SNS COLLEGE OF TECHNOLOGY

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF COMPUTER SCIENCE AND DESIGN

COURSE NAME : 23EET103- ELECTRIC CIRCUITS AND ELECTRON DEVICES

I YEAR /II SEMESTER

Unit-5 - RECTIFIERS AND POWER SUPPLIES

Topic : **Rectifiers:** Full wave

Which type of rectifier should be used for AC to DC conversion?

DT-Empathize

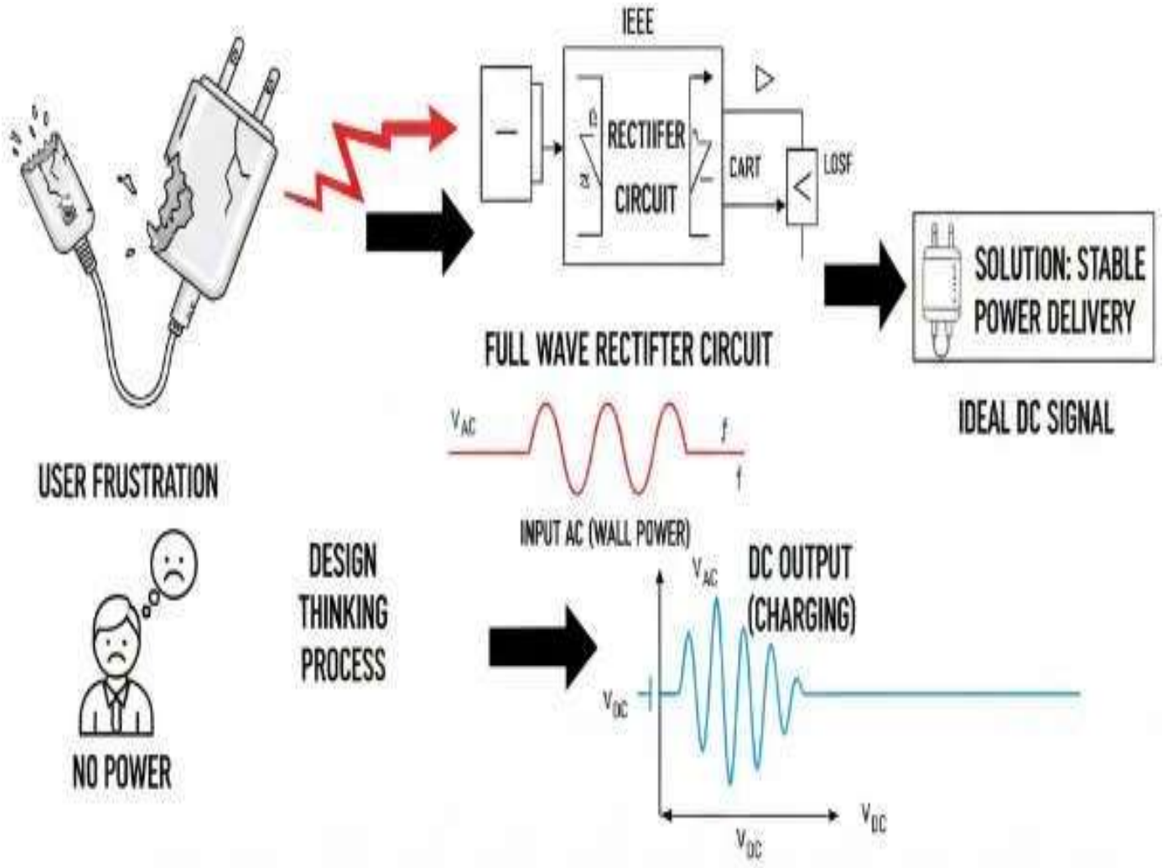
Electric circuits that convert AC to DC are known as rectifiers. Rectifiers are classified into two types as Half Wave Rectifiers and Full Wave Rectifiers.

Significant power is lost while using a half-wave rectifier and is not feasible for applications that need a smooth and steady supply.

DT-Empathize

Topics for discussion

- Defining Full Wave Rectifiers
- Full Wave Rectifier Circuit
- Working of Full Wave Rectifier
- Full Wave Rectifier Formula
- Peak Inverse Voltage
- DC Output Voltage
- RMS Value of Current
- Form Factor
- Peak Factor
- Rectification Efficiency
- Advantages of Full Wave Rectifier
- Frequently Asked Questions – FAQs



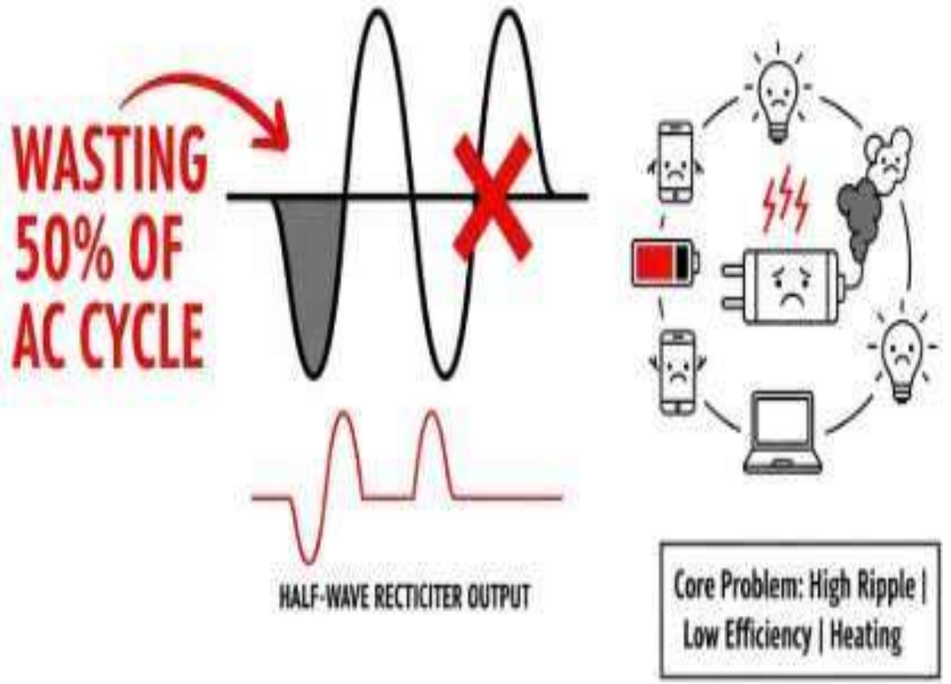
Defining Full Wave Rectifiers

A full wave rectifier is defined as a rectifier that converts the complete cycle of alternating current into pulsating DC.

Unlike halfwave rectifiers that utilize only the halfwave of the input AC cycle, full wave rectifiers utilize the full cycle.

The lower efficiency of the half wave rectifier can be overcome by the full wave rectifier.

