Experiment #3- Part#2

Diode Applications 1

Rectifier Circuit

- **Full-Wave Bridge Rectifier**

The full-wave bridge rectifier uses four diodes as shown in Fig.5. When the input cycle is positive, diodes $D_5$and $D_4$are forward biased and conduct current. A voltage is developed across R_L which looks like the positive half of the input cycle. During this time, diodes $D_3$and $D_6$are reverse-biased.

When the input cycle is negative, diodes $D_3$and D_6become forward-biased and conduct current in the same direction through $R_L$as during the positive half-cycle. During the negative half-cycle, $D_4$and $D_5$are reverse biased. A full-wave rectified output voltage appears across $R_L$as a result of this action.

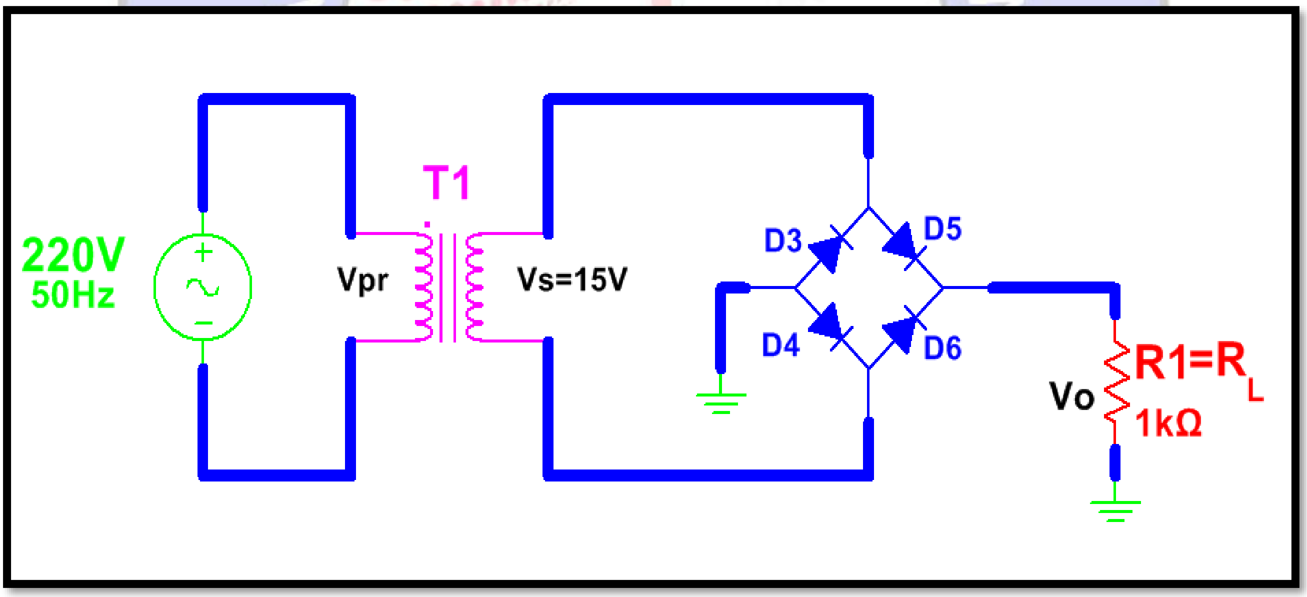

Figure 5: The Full-Wave Bridge Rectifier Circuit

In this circuit, two diodes are always in series with the load resistor during both the positive and negative half-cycles. If these diode drops are taken into account, the output peak voltage is:

$$V_{op} = V_{sp} - 1.4$$

The DC output voltage is given by:

$$V_{dc} = \frac{2V_{op}}{\pi} = \frac{2(V_{sp} - 1.4)}{\pi}$$

The peak inverse voltage of each diode in the circuit is given by:

$$PIV = V_{sp} - 0.7 = V_{op} + 0.7$$

- **Capacitor Filter**

As stated previously, the filter is used to reduce the ripples in the pulsating waveform of the rectifier. A half-wave rectifier with a capacitor filter is shown in Fig.6.

