Rectifiers

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RECTIFIERS:

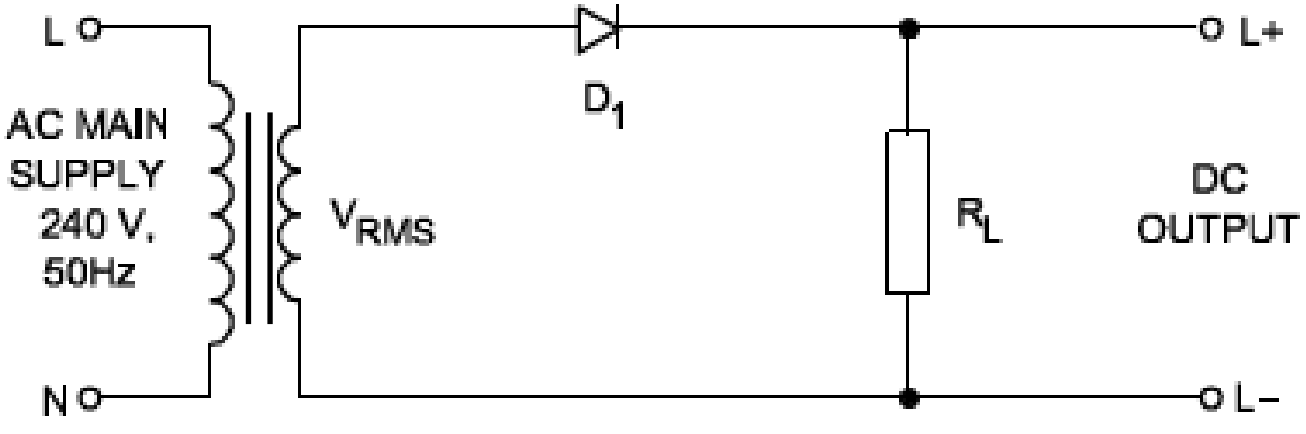
Many equipment/electronic circuits etc. need DC supply for their operation.

Rectifier is a device that converts ac supply into dc.

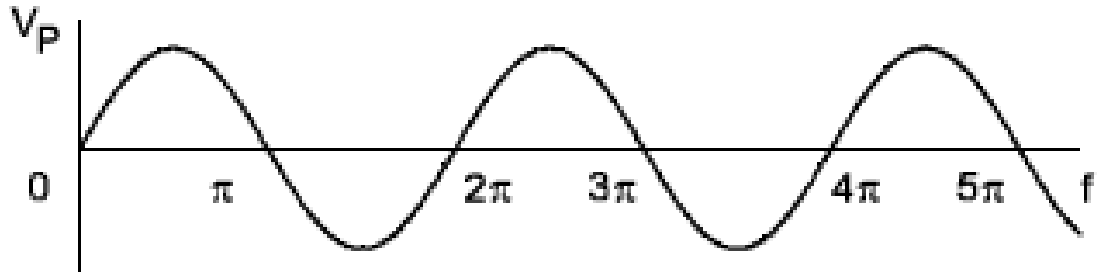
Diodes are used as rectifier in a power supply circuit.

In this section we will discuss half-wave and full-wave rectifier circuits.

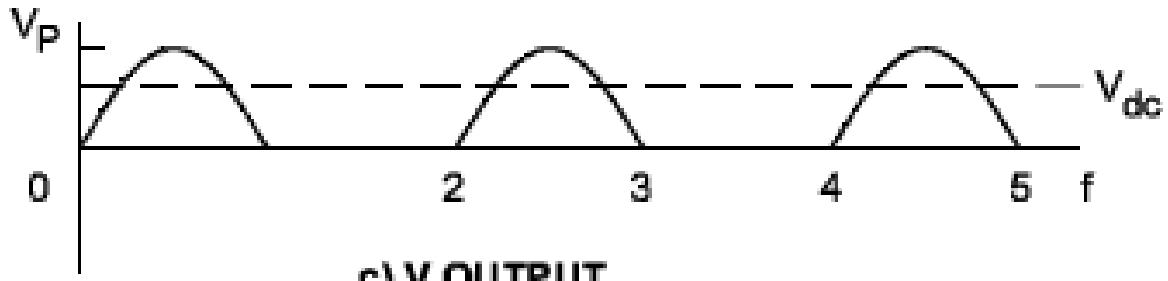
HALF-WAVE RECTIFIER:



a) DIODE AS A RECTIFIER



b) V INPUT



c) V OUTPUT

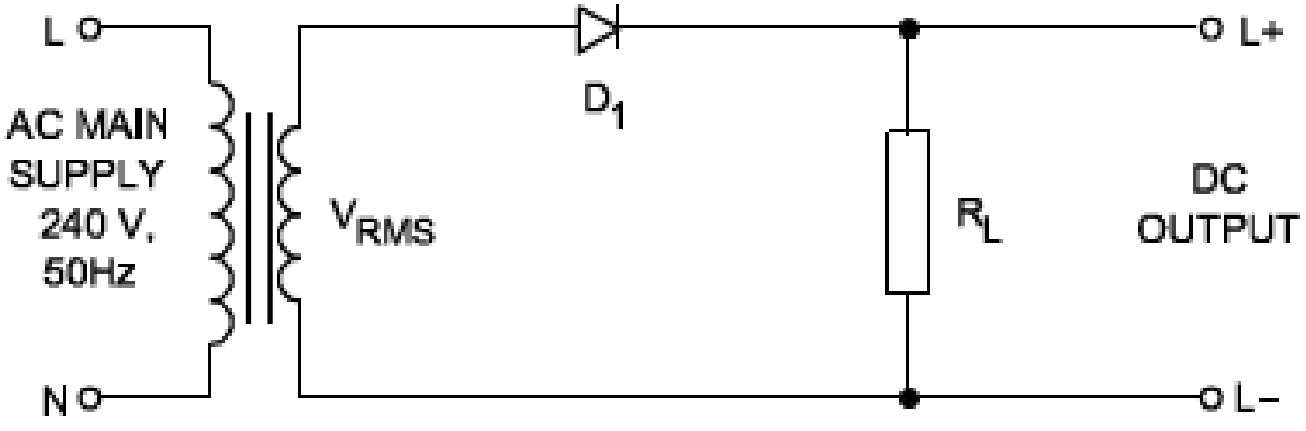
This is the simplest form of AC to DC converter.

A diode D_1 and a load resistance R_L in series are connected across the secondary of a step-down transformer (Fig (a)).

