# RECTIFIERS

# Rectifier

❖The process by which an alternating current (or voltage) is transformed into a direct current (or voltage) is called **rectification.**

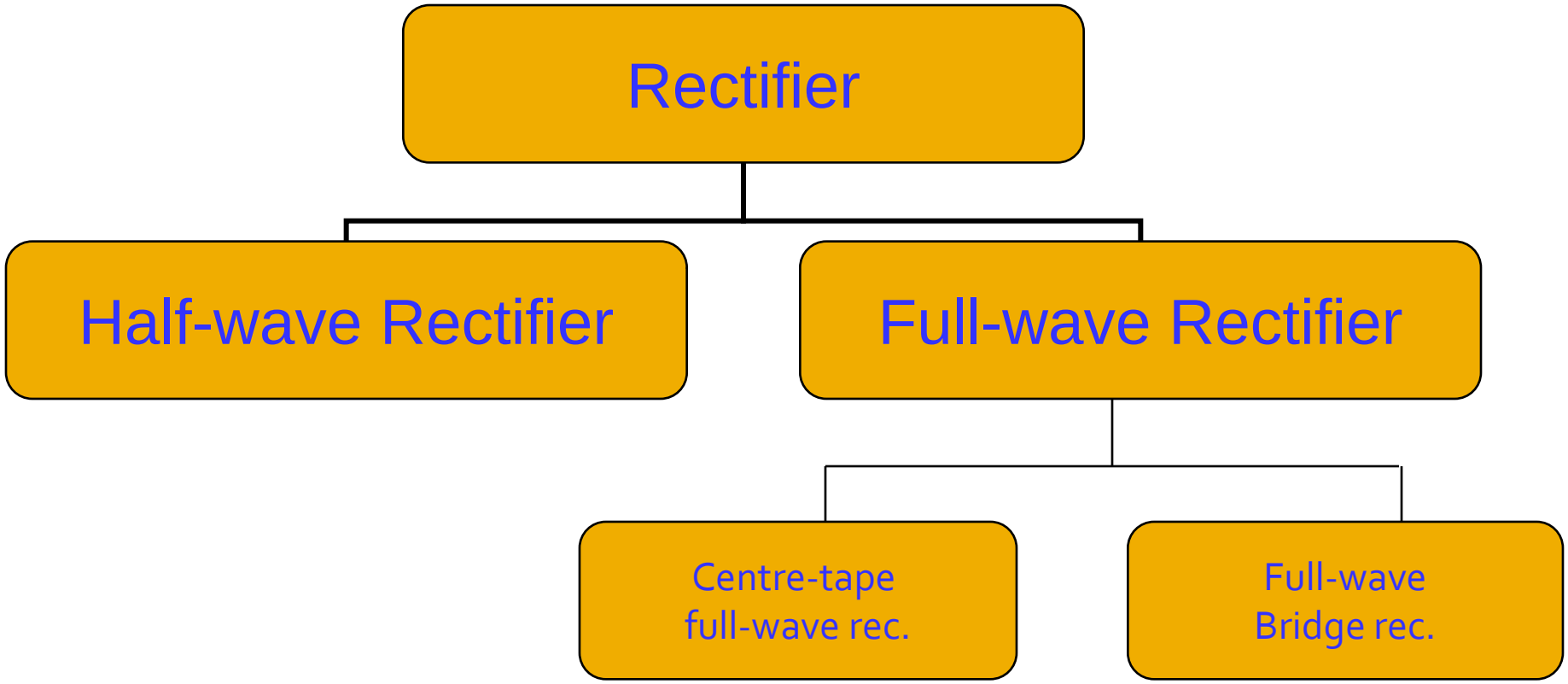
❖The device which converts alternating current (or voltage) into direct current (or voltage) is called a **rectifier.**

❖Rectifiers may be made of **solid state diodes**, **vacuum tube diodes**, mercury arc valves, and other components.

