LECTURE

APPLIED PHYSICS

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TOPIC:

RECTIFIER

CONTENTS:

What is a Rectifier?

- A rectifier is an electrical component that converts alternating current (AC) to direct current (DC). A rectifier is analogous to a one-way valve that allows an electrical current to flow in only one direction. The process of converting AC current to DC current is known as rectification.
- The rectifier consists of semiconductor diodes to do this function. There are various types of rectifiers namely: half-wave, full-wave, and full-wave bridges.

Different Types of Rectifier

Rectifiers are mainly classified into two types as:

1. Uncontrolled Rectifier
2. Controlled Rectifier

Uncontrolled Rectifiers

The type of rectifier whose voltage cannot be controlled is known as an uncontrolled rectifier. Uncontrolled rectifiers are further divided as follows:

1. Half Wave Rectifier 2. Full Wave Rectifier

The type of rectifier that converts only the half cycle of the alternating current into the direct current is known as a half-wave rectifier. Likewise, a full-wave rectifier converts both positive and negative half cycles of the AC. An example of this is a bridge rectifier. A bridge rectifier uses 4 diodes that are connected in the form of a Wheatstone bridge.

Controlled Rectifiers

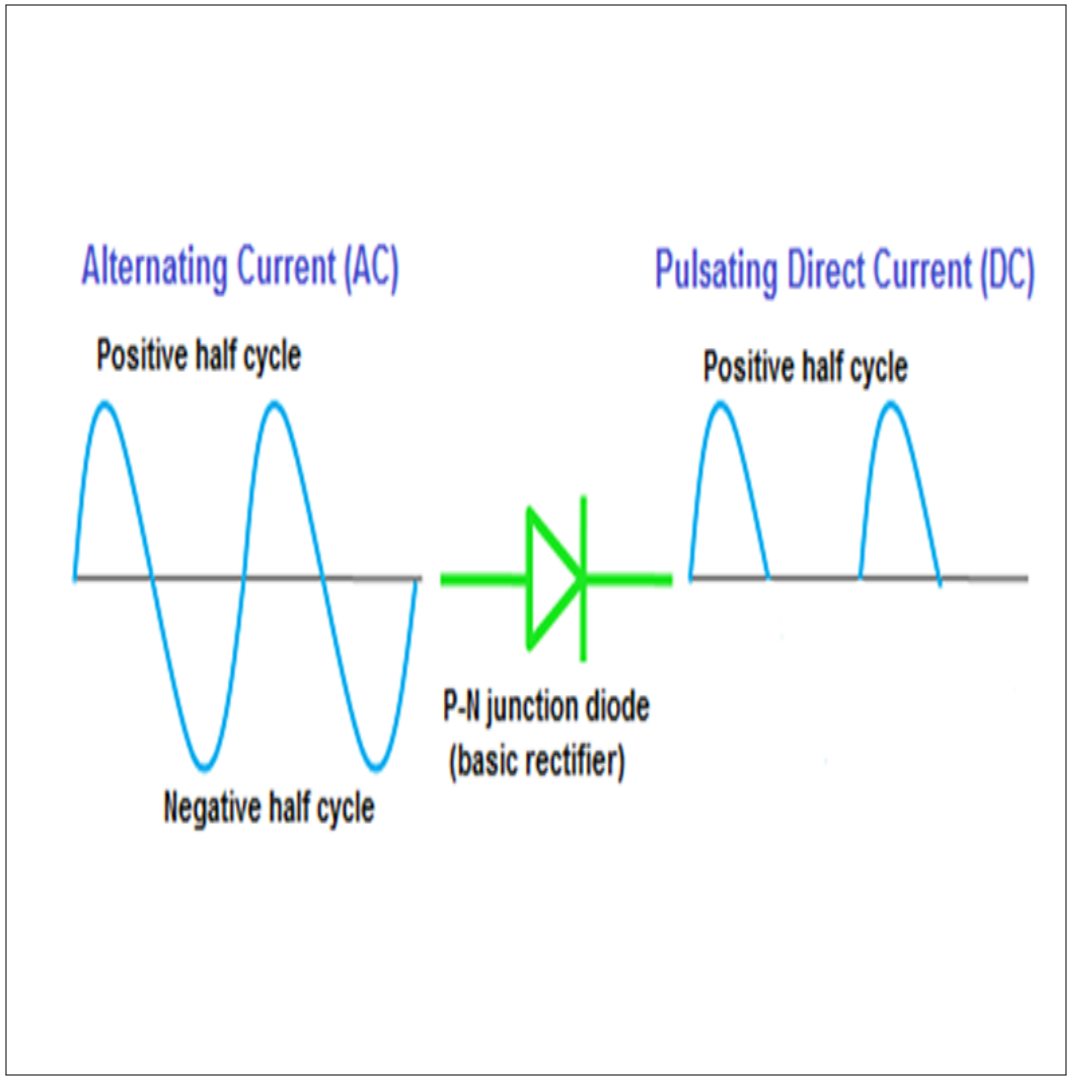
A type of rectifier whose voltage can be varied is known as the controlled rectifier. We use SCRs and MOSFETs to make an uncontrolled rectifier a controlled one. These rectifiers are preferred over their uncontrolled counterparts. There are two types of controlled rectifiers, and they are Half Wave Controlled Rectifier and Full Wave Controlled Rectifier. Half-wave controlled rectifier has the same design as the half-wave uncontrolled rectifier except we replace the diode with an SCR.