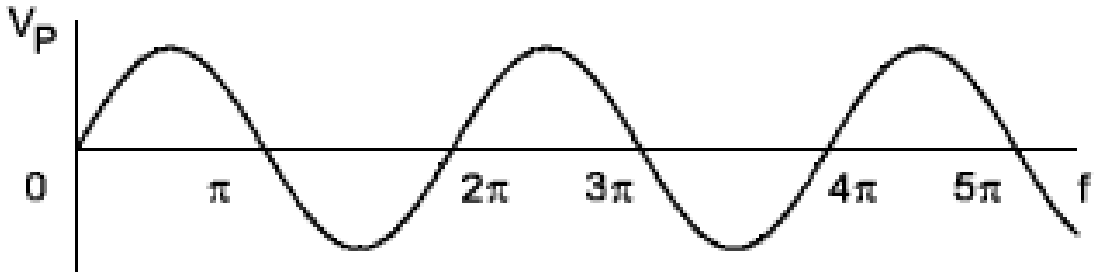
The transformer steps up or steps down the supply voltage as needed.

The transformer also isolates the power line and reduces the risk of electrical shock.

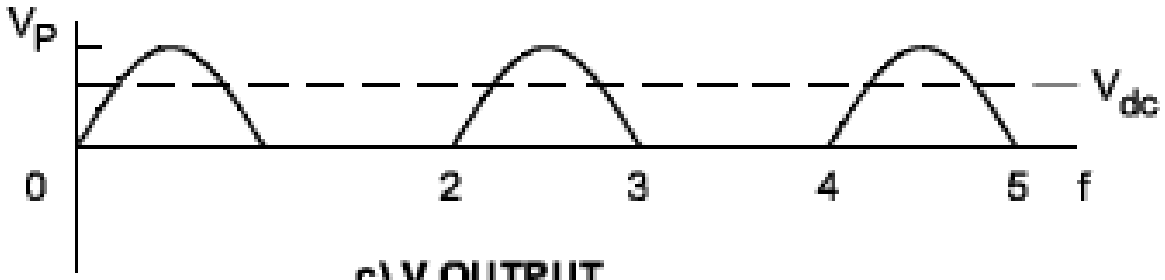
HALF-WAVE RECTIFIER:



a) DIODE AS A RECTIFIER



b) V INPUT



c) V OUTPUT

During the positive half-cycle of the input (Fig (b)), the diode D_1 conducts because it is forward biased.

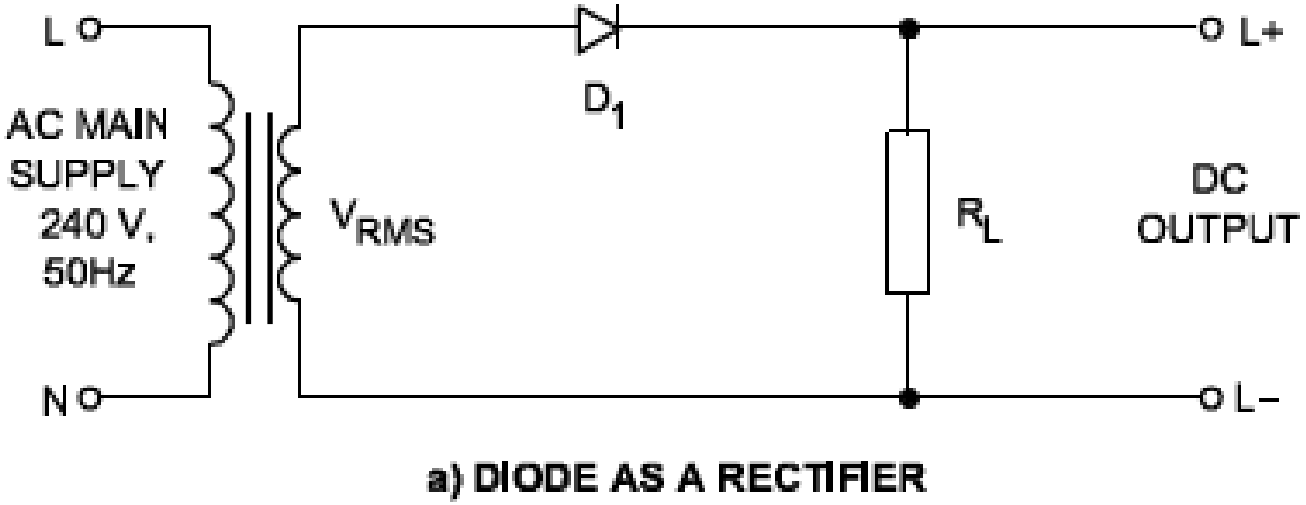
Current flows from the positive end of the supply through diode D_1 and R_L to the negative terminal of the the input.

During this period of time, a voltage is developed across R_L.

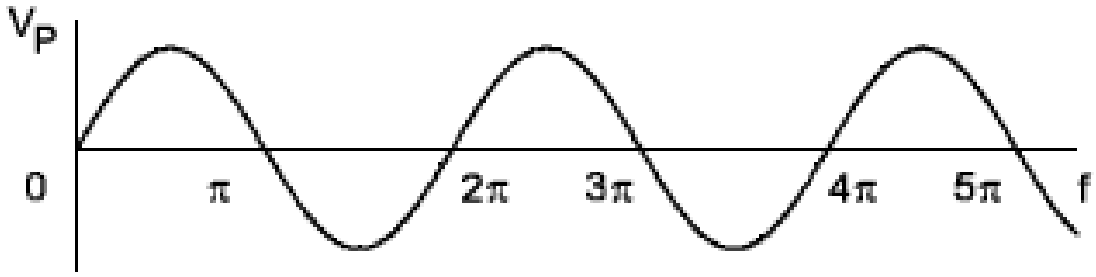
During the negative half cycle of AC input, the diode is reverse-biased.

Practically no current flows through the diode and the load R_L and there is no voltage output.