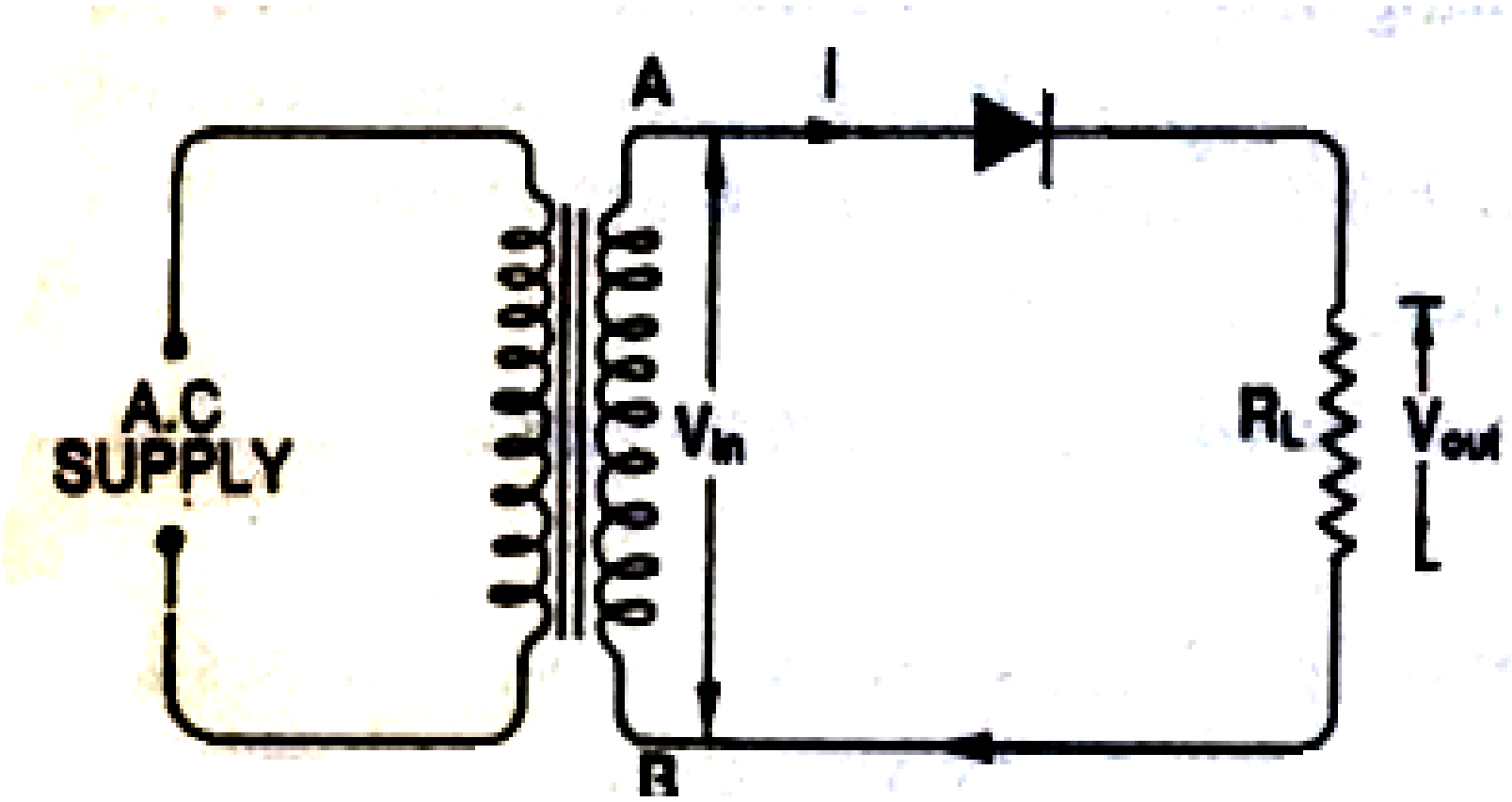
❖Before the development of silicon semiconductor rectifiers, vacuum tube diodes and copper(I) oxide or selenium rectifier stacks were used.