DT-DEFINE



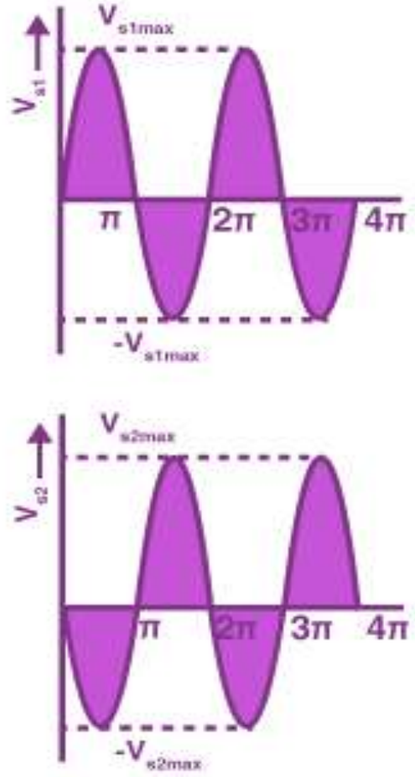
Full Wave Rectifier Circuit

The circuit of the full wave rectifier can be constructed in two ways. The first method uses a centre tapped transformer and two diodes.

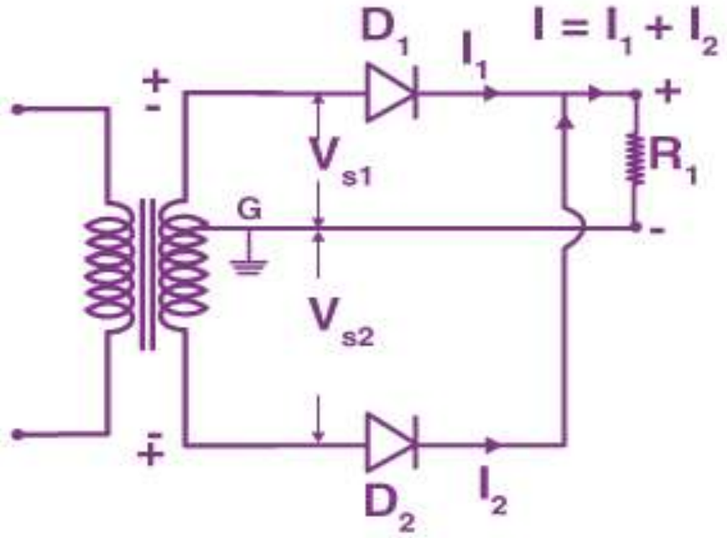
This arrangement is known as a centre tapped full wave rectifier. The second method uses a standard transformer with four diodes arranged as a bridge.This is known as a bridge rectifier.

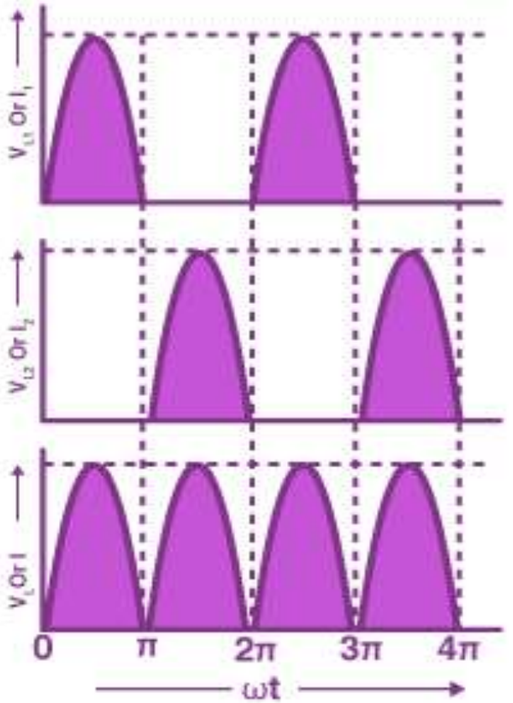
CENTRE-TAP FULL WAVE RECTIFIER

DT-IDEATE



Input voltage waveform





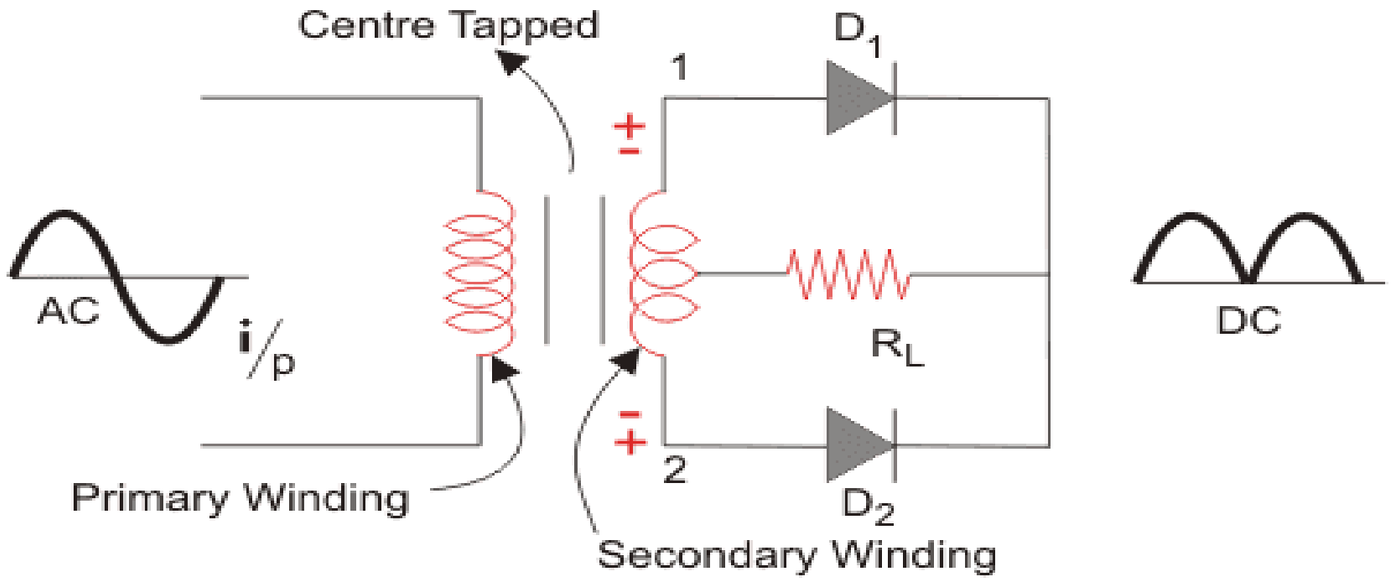
Output voltage waveform

The circuit of the full wave rectifier consists of a step-down transformer and two diodes that are connected and centre tapped. The output voltage is obtained across the connected load resistor.

Working of Full Wave Rectifier

- During the positive half cycle of the alternating current, the top half of the secondary winding becomes positive while the second half of the secondary winding becomes negative.
- During the positive half cycle, diode D_1 is forward biased as it is connected to the top of the secondary winding while diode 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 a 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 the diode D_2 is forward biased because the top half of the secondary circuit becomes negative and the bottom half of the circuit becomes positive.