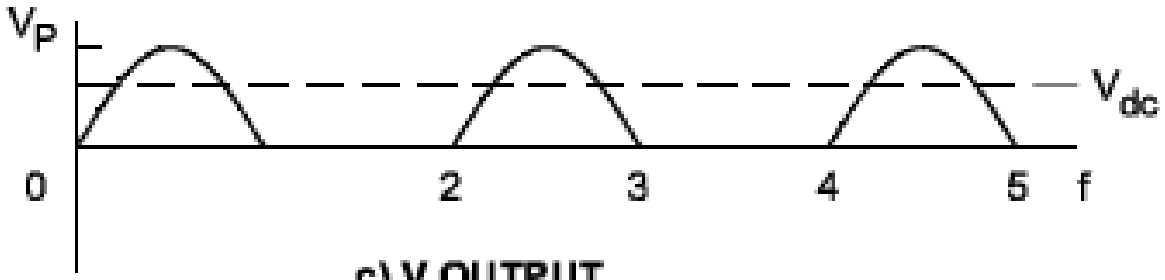
HALF-WAVE RECTIFIER:



a) DIODE AS A RECTIFIER



b) V INPUT



c) V OUTPUT

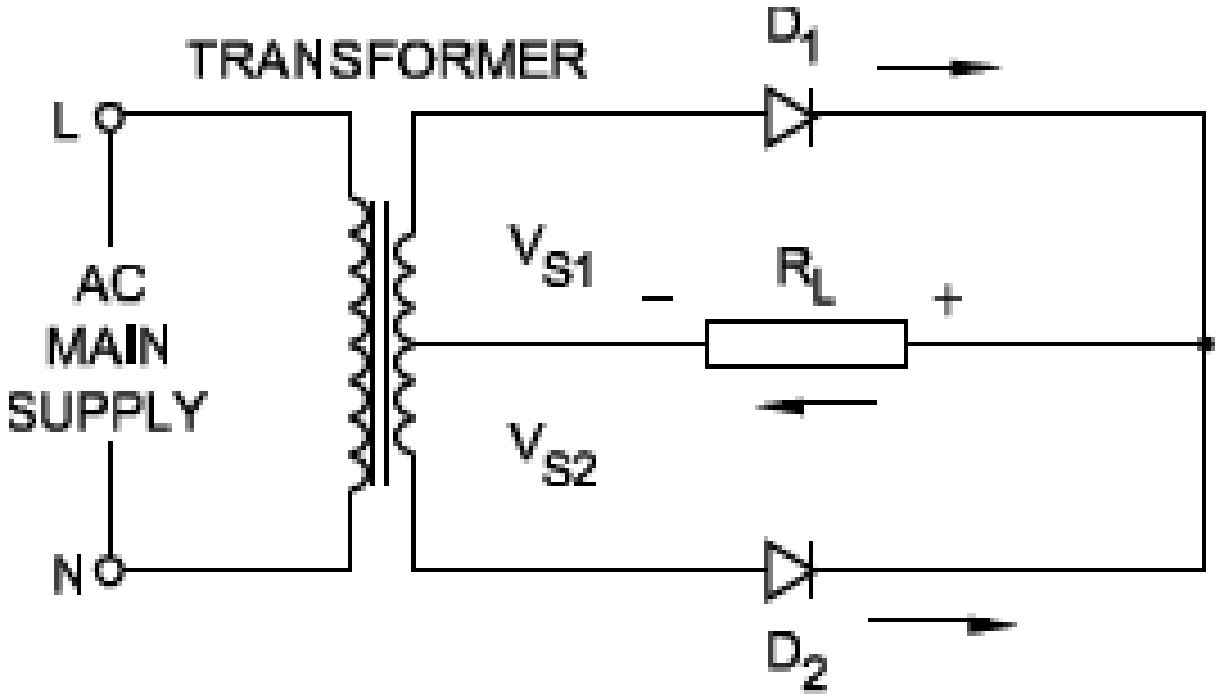
The average value of the half wave DC output $V_{dc} = 0.45 \times V_{RMS}$

For example, if secondary side voltage of transformer = 24 V, then the DC output of the half wave rectifier will be = $0.45 \times 24 = 10.8\,V$

Ripple frequency: The frequency of the rectified pulsating DC is same as the frequency of the input AC signal.

Peak inverse voltage: The peak inverse voltage across the diode under reverse biased condition is equal to the peak value of the secondary voltage.

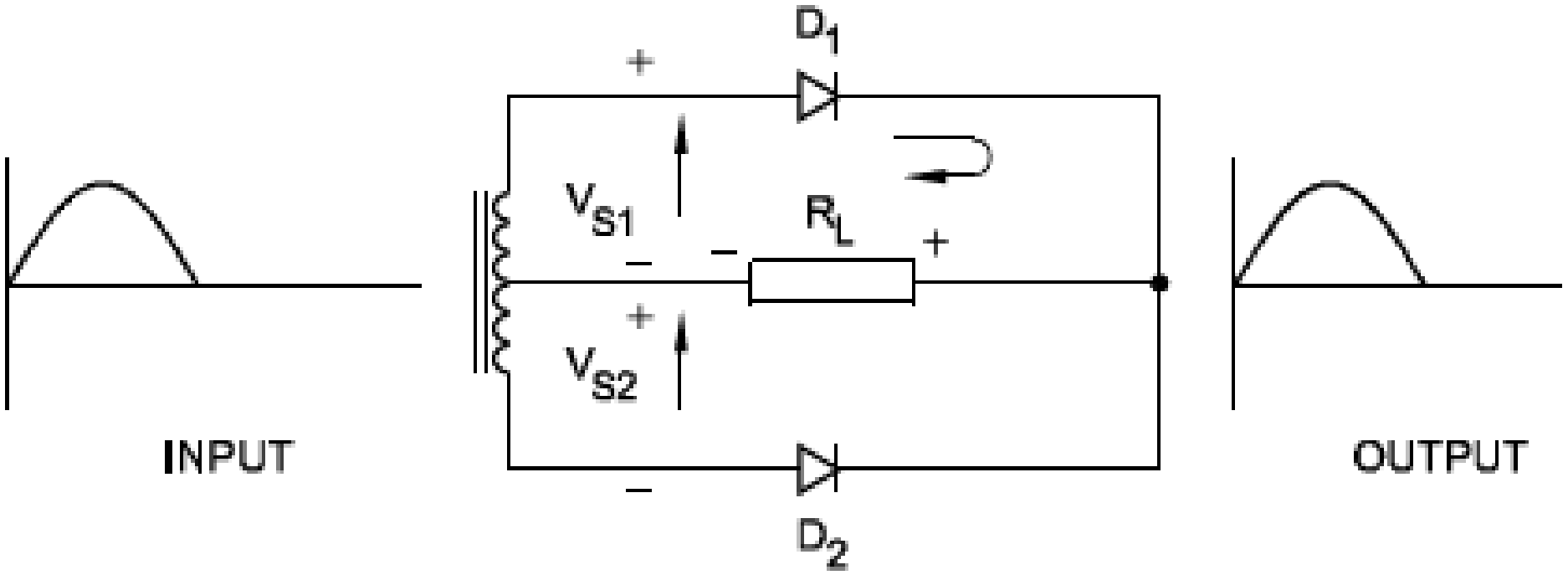
TWO DIODE FULL WAVE RECTIFIER:



The secondary winding of the transformer is center tapped.