# Block Diagram of a Rectifier

# Types Of Rectifier



# Half Wave Rectifier

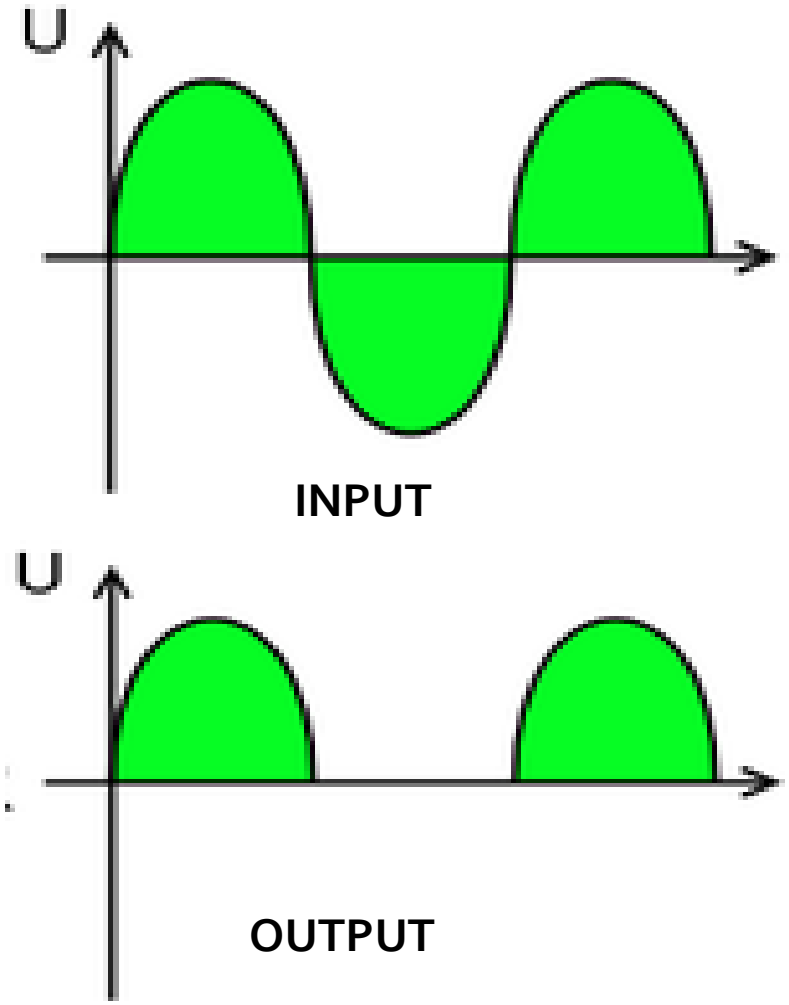



Circuit diagram

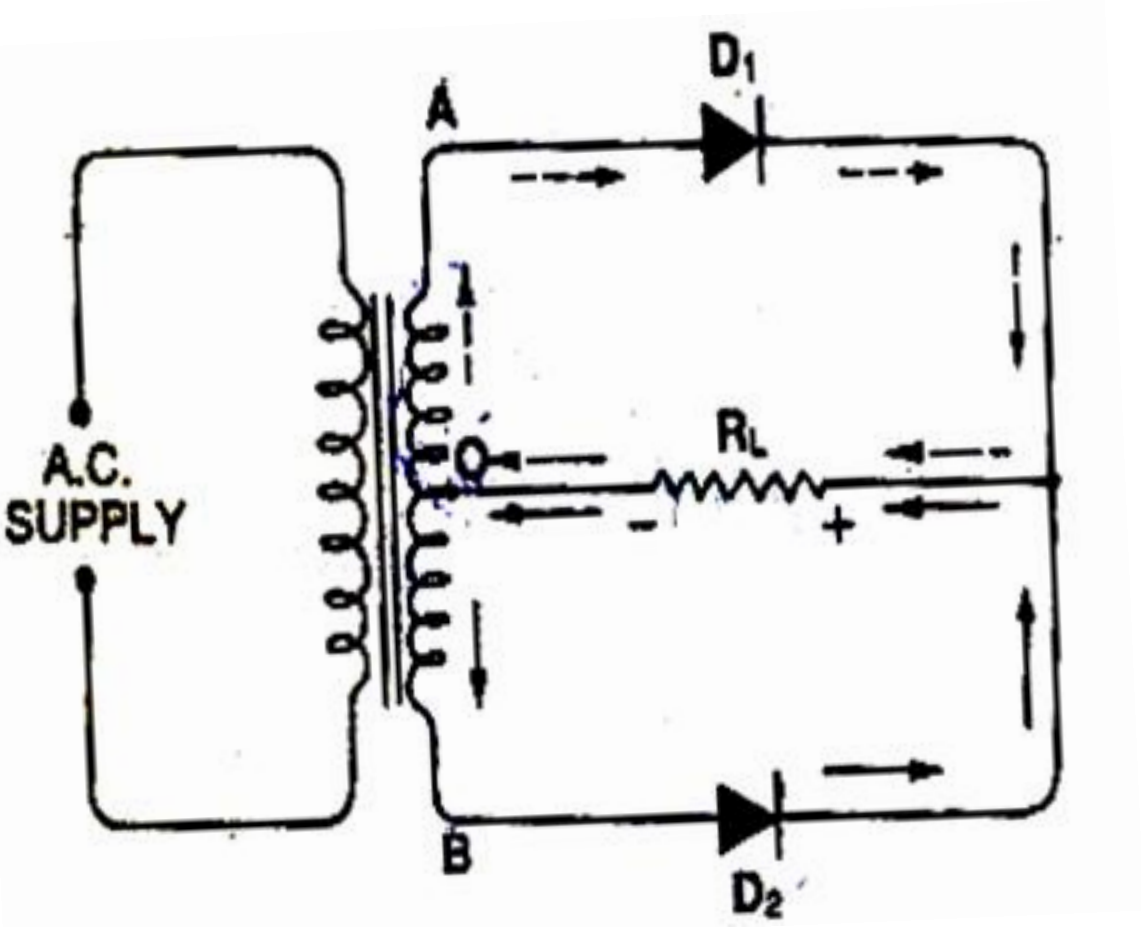
# Half Wave Rectification

## WORKING

- It uses a diode in series with a load resistance.
- The diode is conducting i.e. it is forward biased only for the positive half cycle of the input signal.
- Thus it provides output for only one half cycle of the input signal.
- For the other half cycle of the input the diode is reversed biased i.e. open-circuited and thus zero output is provided.