Full wave rectifiers are further classified into:
Centre-tapped Full Wave Rectifier
Full Wave Bridge Rectifier



Centre Tapped Full Wave Rectifier
Figure - 1

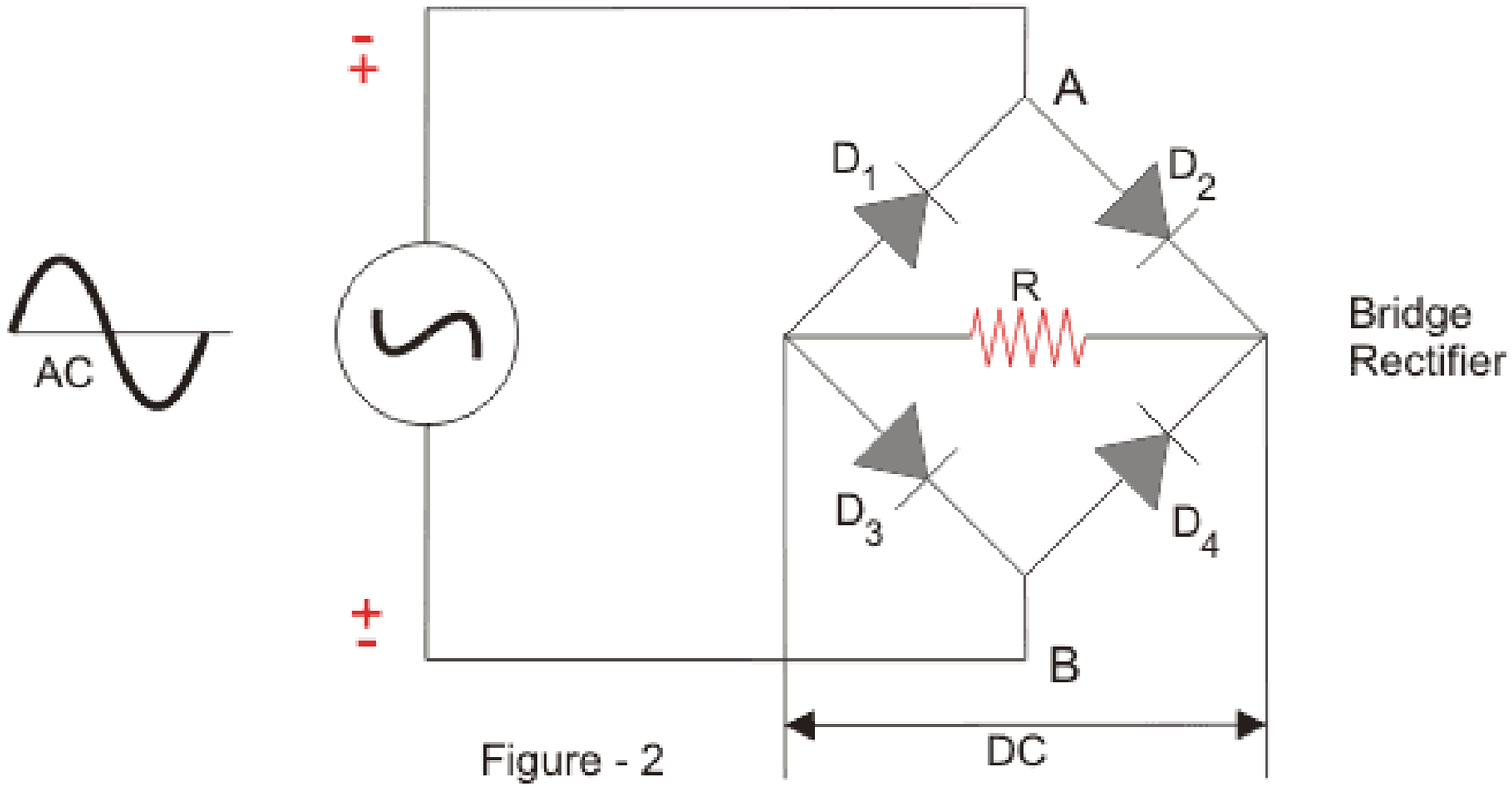


Figure - 2

Centre-tapped Full Wave Rectifier

Construction of Centre-tapped Full Wave Rectifier

A centre-tapped full-wave rectifier system consists of:
Centre-tapped Transformer
Two Diodes
Resistive Load

Centre-tapped Transformer: – It is a normal transformer with one slight modification. It has an additional wire connected to the exact centre of the secondary winding.

This type of construction divides the AC voltage into two equal and opposite voltages, namely +Ve voltage (V_a) and -Ve voltage (V_b). The total output voltage is

