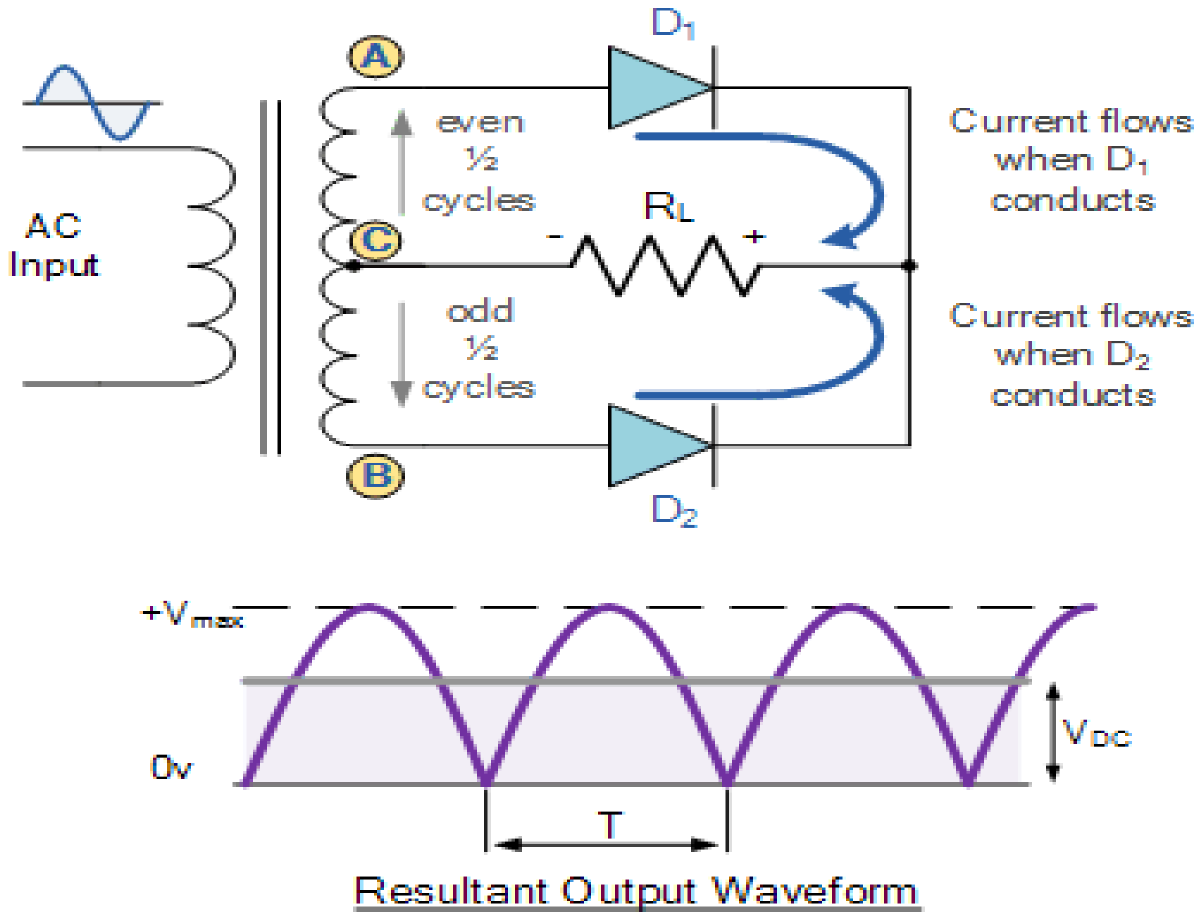
D1
A
even
½
cycles
AC
Input
C
RL
-
+
Current flows
when D1
conducts
odd
½
cycles
Current flows
when D2
conducts
B
D2
+Vmax
0v
VDC
T
Resultant Output Waveform