# Full Wave Rectifier

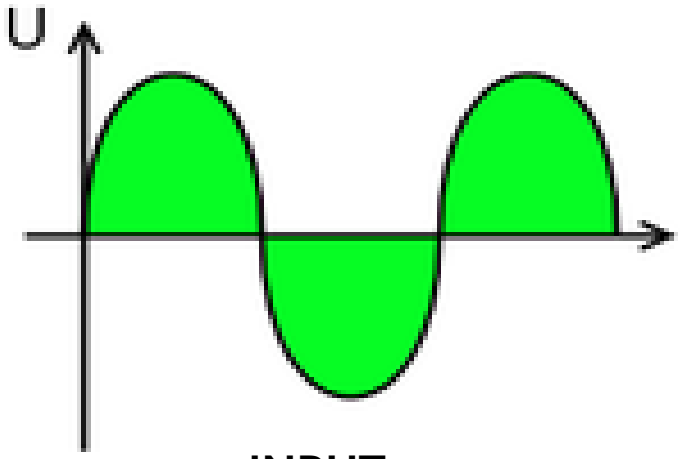



Circuit diagram

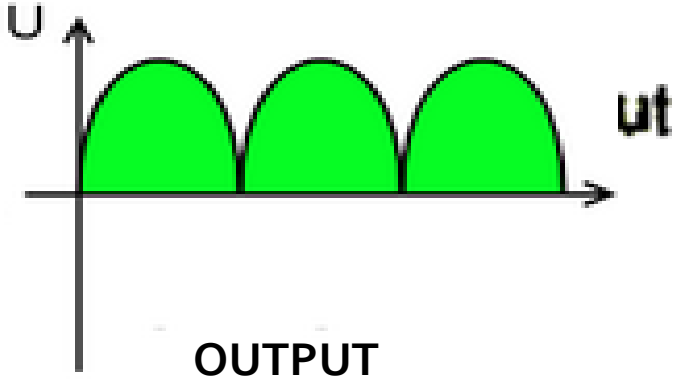
# Full Wave Rectification

- **WORKING**

❖A center-tap full wave rectifier uses only two diodes but a center-tapped (CT) transformer to establish the input signal across each section of the transformer.
❖During the positive half cycle of the input, applied to the primary of transformer D1 will be forward biased assuming short-circuit equivalent and D2 will be reversed biased assuming open-circuit equivalent.
❖Its advantage over half wave rectifier is that it provides output for both the positive and negative half cycles.