The secondary voltage is divided equally into two halves, one end of the load R_L is connected to the center tap and the other end of R_L to the diodes.

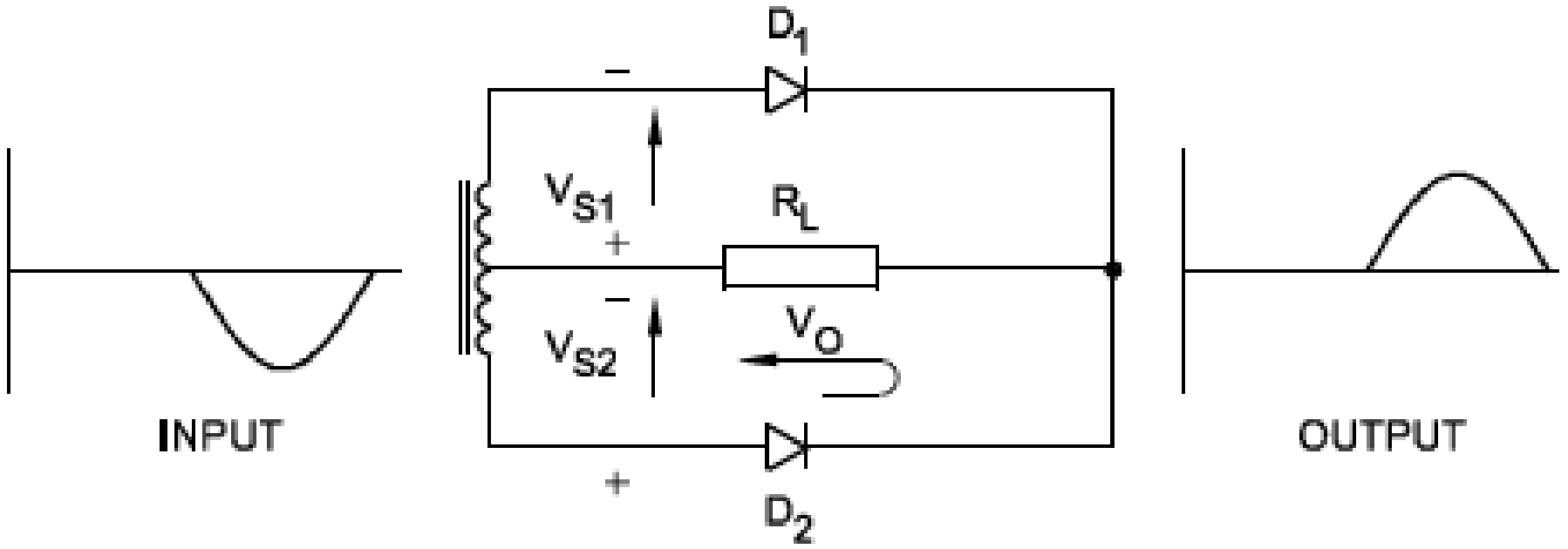
TWO DIODE FULL WAVE RECTIFIER:



During the positive half cycle of the secondary voltage, diode D_1 is forward-biased and diode D_2 is reverse-biased.

The current flows through the load resistor R_L , diode D_1 and the upper half of the secondary winding.

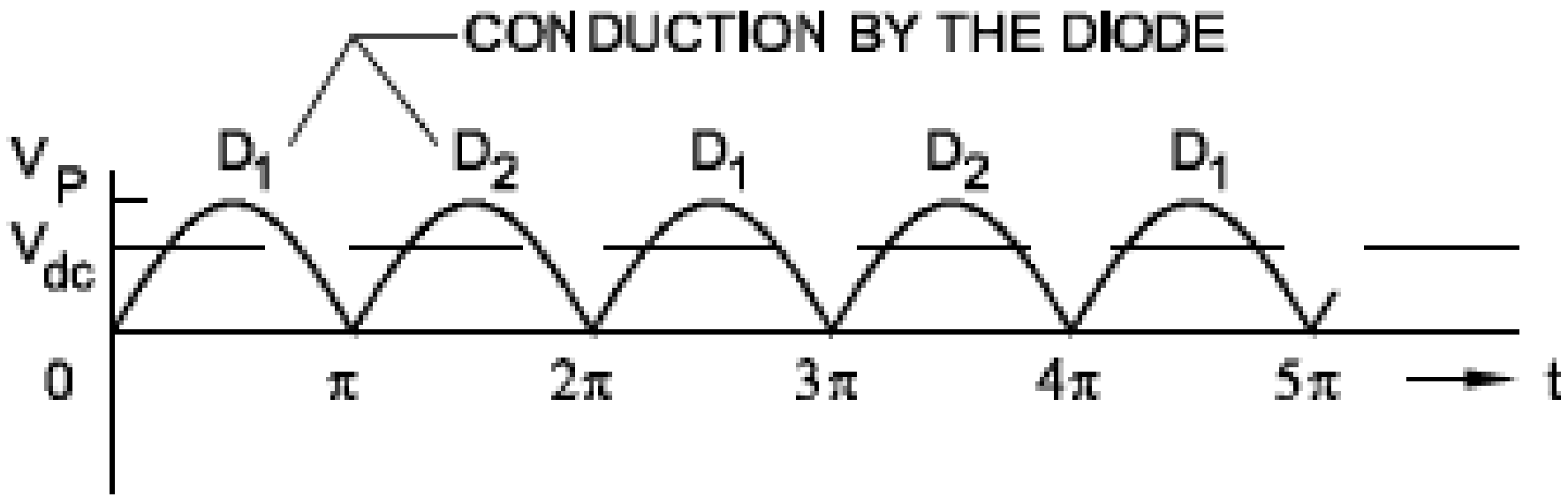
TWO DIODE FULL WAVE RECTIFIER:



During the negative half cycle of secondary voltage, diode D_2 is forward-biased and diode D_1 is reverse-biased.

The current flows through the load resistor R_L diode D_2 and the lower half of the secondary winding.

TWO DIODE FULL WAVE RECTIFIER:



The load current is in the same direction during both the half-cycles of the AC input.

TWO DIODE FULL-WAVE RECTIFIER:

The average DC output of the full wave rectifier is twice the output of half wave rectifier.