Half Wave Rectifier

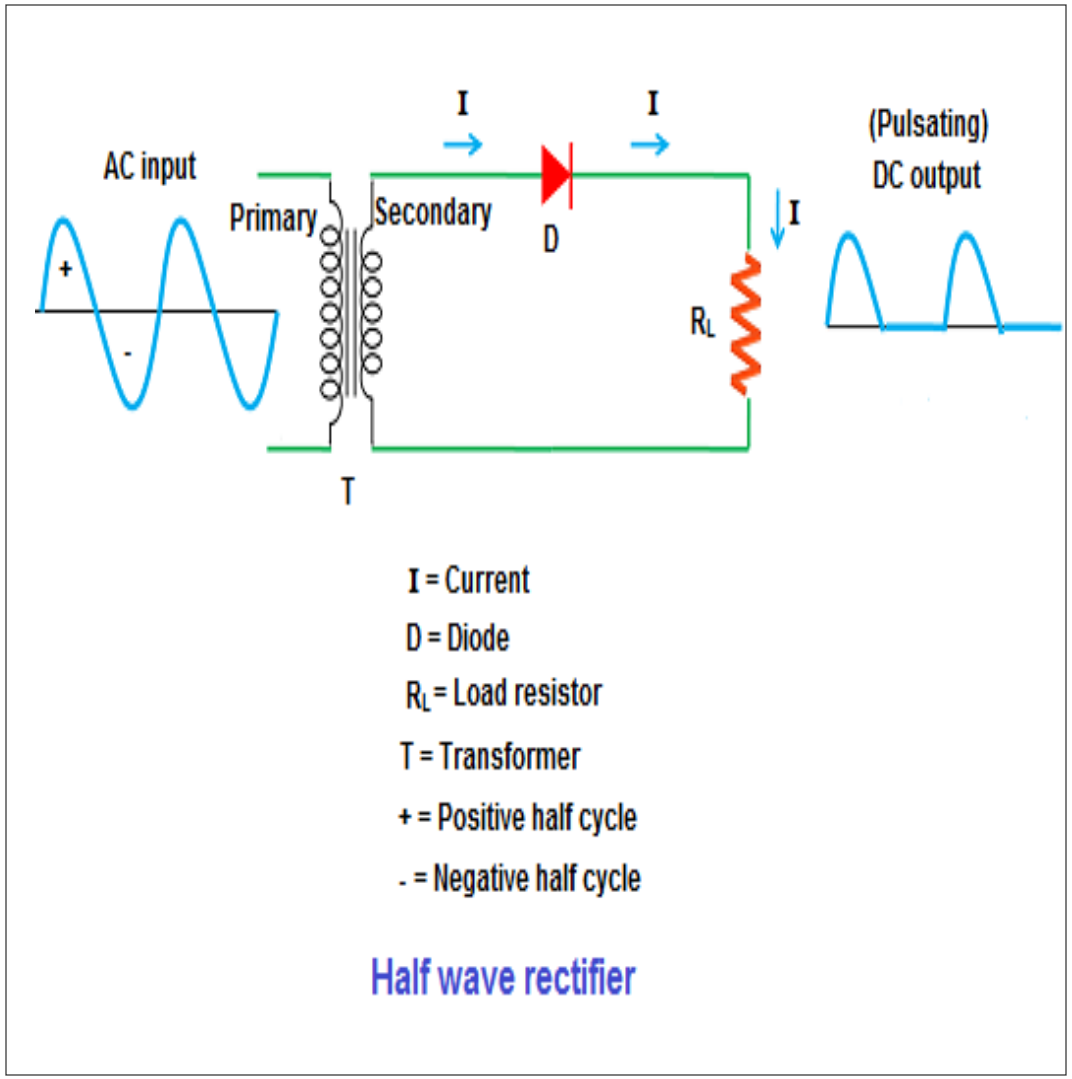
A half-wave rectifier is the simplest form of the rectifier and requires only one diode for the construction of a halfwave rectifier circuit.