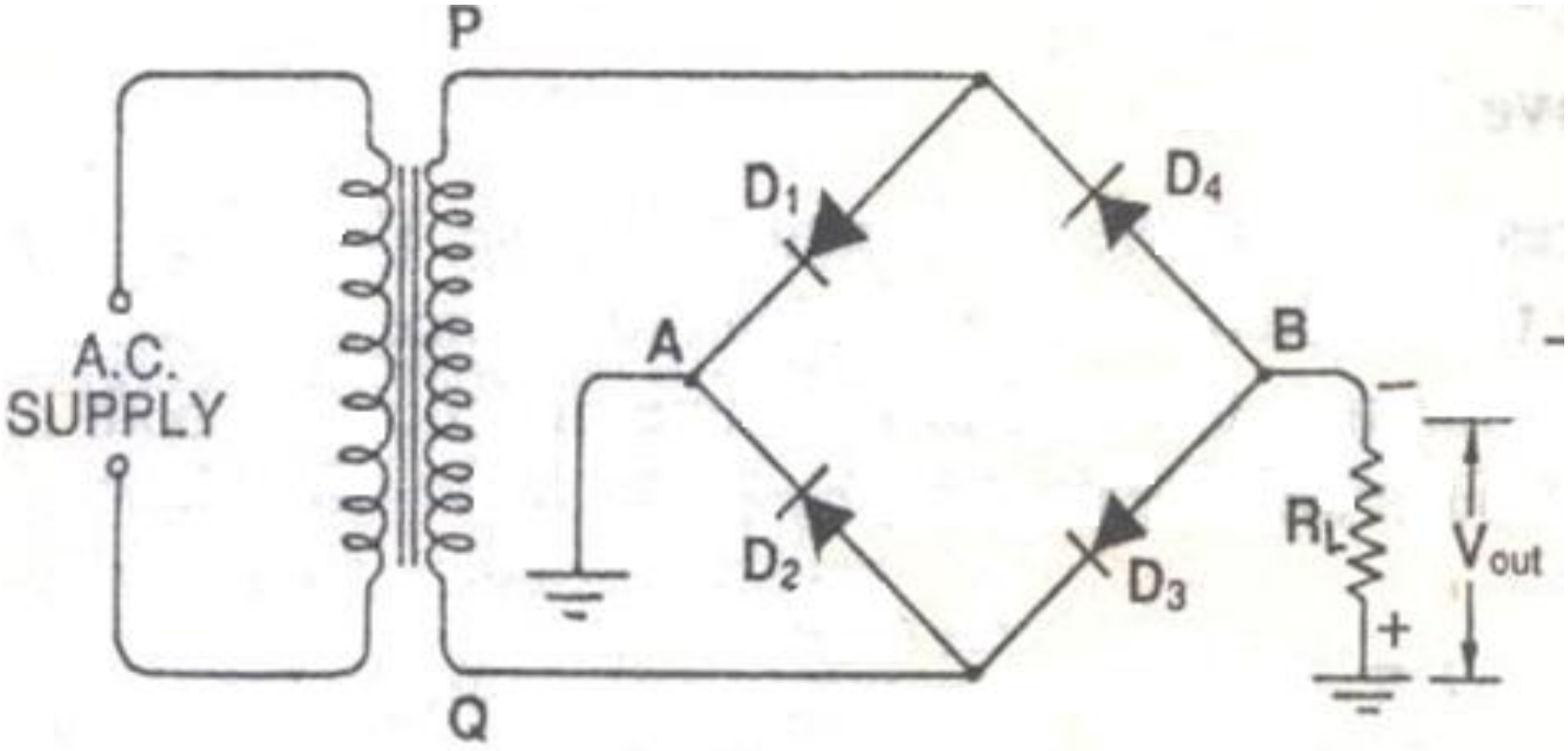



INPUT




OUTPUT

# Bridge Rectifier

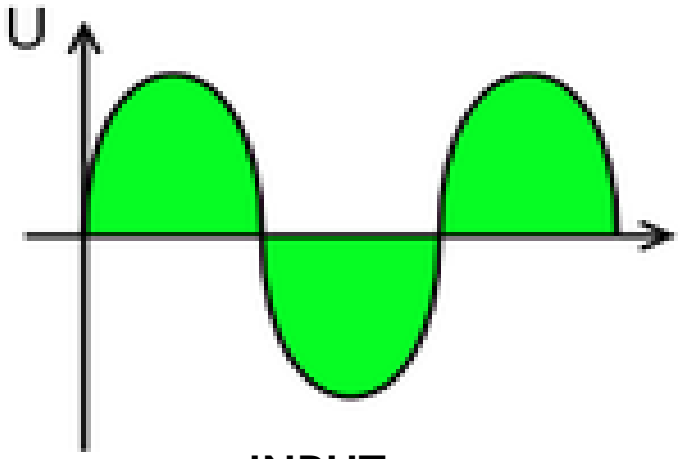



**Circuit diagram**

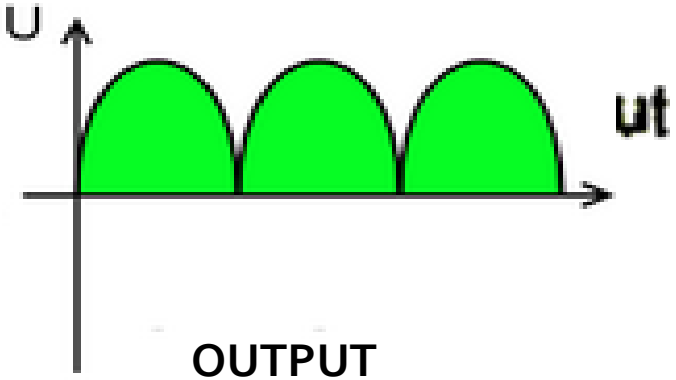
# Working of Bridge Rectifier

- **WORKING**

❖ A bridge rectifier uses four diodes for the process of rectification.
❖Two diodes for each half cycle are conducting i.e. they are forward biased and the other two diodes for this half cycle are reversed biased i.e. they are non-conducting.
❖For the positive half of the input the diodes D2 and D4 are forward biased and conducting while D1 and D3 are non-conducting. For the second half i.e. negative half of cycle the diodes D1 and D3 are conducting while D2 and D4 are reversed biased and non-conducting.




INPUT




OUTPUT

# Ripple Factor

**Ripple Factor (r)= rms value of alternating component of load current (or voltage) / average value of load current (or voltage)**

$$= \frac{I'_{rms}}{I_{dc}} \qquad = \frac{V'_{rms}}{V_{dc}}$$

$$r = \frac{(I^2_{rms} - I^2_{dc})^{1/2}}{I_{dc}}$$

$$= \frac{(V^2_{rms} - V^2_{dc})^{1/2}}{V_{dc}}$$

where

$I_{rms}$ denotes the rms value of the total load voltage.

$I_{dc}$ is the average value of load current.

