EXP.NO: 4

Name of experiment: Filter for Half wave and full wave Rectifiers

Purpose of experiment: To examine the basic diode rectifier systems and associated filters.

Apparatus: 1. Function Generator. 2. Oscilloscope. 3. AVO meter. 4. Breadboard, 5. Four Diodes, 6. Two Capacitors and 1KΩ Resistor, Inductor.

Theory

Capacitor Filter with HWR

The half wave rectifier converts the Alternating Current (AC) into Direct Current (DC). But the obtained DC at the output is not a pure DC. It is a pulsating DC. The pulsating DC is not constant. It fluctuates with respect to time. When this fluctuating DC is applied to any electronic device, the device may not work properly. Sometimes the device may also be damaged. So the fluctuating DC is not useful in most of the applications. Therefore, we need a DC that does not fluctuate with respect to time. The only solution for this is smoothing the fluctuating DC. This can be achieved by using a device called filter. In the below circuit diagram, the capacitor C is connected in shunt with load resistor (R_L).

Capacitor filter is very popular because of its low cost, small size, light weight and good characteristics.
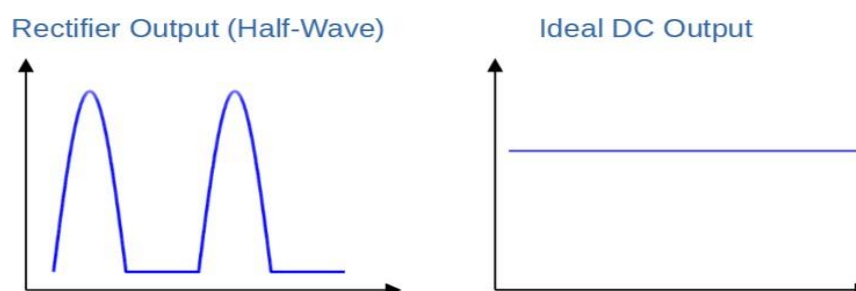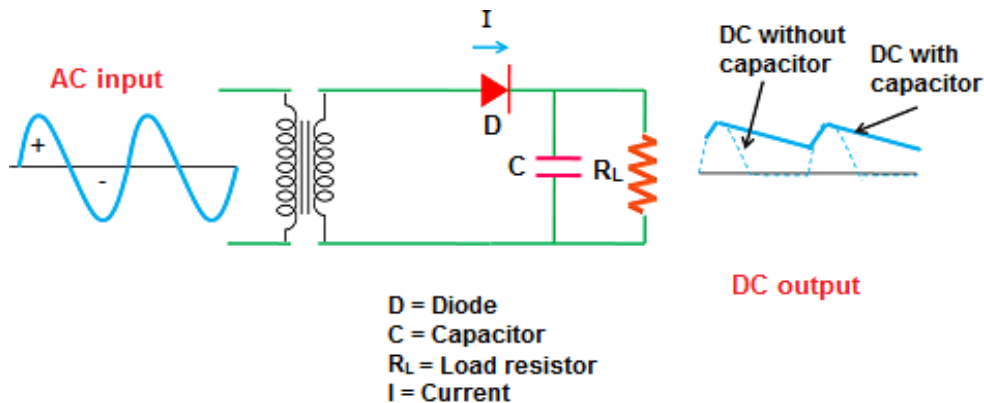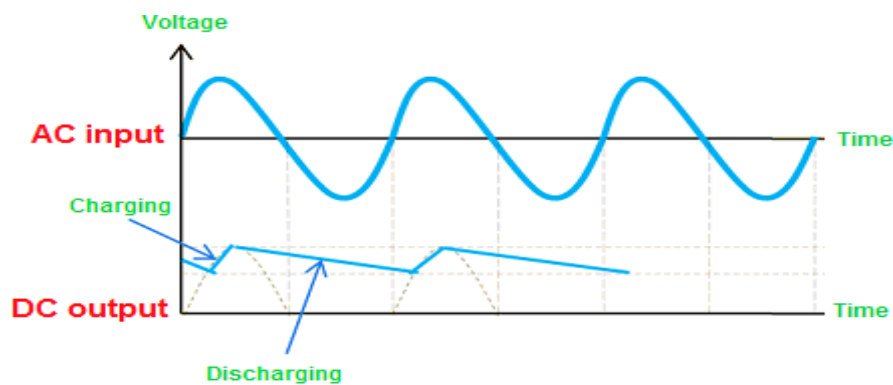
Half wave rectifier with capacitor filter

When AC voltage is applied, during the positive half cycle, the diode D is forward biased and allows electric current through it. As we already know that, the capacitor provides high resistive path to dc components (low-frequency signal) and low resistive path to ac components (high-frequency signal).

Electric current always prefers to flow through a low resistance path. So when the electric current reaches the filter, the dc components experience a high resistance from the capacitor and ac components experience a low resistance from the capacitor. The dc components does not like to flow through the capacitor (high resistance path). So they find an alternative path (low resistance path) and flows to the load resistor (RL) through that path.
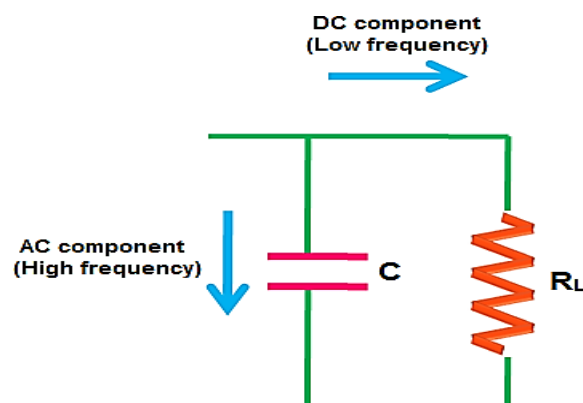
the ac components experience a low resistance from the capacitor. So the ac components easily passes through the capacitor. Only a small part of the ac components passes through the load resistor (R_L) producing a small ripple voltage at the output. The passage of ac components through the capacitor is nothing but charging of the capacitor. In simple words, the ac components is nothing but an excess current that flows through the capacitor and charges it.