OR

A half wave rectifier is a type of rectifier which allows only half cycle of the input AC signal while the another half cycle is blocked.



- For example, if the positive half cycle is allowed then the negative half cycle is blocked. Similarly, if the negative half cycle is allowed then the positive half cycle is blocked. However, a half wave rectifier will not allow both positive and negative half cycles at the same time.
- Therefore, the half cycle (either positive or negative) of the input signal is wasted.



Halfwave rectifier circuit

- A halfwave rectifier circuit consists of three main components as follows:
- A diode
- A transformer
- A resistive load

Working of Half Wave Rectifier

- During the positive half cycle of the AC input, the diode is forward-biased and conducts current through the load resistor. During the negative half cycle of the AC input, the diode is reverse-biased and blocks the flow of current. This results in an output waveform that consists of only the positive half-cycle of the AC input.

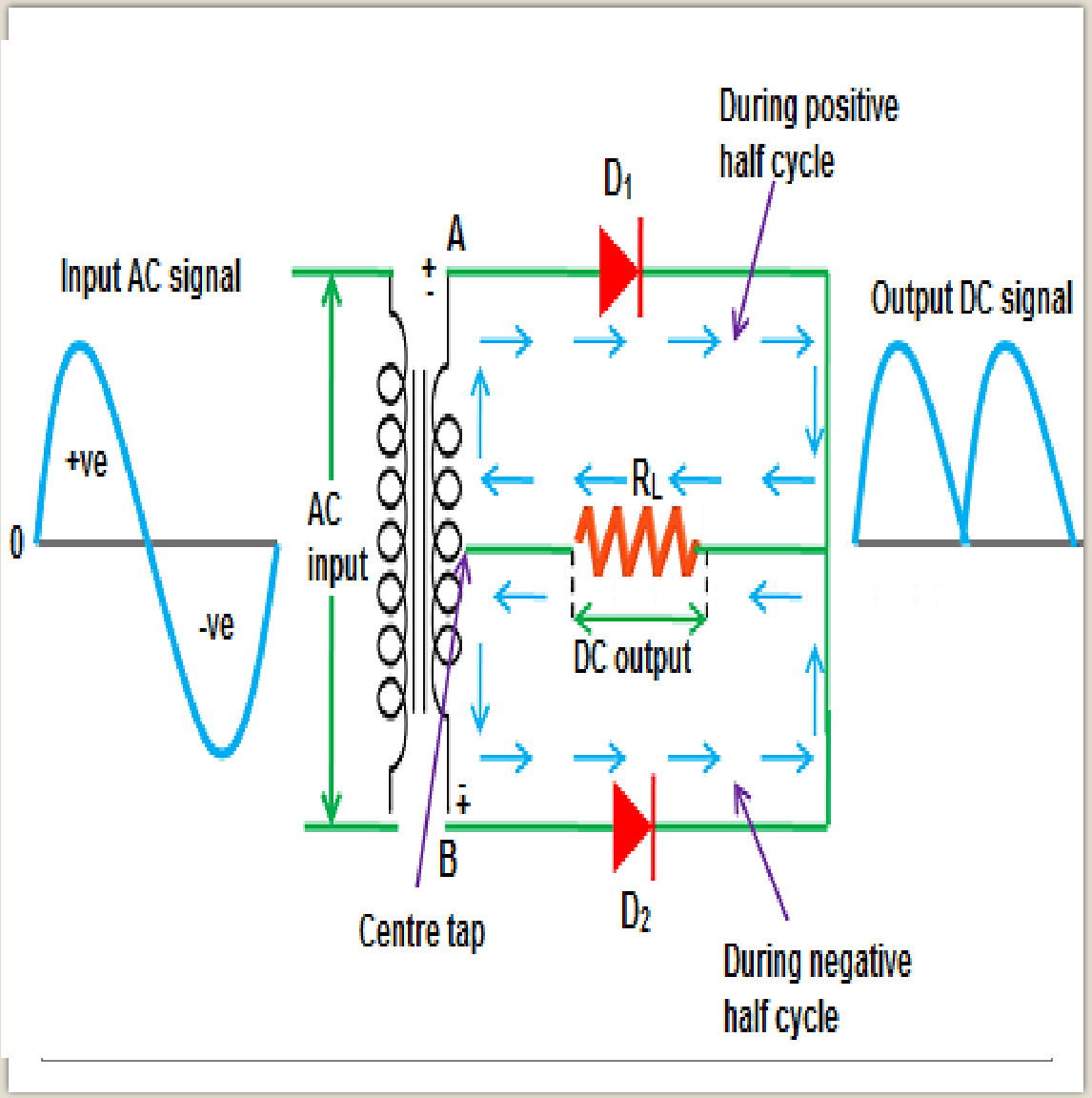
- During the positive half-cycle of the AC input voltage, the diode conducts, and current flows through the load resistor in the forward direction.
- The diode has a low resistance in this direction and effectively acts like a closed switch.