Fig 3

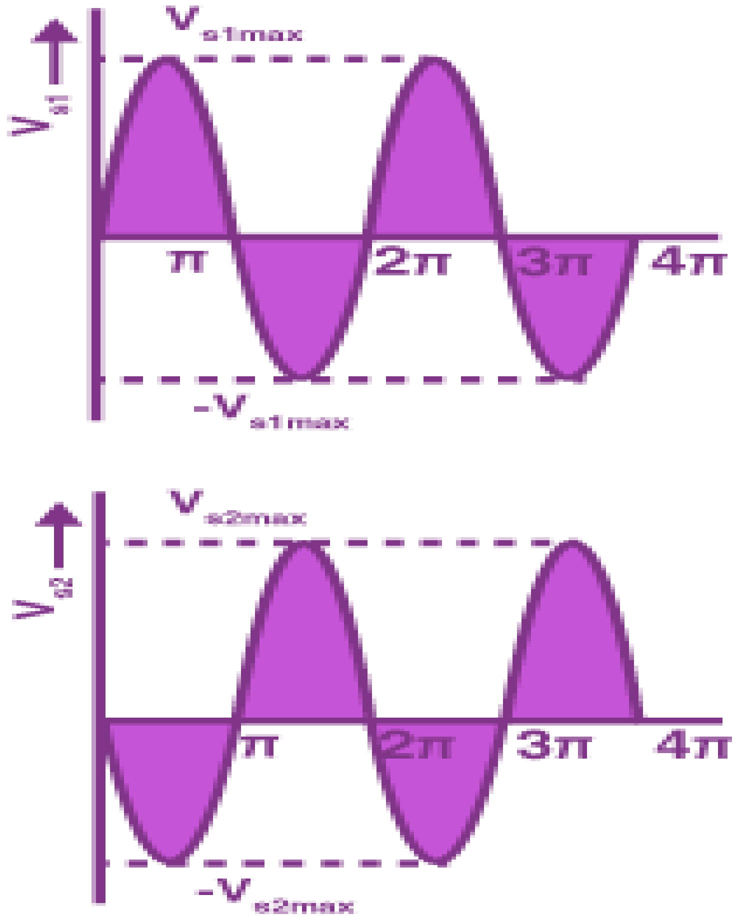

Fig 4 : Input Waveform

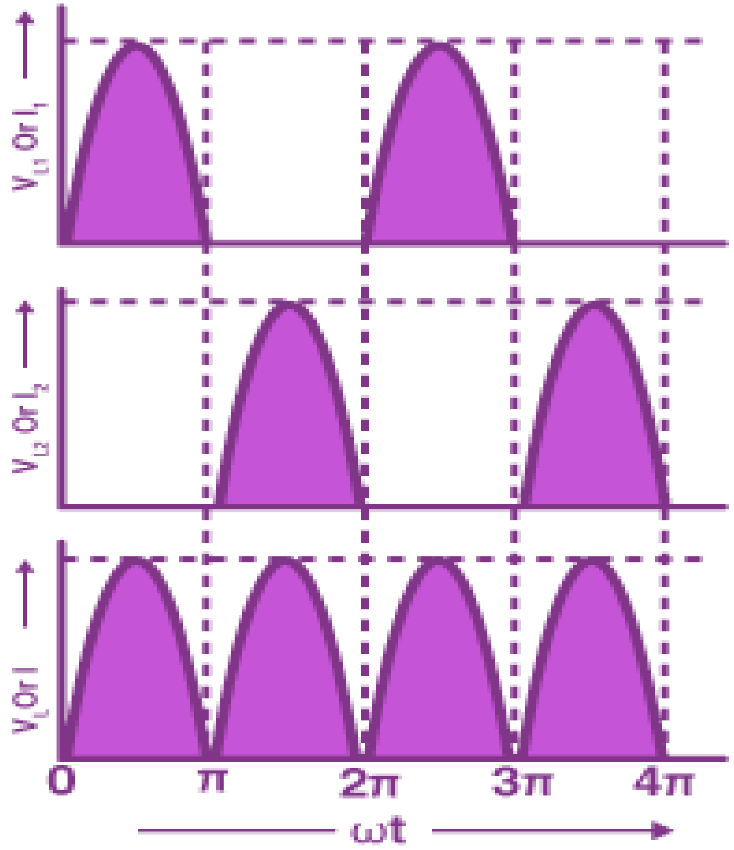

Fig 5 : Output Waveform

The step down transformer in the rectifier circuit converts the high voltage AC into low voltage AC. The anode of the centre taped diodes is connected to the secondary windings and connected to the load resistor. During the positive half cycle of the alternating current the top half of the secondary winding becomes positive while second half of the secondary winding becomes negative. During the positive half cycle the diode D_1 is forward biased as it is connected to top of the secondary winding while D_2 is reverse biased as it is connected to the bottom of the secondary winding. Due to this Diode D_1 will conduct acting as short circuit and D_2 will not conduct acting as an open circuit. During the negative half cycle the diode D_1 is reverse biased and diode D_2 is forward biased.

Because the top half of the secondary circuit becomes negative and bottom half of the circuit becomes positive. Thus a full wave rectifier, DC voltage is obtained for the both positive and negative half cycle. The peak inverse voltage of full wave rectifier is double that of a half wave rectifier. The peak inverse voltage across D_1 and D_2 is $2Vmax$.