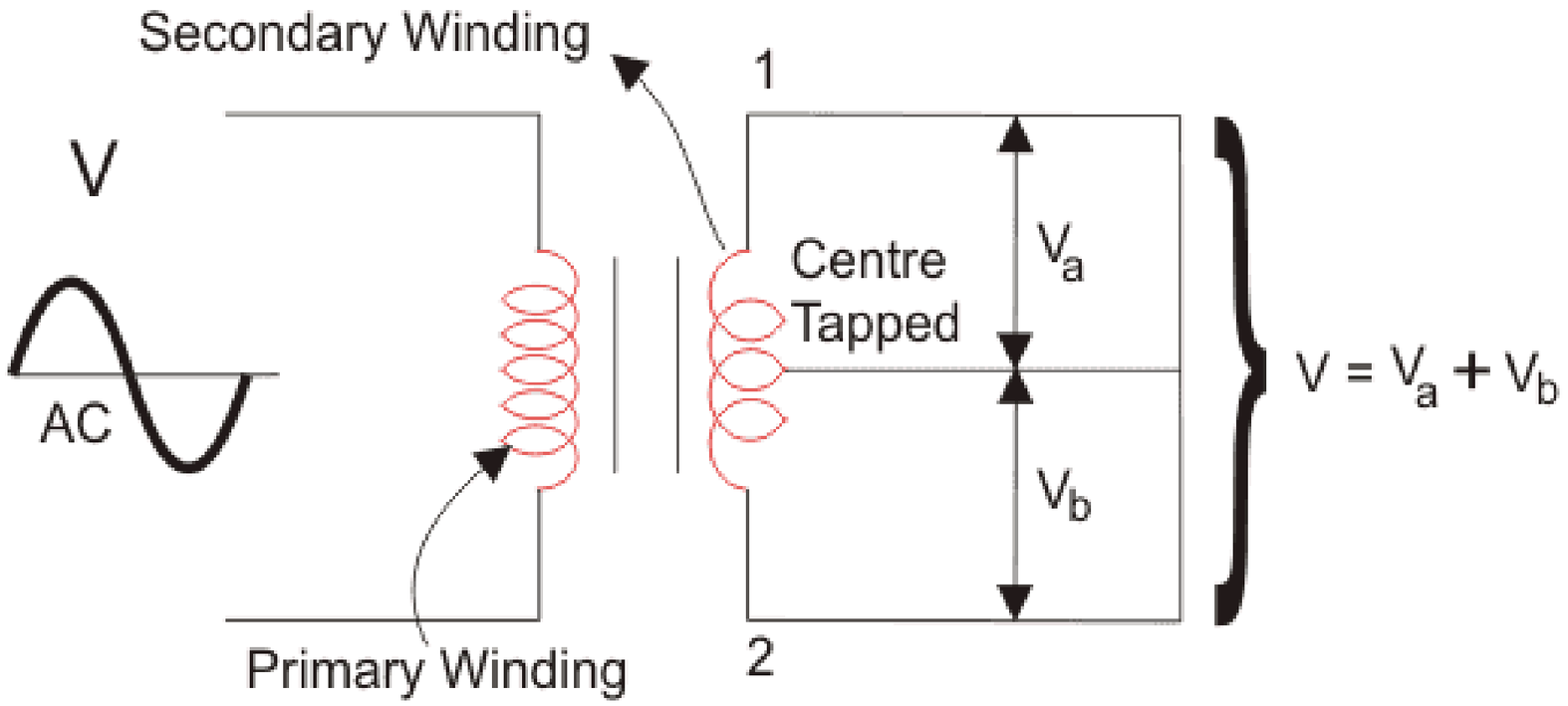

Secondary Winding
1
V
Centre
Tapped
V_a
AC
V_b
$V = V_a + V_b$
Primary Winding
2

Figure - 3

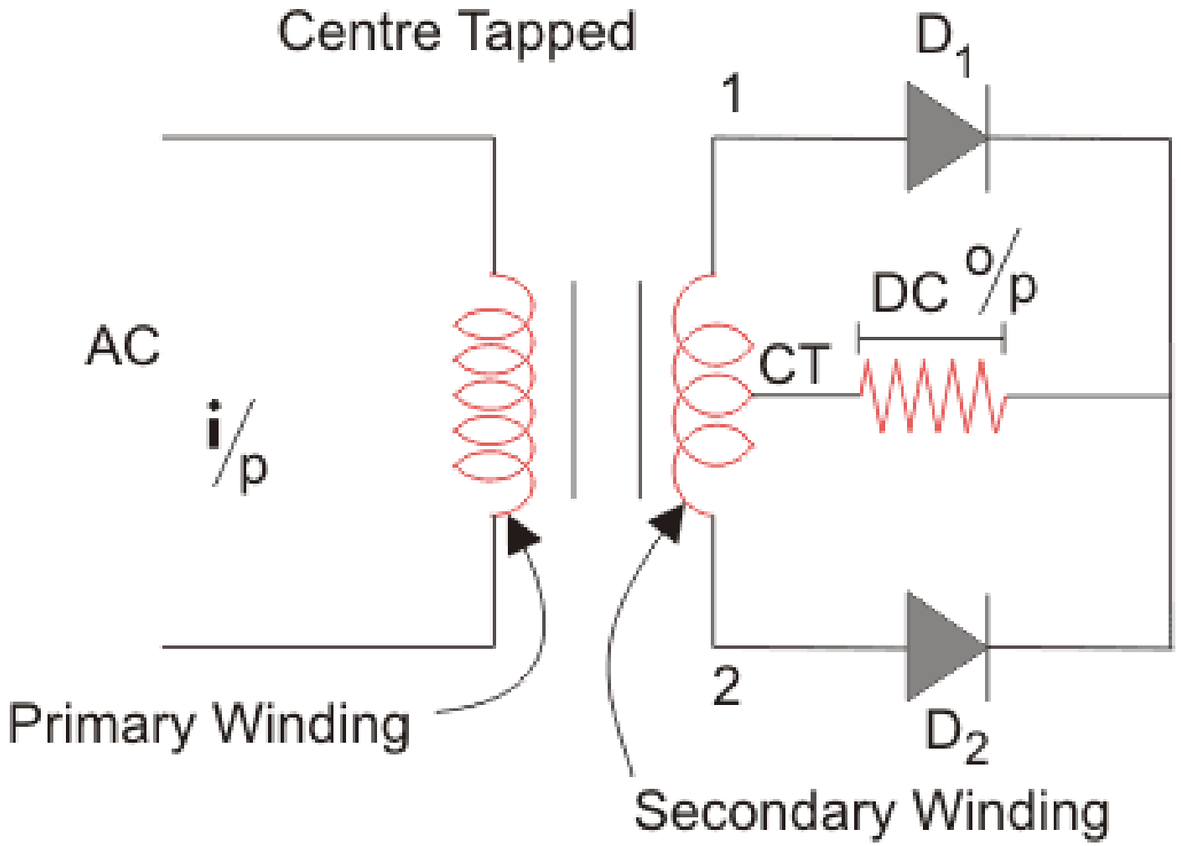

Centre Tapped
D1
1
AC
i/p
DC o/p
CT
2
D2
Primary Winding
Secondary Winding

Figure - 4

Working of Centre-tapped Full Wave Rectifier

We apply an AC voltage to the input transformer. During the positive half-cycle of the AC voltage, terminal 1 will be positive, centre-tap will be at zero potential, and terminal 2 will be negative potential.