Half wave rectifier with filter o/p waveforms

When the capacitor is fully charged, it holds the charge until the input AC supply to the rectifier reaches the negative half cycle.

When the negative half cycle is reached, the diode D gets reverse biased and stops allowing electric current through it. During this non-conduction period, the input voltage is less than that of the capacitor voltage. So the capacitor discharges all the stored charges through the load resistor R_L.

Capacitor Filter with FBWR

In half wave rectifier, the conversion of Alternating Current (AC) into Direct Current (DC) is not efficient. Half wave rectifier allows either positive half cycle or negative half cycle of the input AC signal and the remaining half cycle is blocked. As a result, a large power is wasted.

This ripple voltage fluctuates with respect to time. So it is not suitable for practical applications. To overcome these problems, we use filters at the output. Even though we use filters at the output, the DC signal obtained at the output is not a pure DC. In the circuit diagram, the capacitor C is placed across the load resistor R_L
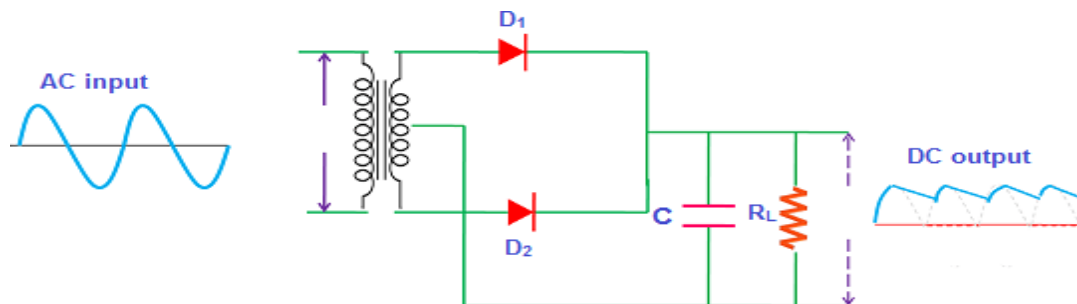
Full wave rectifier with capacitor filter

During the positive half cycle, the diode (D_1) current reaches the filter and charges the capacitor. However, the charging of the capacitor happens only when the applied AC voltage is greater than the capacitor voltage. Initially, the capacitor is uncharged. That means no voltage exists between the plates of the capacitor.
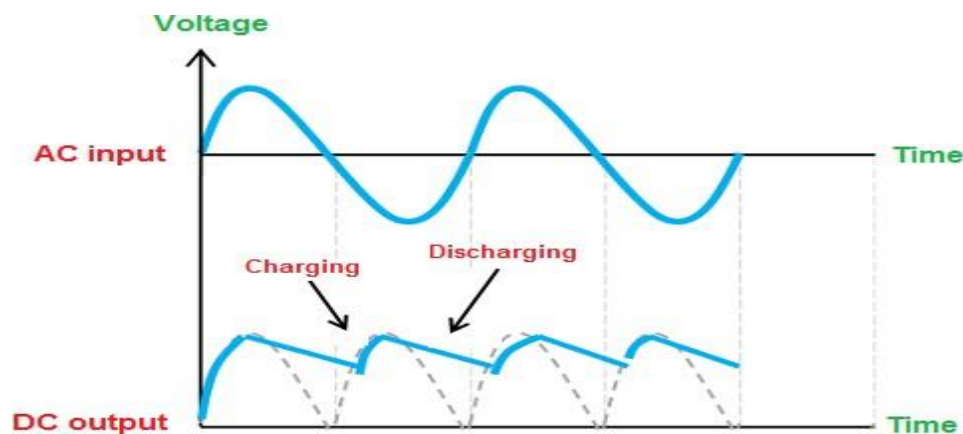
When the AC voltage starts decreasing and becomes less than the capacitor voltage, then the capacitor starts slowly discharging. The discharging of the capacitor is very slow as compared to the charging of the capacitor. So the capacitor does not get

enough time to completely discharged. Before the complete discharge of the capacitor happens, the charging again takes place. So only half or more than half of the capacitor charge get discharged. When the input AC supply voltage reaches the negative half cycle, the diode D_1 is reverse biased (blocks electric current) whereas the diode D_2 is forward biased (allows electric current). During the negative half cycle, the diode (D_2) current reaches the filter and charges the capacitor. However, the charging of the capacitor happens only when the applied AC voltage is greater than the capacitor voltage.

In both positive and negative half cycles, the current flows in the same direction across the load resistor R_L. So we get either complete positive half cycles or negative half cycles. In our case, they are complete positive half cycles.

How exactly the capacitor filter removes the ripples in the signal?

The pulsating Direct Current (DC) produced by the full wave rectifier contains both AC and DC components. that the capacitor allows the AC components and blocks the DC components of the current. When the DC current that contains both DC components and AC components reaches the filter, the DC components experience a high resistance from the capacitor whereas the AC components experience a low resistance from the capacitor. Electric current always prefers to flow through a low resistance path. So the AC components will flow through the capacitor whereas the DC components are blocked by the capacitor. Therefore, they find an alternate path and reach the output load resistor R_L. The flow of AC components through the capacitor is nothing but the charging of a capacitor.

Discussion

1. What are the advantages and disadvantage of capacitor filters?

2. Discuss the results for a full-wave circuit with a capacitor filter?