The DC output voltage is

$$V_{DC} = \frac{2}{\pi} I_{max} R_L \rightarrow (iii)$$

The form factor

$$Form\ Factor = \frac{RMS\ current}{Average\ current} = 1.11 \rightarrow (iv)$$

The peak factor is

$$Peak\ Factor = \frac{Peak\ value\ of\ current}{RMS\ value\ of\ current} = \frac{I_{max}}{\frac{I_{max}}{\sqrt{2}}} = \sqrt{2} \rightarrow (v)$$

The efficiency of full wave rectifier is

$$\rho = \frac{DC\ output\ power}{AC\ output\ power} = 81.2\% \rightarrow (vi)$$

The ripple factor is

$$\gamma = 0.482$$

Advantage :

The efficiency is double than half wave rectifier.

The ripple factor is low than half wave rectifier.

The output voltage and output power obtained in the full wave rectifier are higher than that obtained in half wave rectifier.

Disadvantage:

The only disadvantage of full wave rectifier is that they need more circuit elements that of half wave rectifier that make it costly.

Bridge Rectifier Circuit:

Bridge rectifier circuits that convert alternating current (AC) into direct current (DC) using diodes in bridge circuit configuration. Bridge rectifier typically comprises of four or more diodes. The output wave generated is of the same polarity irrespective of the polarity in input.