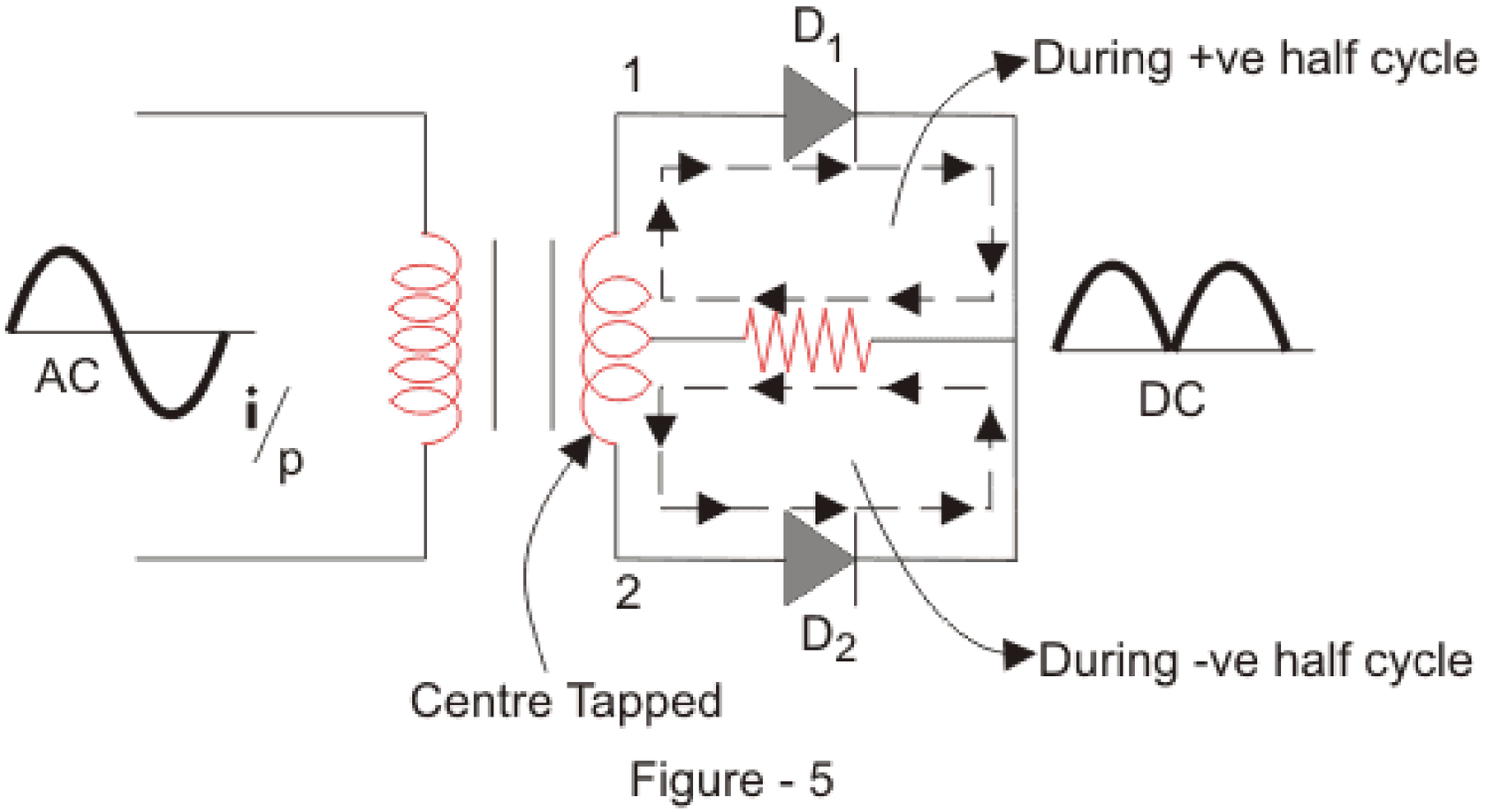


Figure - 5

This will lead to forwarding bias in diode D_1 and cause current to flow through it. During this time, diode D_2 is in reverse bias and will block current through it.

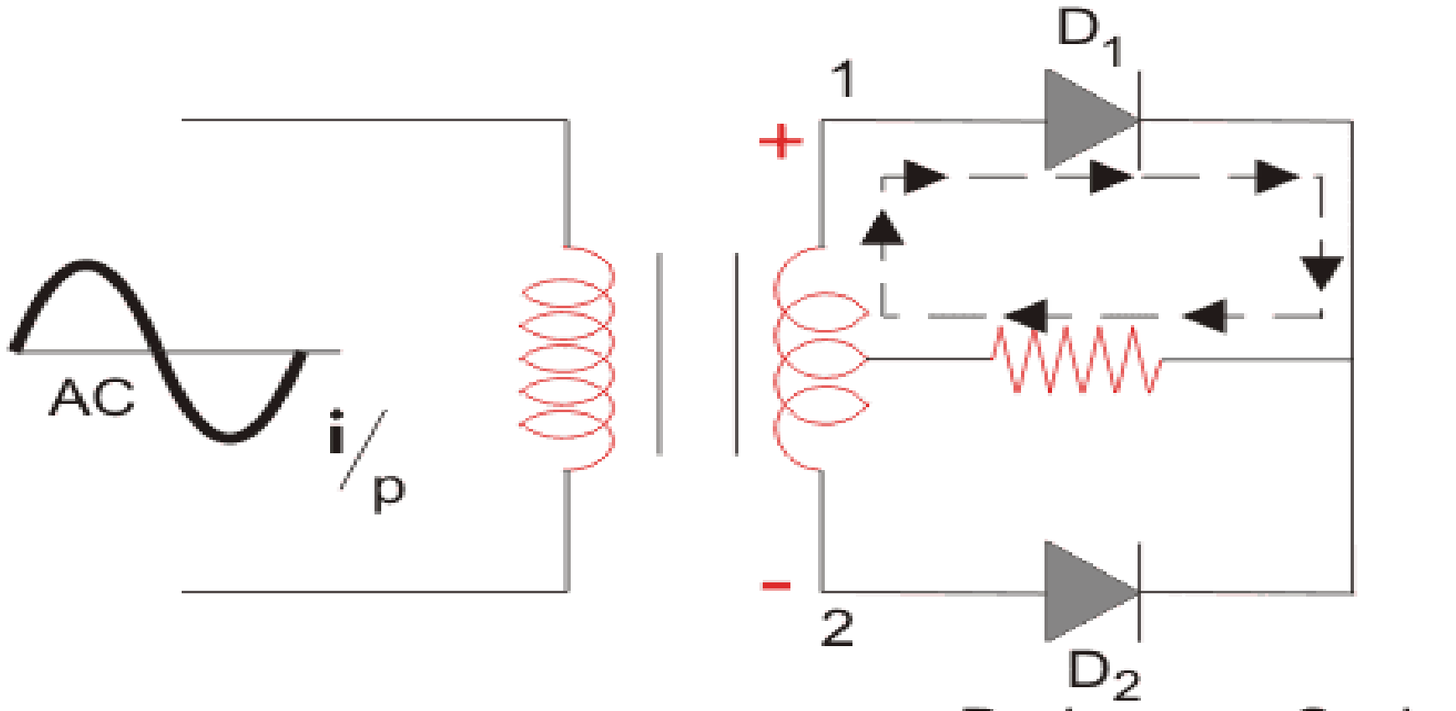
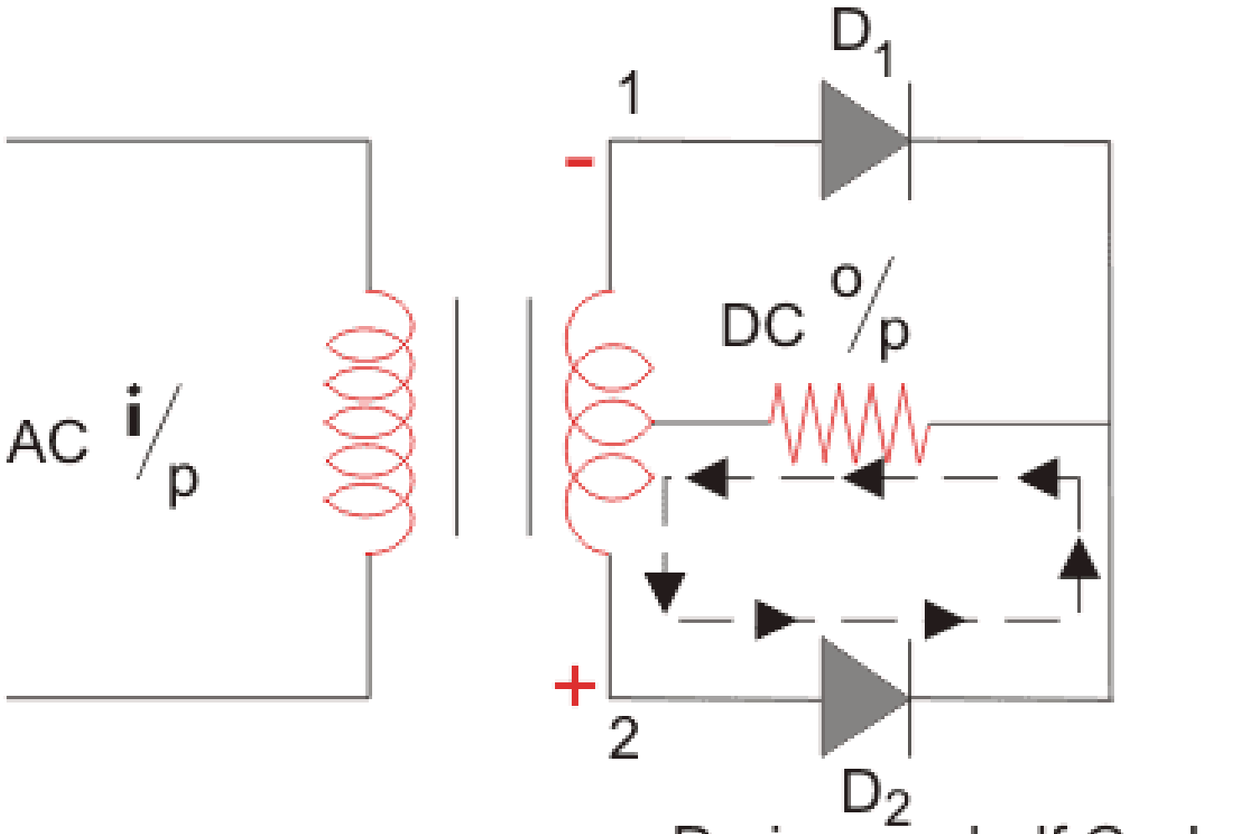