- During the negative half-cycle of the AC input voltage, the diode becomes reverse-biased and does not conduct.
- No current flows through the load resistor during this time.

Application of Half Wave Rectifier

- The half wave rectifier finds applications in various electronic devices where low DC voltage is required. Some of the common applications of the half wave rectifier are:
- **Battery Chargers:** The half wave rectifier is used in battery chargers where the input AC voltage is converted into DC voltage to charge the battery.
- **Power Supplies:** The half wave rectifier is used in small power supplies where low DC voltage is required for electronic devices.
- **Signal Detectors:** The half wave rectifier is used in signal detectors to extract the envelope of an AM (amplitude-modulated) signal.
- **LED lighting:** The half wave rectifier can be used in LED lighting circuits where the input AC voltage is rectified to provide DC voltage to the LEDs.
- **Temperature Sensors:** The half wave rectifier is used in temperature sensors to rectify the output of a thermocouple to obtain a measurable DC voltage.

Full Wave Rectifiers

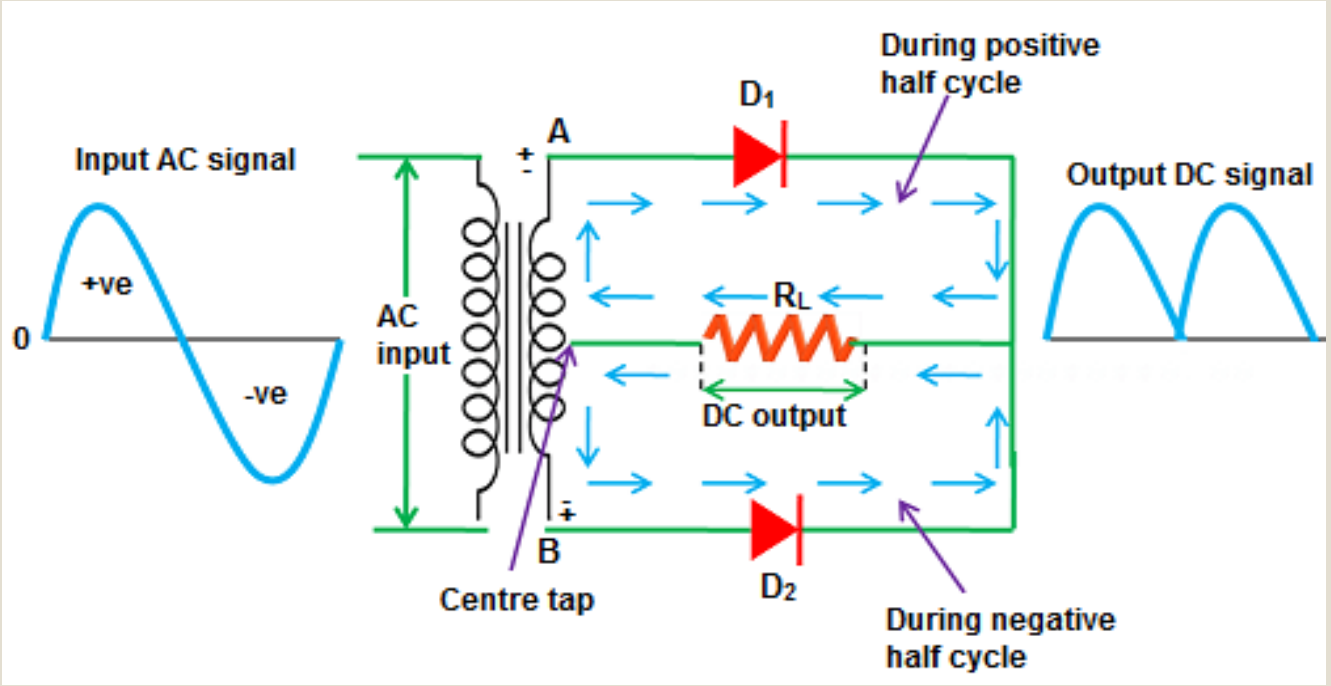


- A full wave rectifier is a type of rectifier which converts both half cycles of the AC signal into pulsating DC signal.
- As shown in the figure, the full wave rectifier converts both positive and negative half cycles of the input AC signal into output pulsating DC signal.
- The circuit of the full wave rectifier consists of a step-down transformer and two diodes that are connected and center tapped. The output voltage is obtained across the connected load resistor.