DC output $V_{dc} = 0.9 \times V_{RMS}$

For example, if secondary side voltage of transformer = 24-0-24 V (RMS), then the DC output of the full wave rectifier will be = $0.9 \times 24 = 21.6\,V$

Ripple frequency: the output of a full wave rectifier has frequency double the input AC frequency.

For example, If mains AC frequency is 50 Hz, the output frequency of the pulsating DC will be 100 Hz.

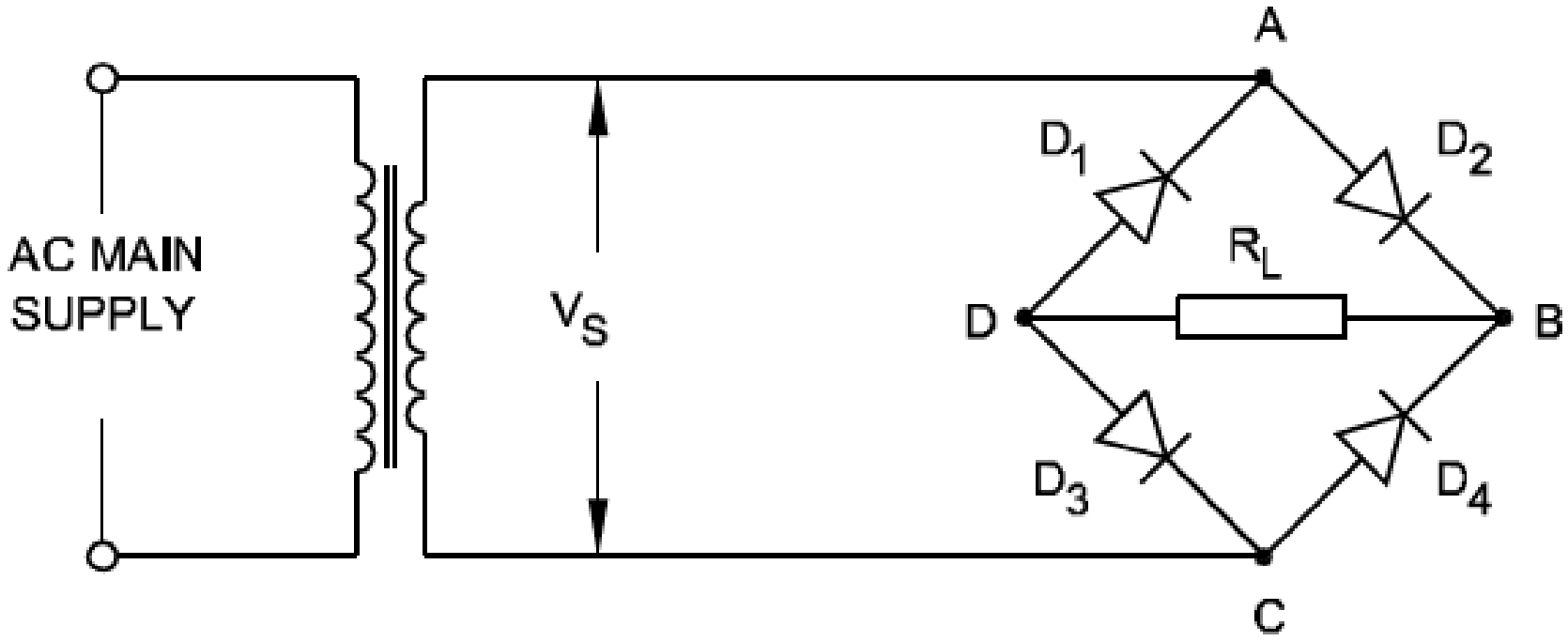
Peak inverse voltage: The peak inverse voltage across the diode under reverse biased condition is equal to two times the peak value of the secondary voltage.

TWO DIODE FULL-WAVE RECTIFIER:

Disadvantages of TWO DIODE full wave rectifier:

1) A center-tapped transformer that produces equal voltages on each half of the secondary winding is difficult to manufacturer and, hence, costly.
2) Centre-tapped transformers are generally bulkier than ordinary transformers, and, hence, occupy larger space.
3) Only half of the secondary voltage is used at a time.

BRIDGE RECTIFIER:

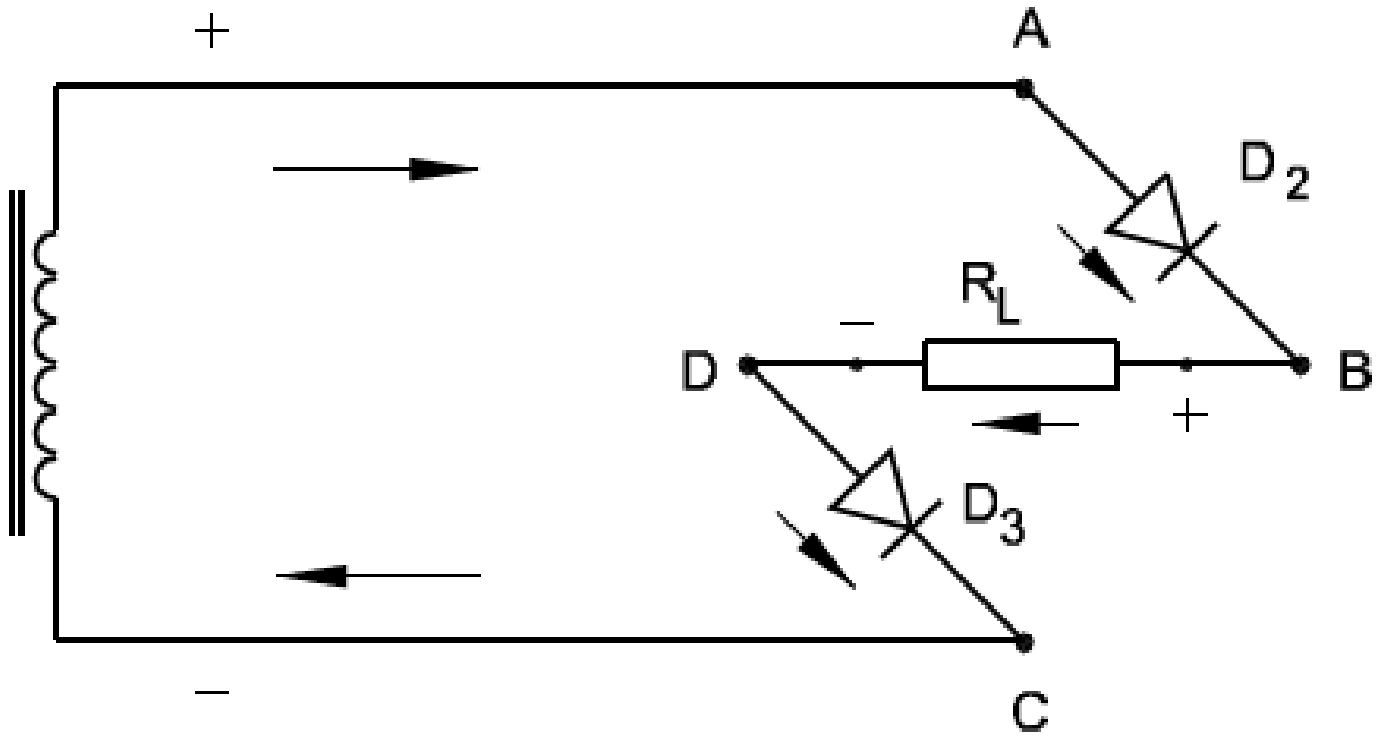


It is a full-wave rectifier.

In the bridge rectifier four diodes are used.

There is no need of center tap on the secondary of the transformer.

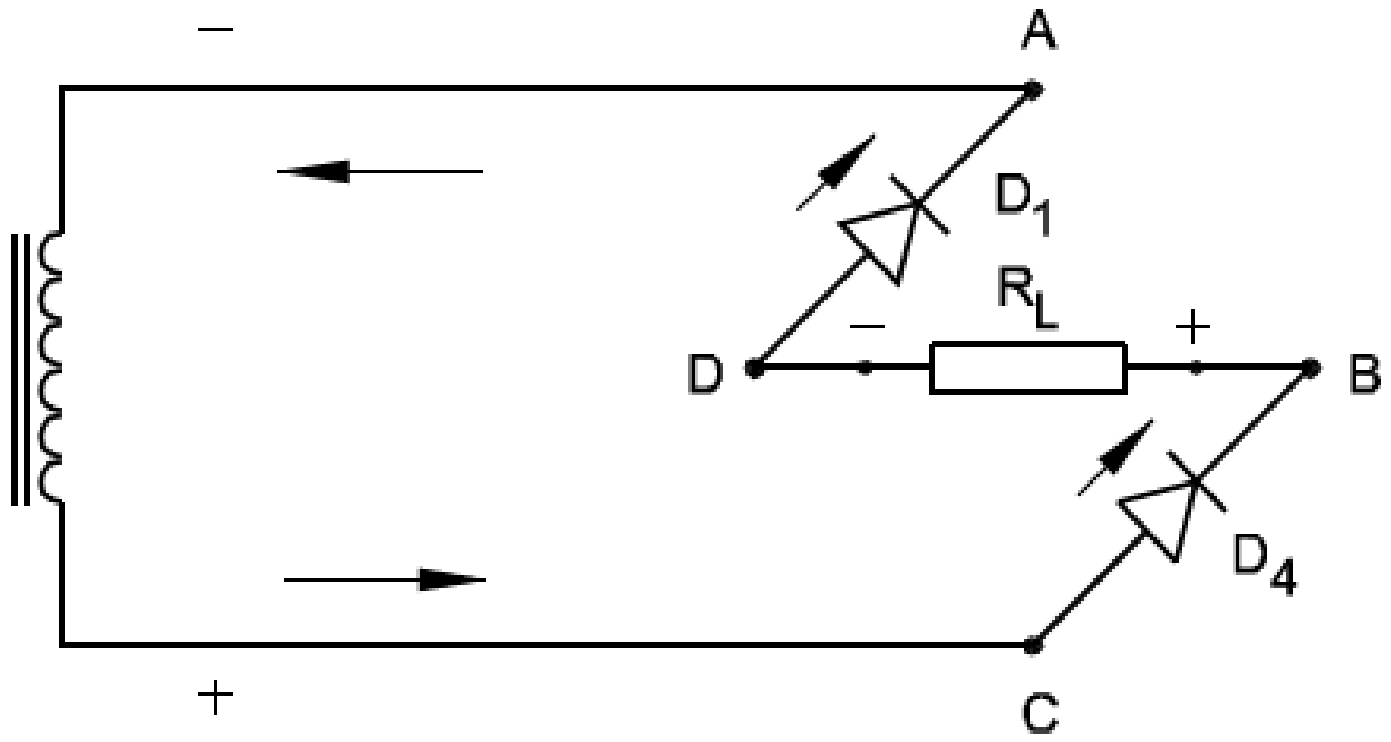
BRIDGE RECTIFIER:



During the positive half of the secondary voltage, diodes D_2 and D_3 are forward-biased.

Hence, current flows through diode D_2 load resistance R_L and D_3 to the other end of the secondary.

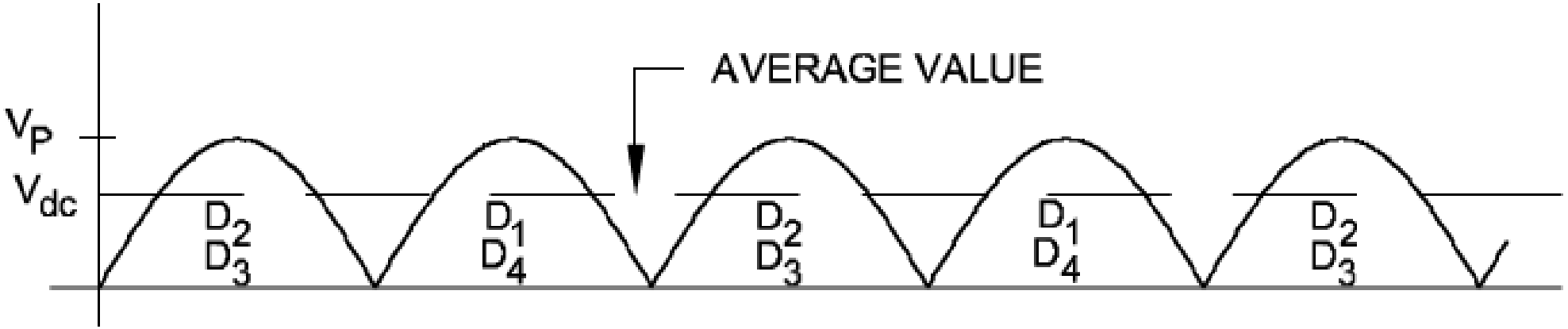
BRIDGE RECTIFIER:



During the negative half of the secondary voltage, diodes D_1 and D_4 are conducting.