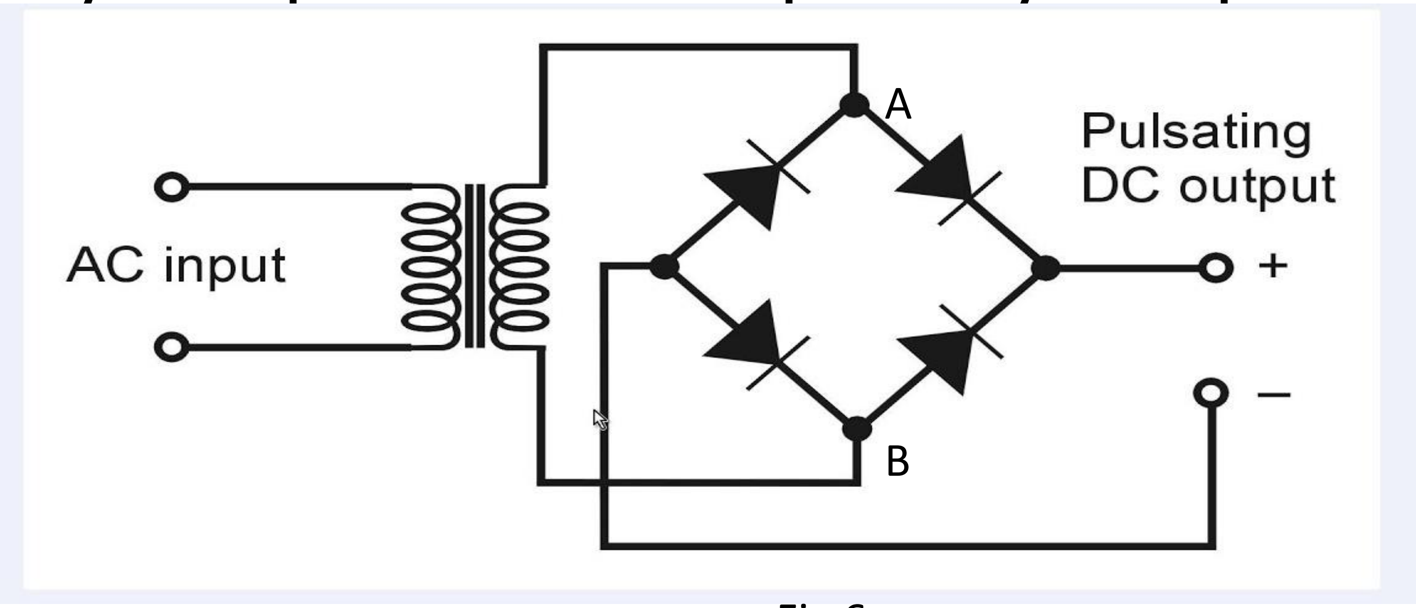

Fig 6

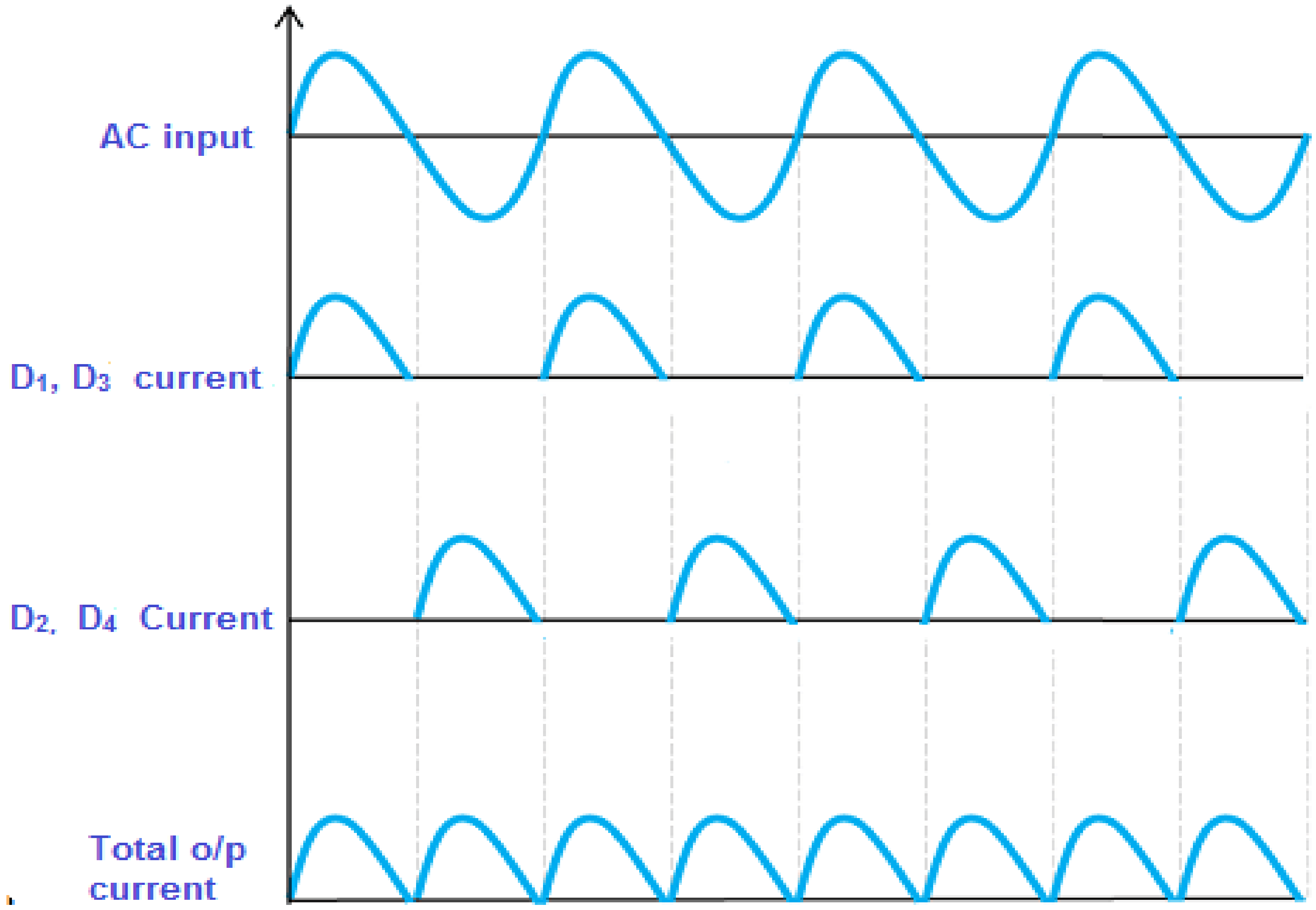

Fig 7

Bridge rectifier can be defined as a type of full wave rectifier that uses four or more diodes in a bridge circuit configuration to efficiently convert AC to DC current. Asa shown in fig 6 the bridge rectifier circuit is made up of four diodes $D_1, D_2, D_3, D_4$and a load resistor R_L. The four diodes are connected in a closed loop configuration. The main advantage of this configuration is the absence of expensive transformer. Therefore the size and cost are reduced. The input signal is applied into point A and B. The output DC signal is obtain at the other two terminal through load resistance R_L. The four diodes are connected in such a way that only two diodes are conducted for each half cycle. The D_1, D_2 are conducted for positive half cycle and D_3, D_4 conduct for negative half cycle.

When AC signal is applied across the bridge rectifier, during the positive half cycle terminal A becomes positive and terminal B becomes negative. This results the diode D_1 and D_3 become forward biased, while D_2 and D_4 are in reverse biased. During the negative half cycle the terminal B becomes positive while terminal A becomes negative. This causes diode D_2 and D_4 to become forward biased, while D_1 and D_3 becomes reverse biased. The current flow across the load resistance R_L is the same during positive and negative half cycle.

The ripple factor for bridge rectifier circuit is

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

It is equal to i.e.

$$\gamma = .48$$

The efficiency is

$$\eta = \frac{DC\ output\ power}{AC\ output\ power} = 81.2\% \rightarrow (viii)$$

Advantage:

The efficiency is better than half wave rectifier circuit.

The DC output signal is smother.

In this case output signal is almost same with the input signal.

Disadvantage:

It is a complex circuit rather than half and full wave circuit. When more diodes are used more power loss occur. In bridge rectifier two diodes connected in series conduct in each half cycle, then voltage drop is higher in this case.