Figure - 6

During the negative half-cycle of the input AC voltage, terminal 2 will become positive relative to terminal 2 and centre-tap. This will lead to forwarding bias in diode D_2 and cause current to flow through it. During this time, diode D_1 is in reverse bias and will block current through it.



During -ve half Cycle

Figure - 7

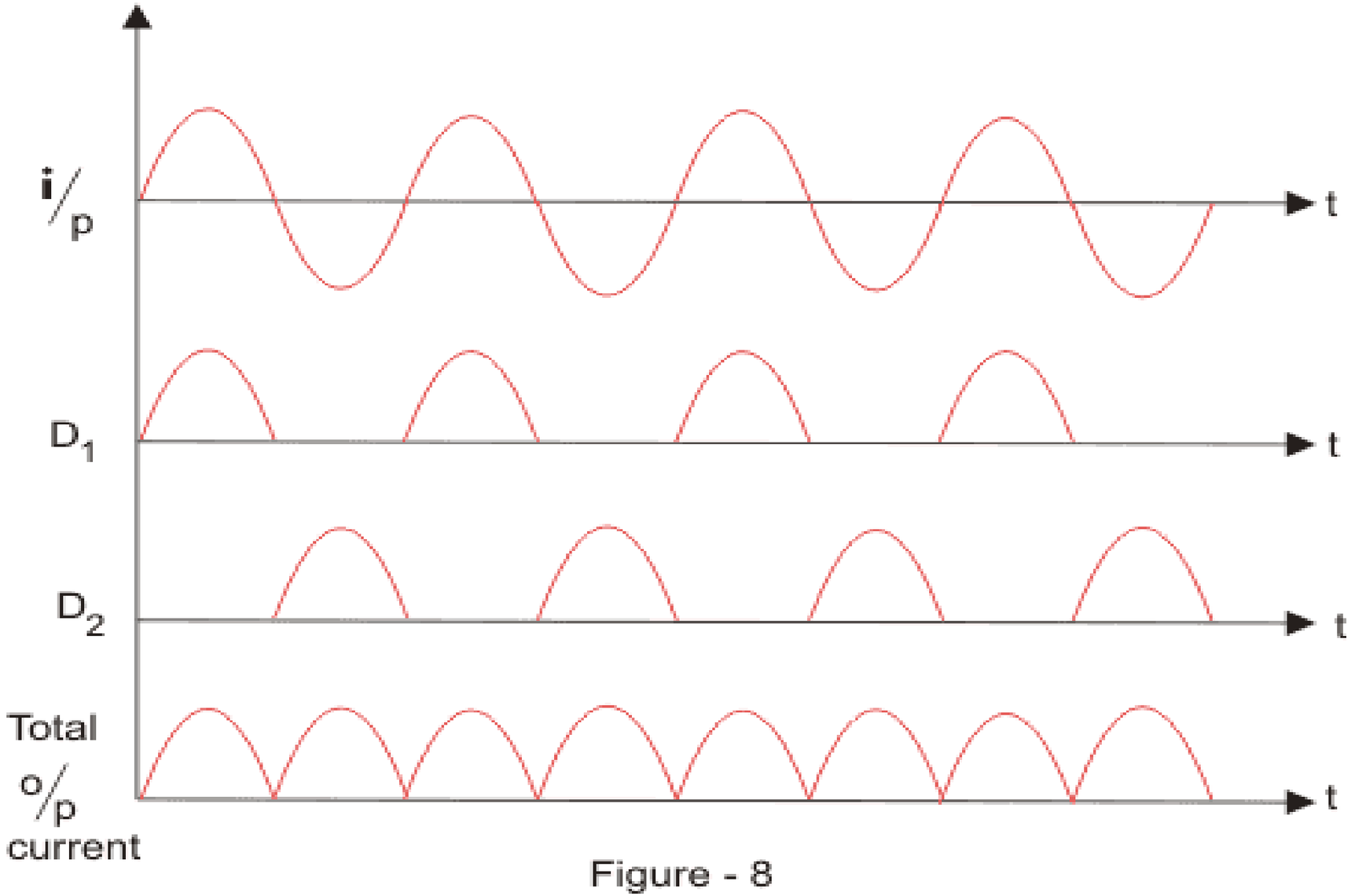


Figure - 8

During the positive cycle, diode D_1 conducts, and during the negative cycle, diode D_2 conducts and during the positive cycle.

As a result, both half-cycles are allowed to pass through. The average output DC voltage here is almost twice the DC output voltage of a half-wave rectifier.

We get a pulsating DC voltage with many ripples as the output of the centre-tapped full wave rectifier. We cannot use this pulsating for practical applications.

So, to convert the pulsating DC voltage to pure DC voltage, we use a filter circuit as shown above. Here we place a capacitor across the load.