The current flows through diode D_4, resistor R_L and diode D_1 to the other end of the secondary.

BRIDGE RECTIFIER:



In both cases the current flows through the load resistor in the same direction.

Hence, a fluctuating DC is developed across the load resistor R_L.

BRIDGE RECTIFIER:

The average DC output of the bridge rectifier, $V_{dc} = 0.9 \times V_{RMS}$

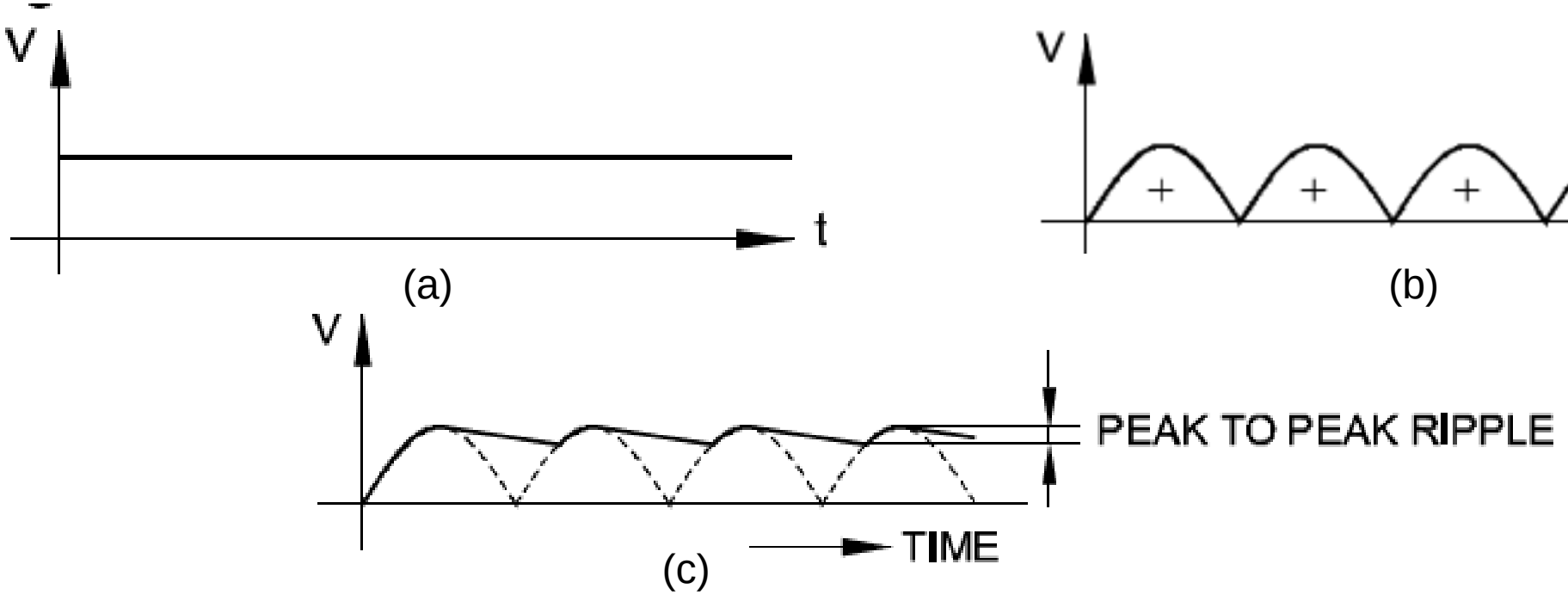
For example, if secondary side voltage of transformer = 24 V (RMS), then the DC output of the full wave rectifier will be = $0.9 \times 24 = 21.6\,V$

Ripple frequency: the output of a full wave rectifier has frequency double the input AC frequency.

For example, If mains AC frequency is 50 Hz, the output frequency of the pulsating DC will be 100 Hz.

Peak inverse voltage: The peak inverse voltage across the diode under reverse biased condition is equal to the peak value of the secondary voltage.

FILTER CIRCUITS:



Alternating current is rectified to provide a steady DC voltage similar to the output of a battery as shown in Fig (a).

However, the output of rectifier is pulsating DC as shown in Fig. (b).

Pulsating DC voltages cannot be used in most of the electronic circuits.

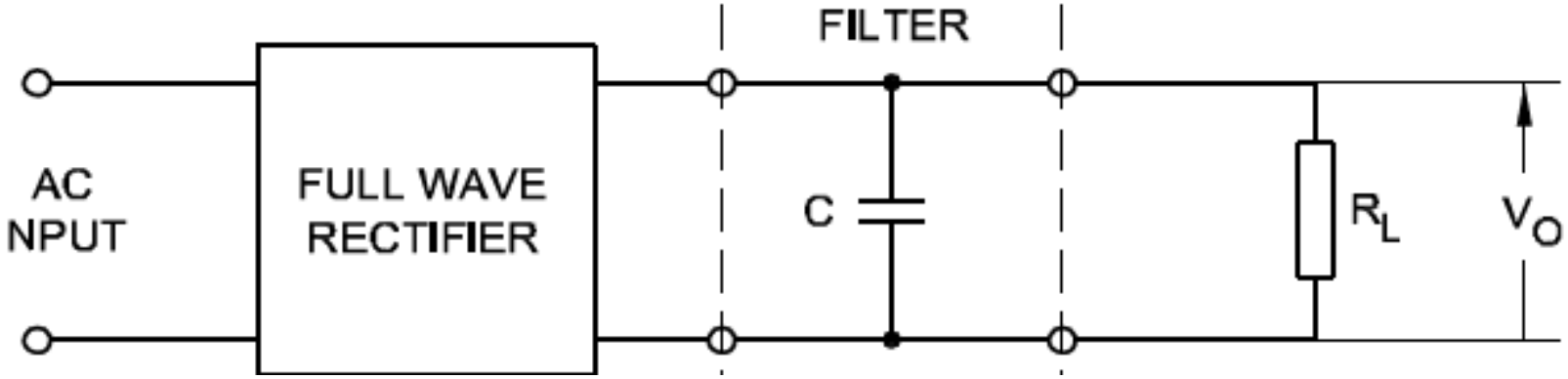
The circuits used to reduce the pulsation in the DC output of rectifiers are known as smoothing circuits or popularly as Ripple filters.

The small voltage fluctuations in the output as shown in Fig. (c) are called Ripple.