# Rectification Efficiency

The efficiency of rectification is defined to be the ratio of the dc output power ($P_{dc}$) to the ac input power ($P_i$) of the rectifier. It is denoted by η and is usually expressed as a percentage

$$\eta = \frac{P_{dc}}{P_i} \times 100\ \%$$

$$= \frac{I_{dc}^2 R_L}{I^2_{rms}(R_f + R_L)} \times 100\%$$

# Transformer Utilization Factor(TUF)

Transformer Utilization Factor is defined by

$$TUF = \frac{\text{dc power supplied to the load}}{\text{ac power rating of the transformer}} = \frac{P_{dc}}{P_{ac(rated)}}$$

The Transformer Utilization Factor for

- A half wave rectifier is 0.287
- A full wave rectifier is 0.693
- A bridge rectifier is 0.812

# COMPARISON OF RECTIFIERS

| | HALF - WAVE | CENTER - TAP | BRIDGE TYPE |
|---|---|---|---|
| **Number of diodes** | 1 | 2 | 4 |
| **Transformer necessary** | NO | YES | NO |
| **Maximum Efficiency** | 40.6% | 81.2% | 81.2% |
| **Ripple Factor** | O.48 | 1.21 | 1.21 |
| **rms value of output** | $\frac{V_0}{2}$ | $\frac{V_0}{\sqrt{2}}$ | $\frac{V_0}{\sqrt{2}}$ |

# Merits and Demerits of Bridge Rectifier

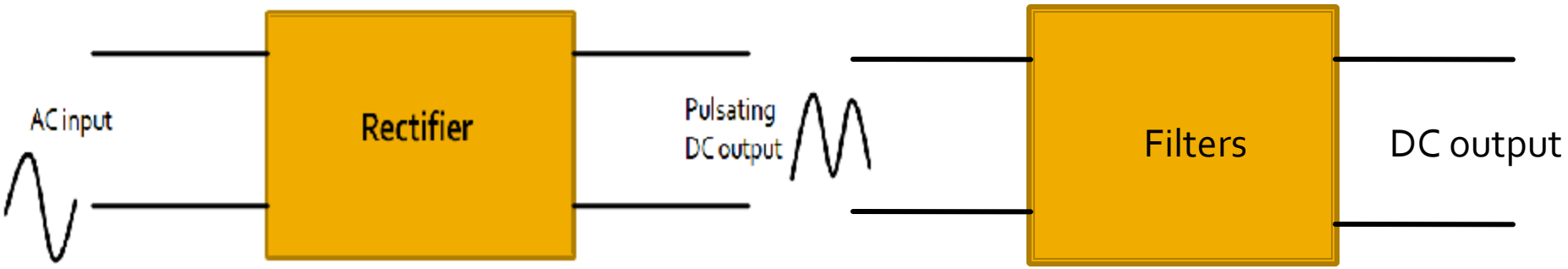
## Merits

- It does not require a transformer.
- The peak inverse voltage (PIV) rating of a diode in a bridge rectifier is half that for a FWR, yielding same dc output.
- Bridge circuit is more compact and cheaper.
- The Transformer Utilization Factor(TUF) of a bridge rectifier is 0.812 compared to 0.693 of a full wave rectifier.

## Demerits

- A full wave rectifier uses two diodes whereas Bridge rectifier uses four diodes.
- Since current flows in two diodes in series, large power is dissipated. Hence it is not suitable for low voltages.

# FILTERS




- The pulsating DC output of a rectifier is provided as input to the Filter circuit which provides a pure DC as output.
- The filter circuit generally consist of a combination of inductance and capacitance but in its simplest form this can be what is known as filter capacitor.
- A capacitor resists change in voltage and inductor resists change in current. This property of capacitor and inductor is used in a filter circuit.

# Types Of Filters

**There are basically four types of filters :**

- C – Filter
- L – Filter
- LC – Filter
- CLC (or π) Filter

# Applications Of Rectifiers

❖ The primary application of rectifiers is to derive DC power from an AC supply. Virtually all electronics except simple motor circuits such as fans require a DC supply but mains power is AC so rectifiers find uses inside the power supplies of virtually all electronic equipment.

❖ Rectifiers also find a use in detection of amplitude modulated radio signals. The signal may or may not be amplified before detection but if unamplified a very low voltage drop diode must be used.

❖ Rectifiers are also used to supply polarised voltage for welding.