Working of Full Wave Rectifier

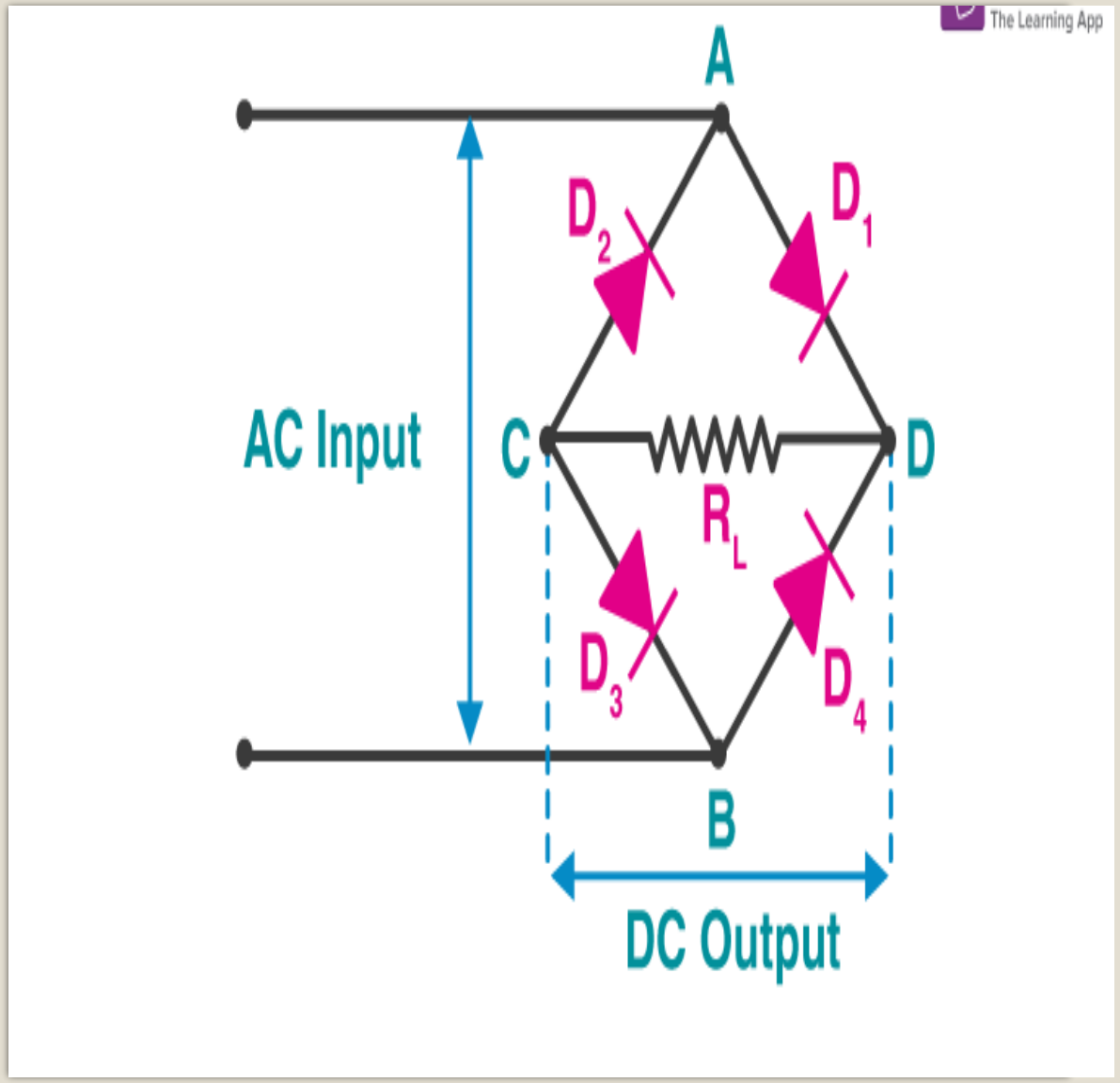
- The input AC supplied to the full wave rectifier is very high. The step-down transformer in the rectifier circuit converts the high voltage AC into low voltage AC. The anode of the center tapped diodes is connected to the transformer's secondary winding and connected to the load resistor. During the positive half cycle of the alternating current, the top half of the secondary winding becomes positive while 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. Thus in a full wave rectifiers, DC voltage is obtained for both positive and negative half cycle.



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.



Bridge Rectifier

- We can define bridge rectifiers as a type of full-wave rectifier that uses four or more diodes in a bridge circuit configuration to efficiently convert alternating (AC) current to a direct (DC) current.

Construction

- The construction of a bridge rectifier is shown in the figure. The bridge rectifier circuit is made of four diodes D1, D2, D3, D4, and a load resistor RL. The four diodes are connected in a closed-loop configuration to efficiently convert the alternating current (AC) into Direct Current (DC). The main advantage of this configuration is the absence of the expensive center-tapped transformer. Therefore, the size and cost are reduced.
- The input signal is applied across terminals A and B, and the output DC signal is obtained across the load resistor RL connected between terminals C and D. The four diodes are arranged in such a way that only two diodes conduct electricity during each half cycle. D1 and D3 are pairs that conduct electric current during the positive half cycle/. Likewise, diodes D2 and D4 conduct electric current during a negative half cycle.

Advantages of Bridge Rectifier

- The efficiency of the bridge rectifier is higher than the efficiency of a half-wave rectifier. However, the rectifier efficiency of the bridge rectifier and the center-tapped full-wave rectifier is the same.
- The DC output signal of the bridge rectifier is smoother than the output DC signal of a half-wave rectifier.
- In a half-wave rectifier, only half of the input AC signal is used, and the other half is blocked. Half of the input signal is wasted in a half-wave rectifier. However, in a bridge rectifier, the electric current is allowed during both positive and negative half cycles of the input AC signal. Hence, the output DC signal is almost equal to the input AC signal.


Thank
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