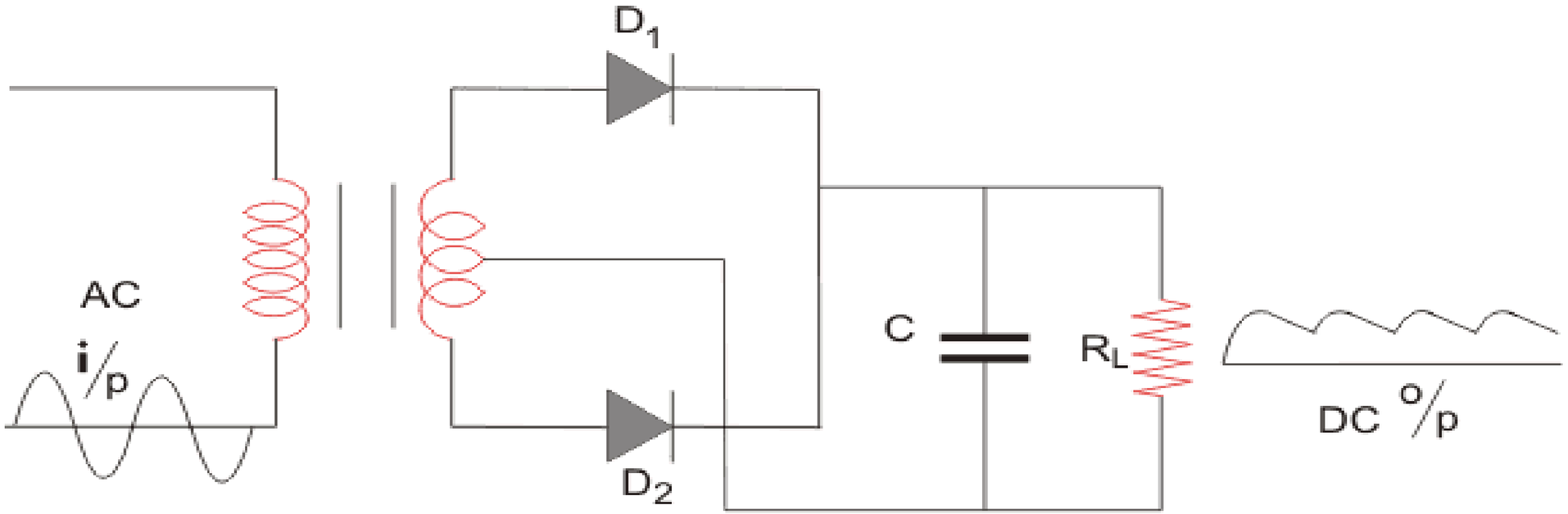


Figure - 9

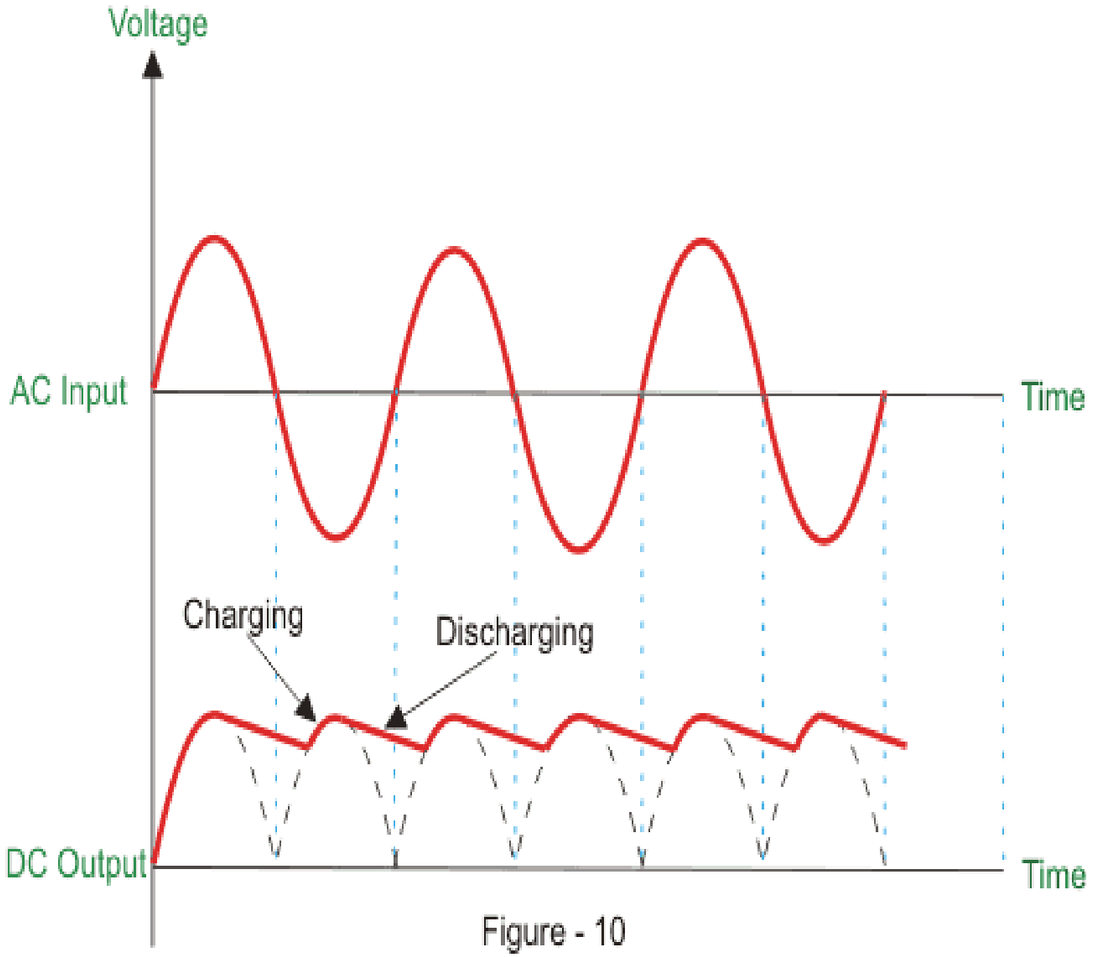
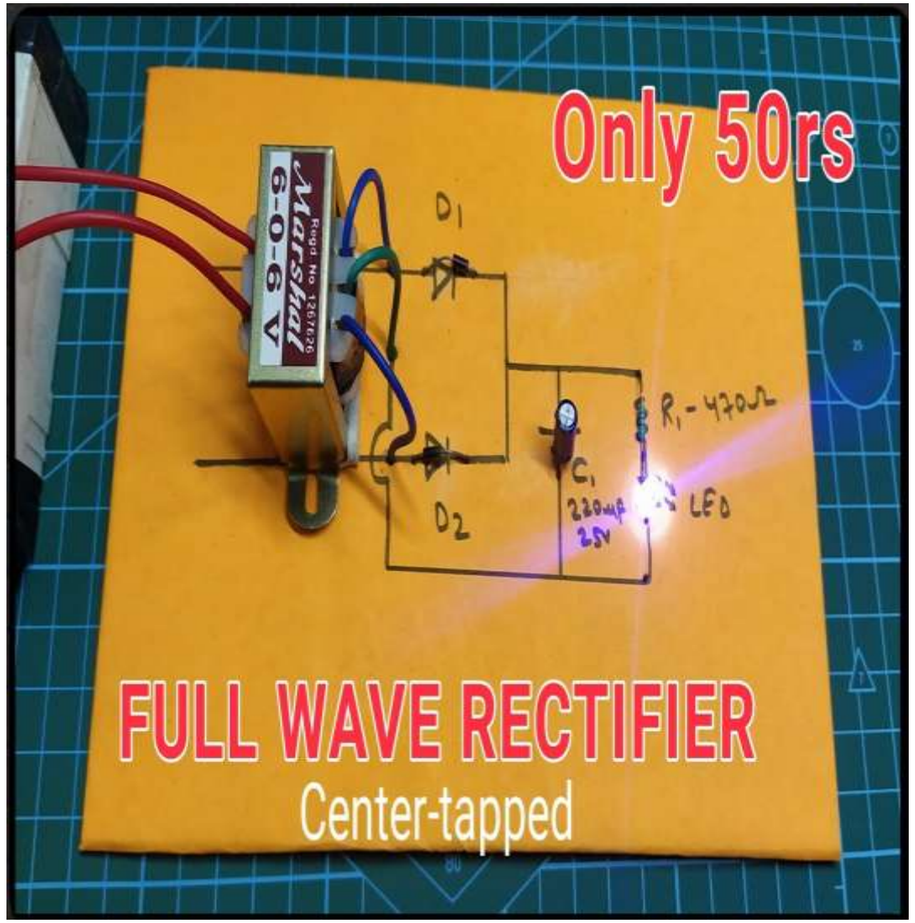


Figure - 10

DT-Prototype



Full Wave Rectifier Formula

Peak Inverse Voltage

Peak inverse voltage is the maximum voltage a diode can withstand in the reverse-biased direction before breakdown. The peak inverse voltage of the full-wave rectifier is double that of a half-wave rectifier. The PIV across D_1 and D_2 is $2V_{max}$.