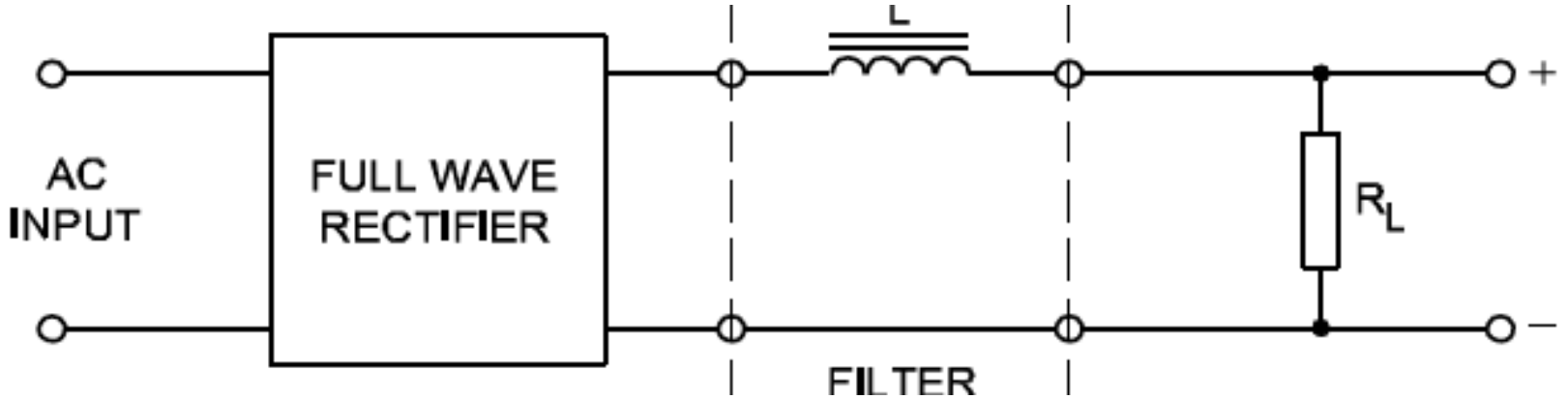
FILTER CIRCUITS:

Some commonly used filter circuits:

a) Capacitor Filter:



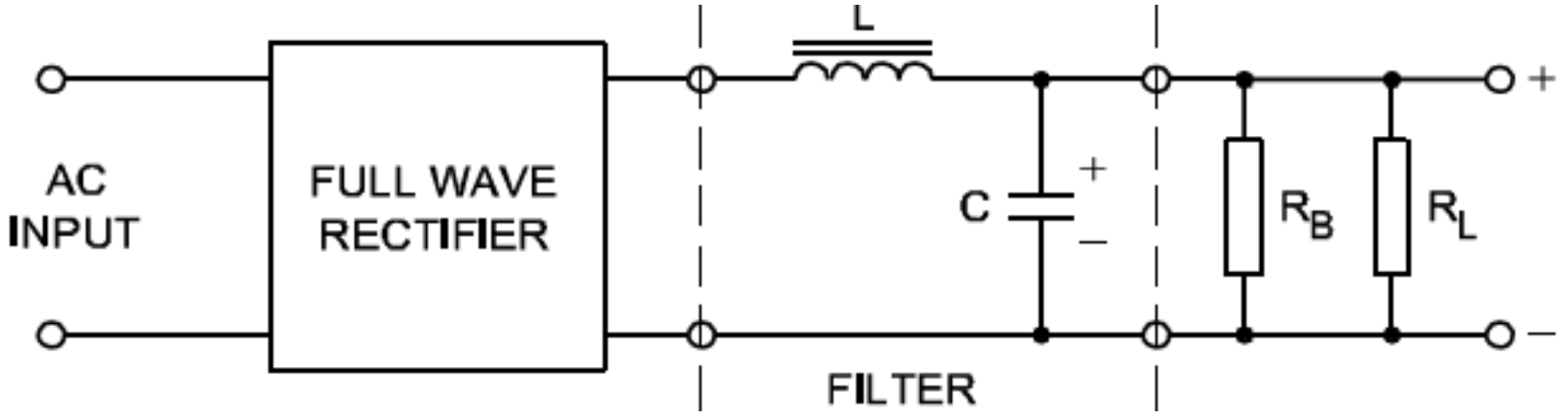
b) Series Inductor Filter:



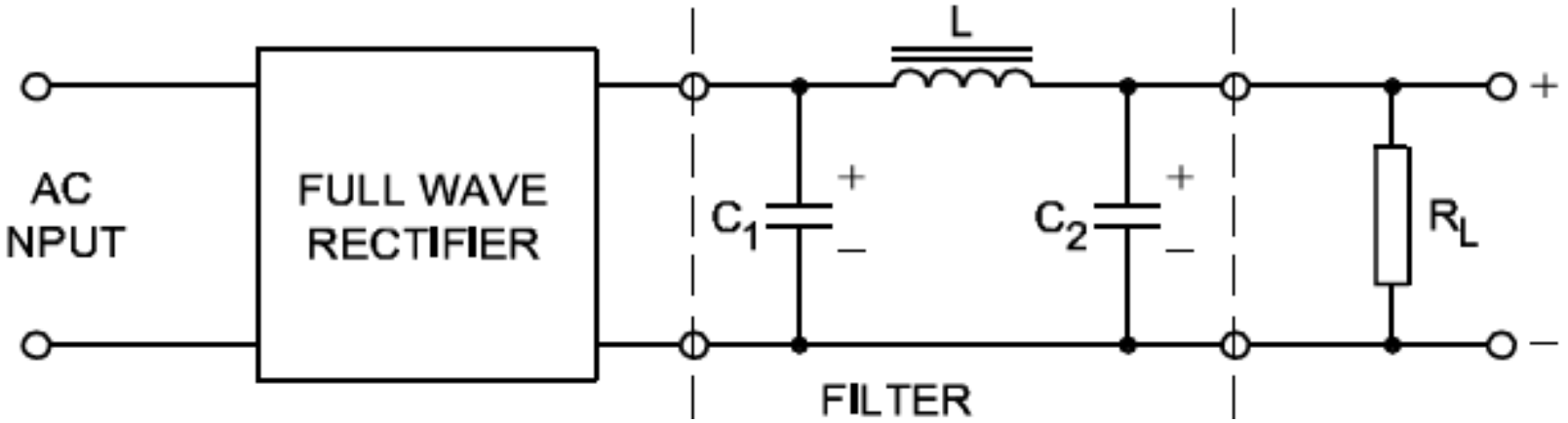
FILTER CIRCUITS:

Some commonly used filter circuits:

c) L-C Filter:



d) π Filter:



Thank You