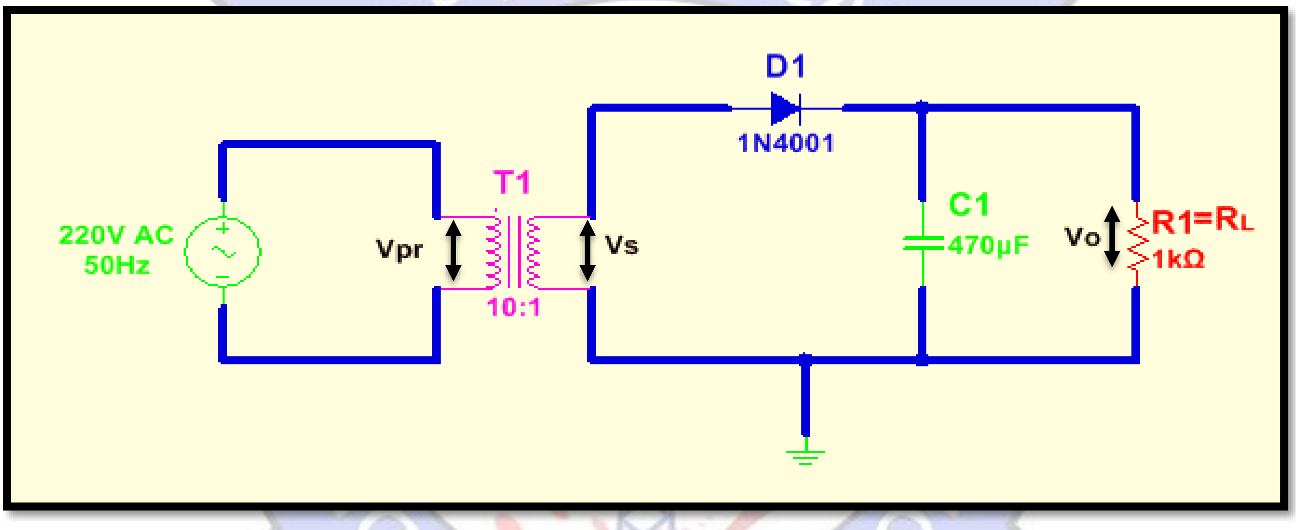

Figure 6: Half-Wave Rectifier with a Capacitor Filter

During the positive first quarter-cycle of the input signal, the diode is forward-biased, allowing the capacitor to charge to within 0.7V of the peak value of the secondary winding voltage. When the input begins to decrease below its peak, the capacitor retains its charge and the diode becomes reverse-biased because the cathode is more positive than the anode. During the remaining part of the cycle, the capacitor can discharge only through the load resistance at a rate determined by the $R_L C$ time constant, which is normally long compared to the period of the input signal. Figure 7 shows the output voltage of the filter circuit.

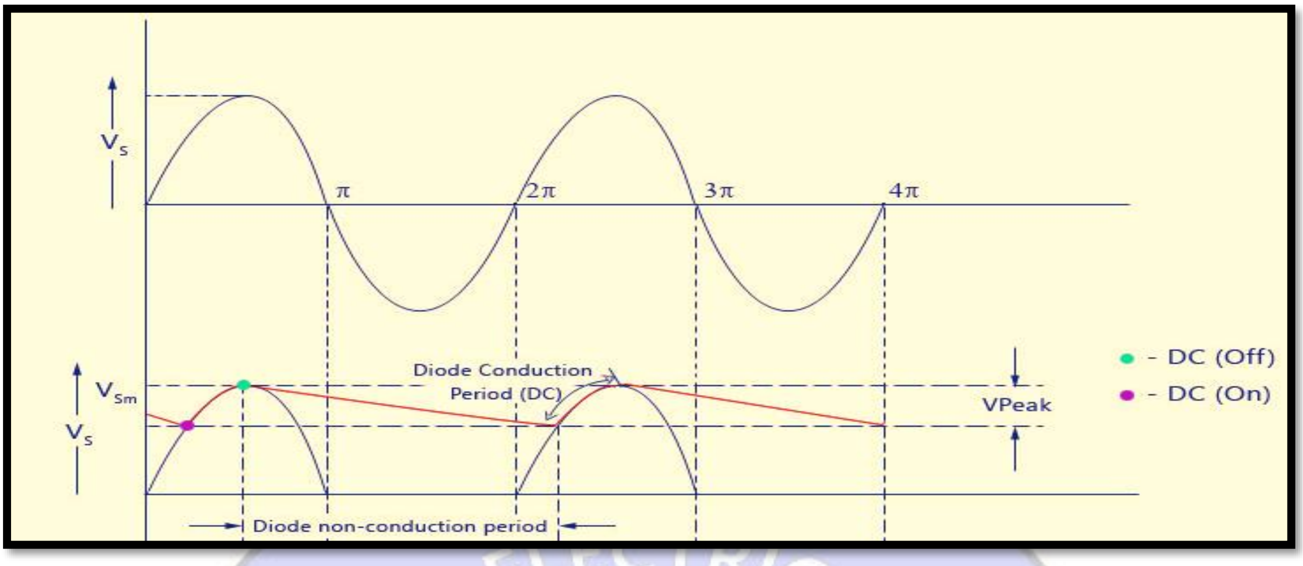

Figure 7: Output Waveform of the Capacitor Filter

Connected with the Half-Wave Rectifier

The variation in the capacitor voltage due to the charging and discharging is called the ripple voltage as illustrated in Fig.7. Generally, ripple is undesirable. Thus, the smaller the ripple, the better the filtering action.

For a half-wave rectified capacitor filter, the approximate value of the peak-to-peak ripple voltage is given by:

$$V_{r(pp)} \cong \left(\frac{1}{fR_LC}\right)V_{op}$$

Where f is the frequency of the input signal, and V_{op} is the measured peak value of the output waveform.

The DC voltage of the output waveform can be approximated by:

$$V_{dc} = V_{op} - \left(\frac{V_{r(pp)}}{2}\right)$$

Or,

$$V_{dc} \cong \left(1 - \frac{1}{2fR_LC}\right)V_{op}$$

For the full-wave rectifier, the output frequency is twice that of the half-wave rectifier. This makes a full-wave rectifier easier to filter because of the shorter time between peaks. The peak-to-peak ripple voltage for the full-wave rectified capacitor filter is given by:

$$V_{r(pp)} \cong \left(\frac{1}{fR_LC}\right)V_{op}$$

The DC voltage of the output waveform for the full-wave rectified capacitor filter can be approximated by:

$$V_{dc} \cong \left(1 - \frac{1}{4fR_LC}\right)V_{op}$$

The ripple factor is an indication of the effectiveness of the filter and is defined as:

$$r = \frac{V_{r(pp)}}{V_{dc}}$$

The lower the ripple factor, the better the filter. The ripple factor can be lowered by increasing the value of the filter capacitor or increasing the load resistance.