DC Output Voltage

The following formula gives the average value of the DC output voltage:

$$V_{dc} = I_{av}R_L = \frac{2}{\pi} I_{max}R_L$$

RMS Value of Current

The RMS value of the current can be calculated using the following formula:

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

Form Factor

The form factor of the full wave rectifier is calculated using the formula:

$$K_f = \frac{RMS\ value\ of\ current}{Average\ value\ of\ current} = \frac{I_{rms}}{I_{dc}} = \frac{I_{max}/\sqrt{2}}{2I_{max}/\pi} = \frac{\pi}{2\sqrt{2}} = 1.11$$

Peak Factor

The following formula gives the peak factor of the full wave rectifier:

$$K_p = \frac{Peak\ value\ of\ current}{RMS\ value\ of\ current} = \frac{I_{max}}{I_{max}/\sqrt{2}} = \sqrt{2}$$

Rectification Efficiency

The rectification efficiency of the full-wave rectifier can be obtained using the following formula:

$$\eta = \frac{DC\ Output\ Power}{AC\ Output\ Power}$$

The efficiency of the full wave rectifiers is 81.2%.

Advantages of Full Wave Rectifier

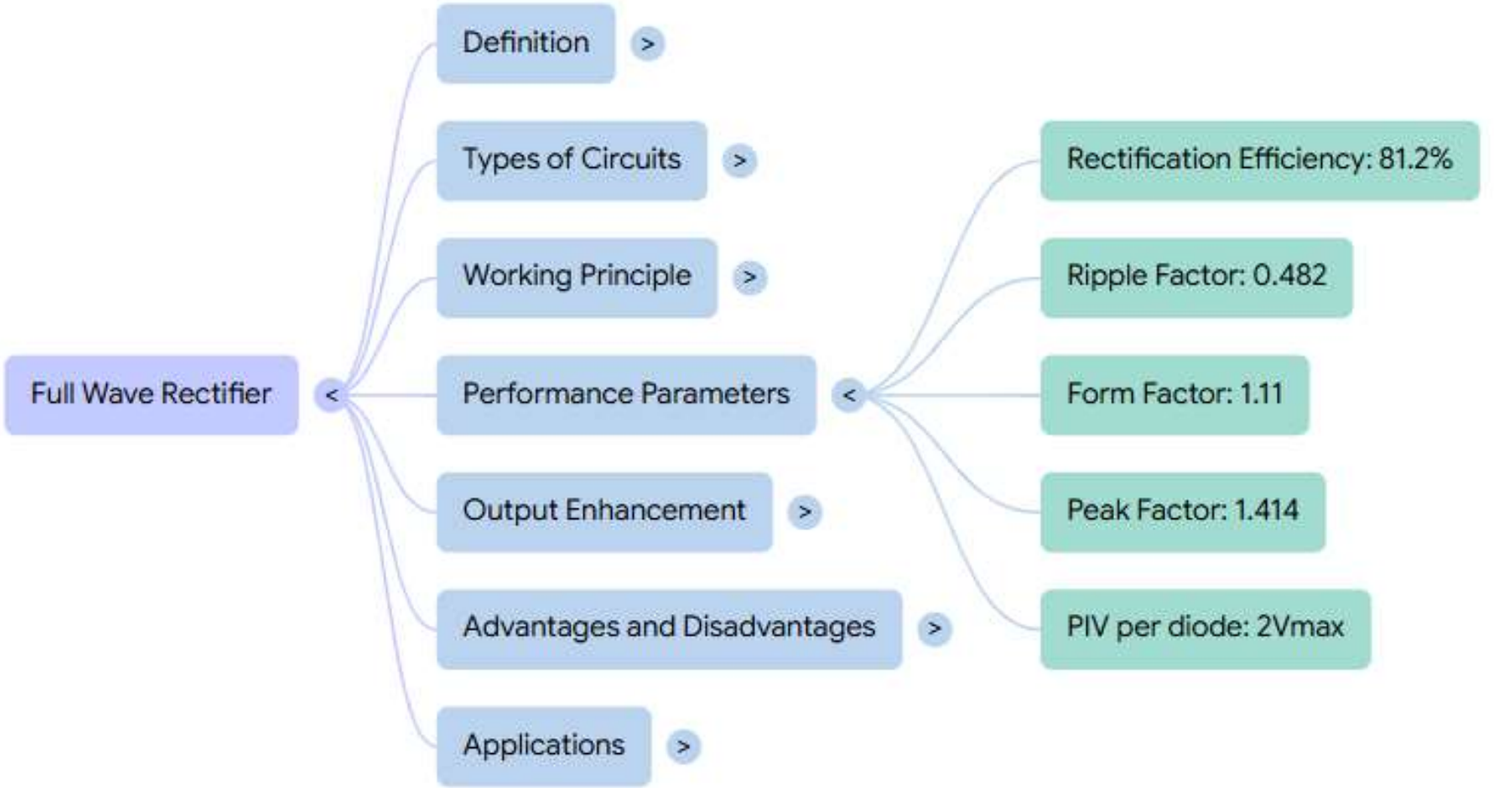
The rectification efficiency of full wave rectifiers is double that of half wave rectifiers. The efficiency of half wave rectifiers is 40.6% while the rectification efficiency of full wave rectifiers is 81.2%.

The ripple factor in full wave rectifiers is low hence a simple filter is required. The value of ripple factor in full wave rectifier is 0.482 while in half wave rectifier it is about 1.21.

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

The only disadvantage of the full wave rectifier is that they need more circuit elements than the half wave rectifier which makes, making it costlier.

Summary


Full Wave Rectifier
Definition
Types of Circuits
Working Principle
Performance Parameters
Output Enhancement
Advantages and Disadvantages
Applications
Rectification Efficiency: 81.2%
Ripple Factor: 0.482
Form Factor: 1.11
Peak Factor: 1.414
PIV per diode: 2Vmax

1.Multiple Choice: A centre-tapped full wave rectifier requires:
A) One diode
B) Two diodes
C) Four diodes
D) Six diodes
(Correct: B)

1.Scenario: You are designing a power supply for a 12V DC LED system. Which rectifier will reduce ripple better, half wave or full wave? Explain with reasoning.

1.Real-time: If peak AC voltage is 20V, find the average output voltage of the full wave rectifier.

References

Muthusubramanian R, Salivahanan S, "Basic Electrical and Electronics Engineering", TataMcGrawHillPublishers,2014.
Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", Second Edition, McGraw Hill Education, 2020.

Thank you