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School of Electrical Engineering

Course Title: Introduction to Engineering

Course Code: BEEE101N

Design of 10 V DC Power Supply using Diode Bridge Rectifier

Learning objectives:

- Understand the operation of a diode bridge rectifier circuit.
- Analyze the operation of rectifier circuit with capacitor filter.
- Determination of output voltages without and with filter capacitor.
- Study the application of rectifier based power supplies.

Components required for hardware setup:

Sl. No.	Item	Range	Quantity
1.	Transformer	230/12 V	1
2.	PN Junction Diode	1N4002	4
3.	Capacitor	Any value in the range of 47µF to 100µF (> 30 V)	1
4.	Resistor	Any value in the range 470Ω to 1kΩ	1
5.	Breadboard	-	1
6.	Wires	-	As required
7.	Oscilloscope with voltage probes	-	1

Circuit Diagram of 10 V DC power supply using Full Wave Diode Bridge Rectifier:

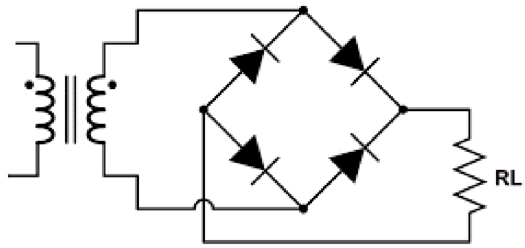

Figure 1 (a). DC power supply using full wave diode bridge rectifier (without filter capacitor)

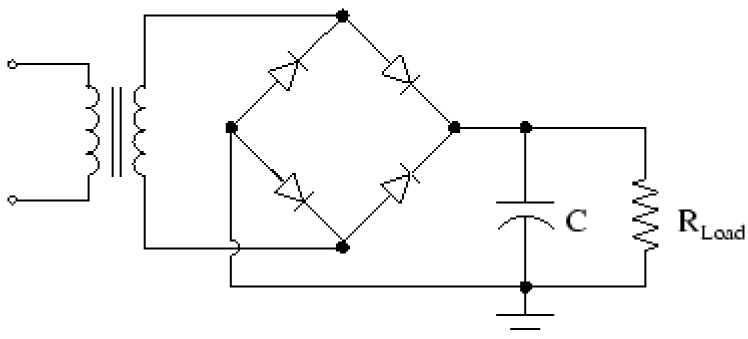

Figure1 (b). DC power supply using full wave diode bridge rectifier (with filter capacitor)

Theory:

The purpose of a power supply is to take electrical energy in one form and convert it into another. There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices such as computers, fax machines and telecommunication equipment. A power supply can by broken down into a series of blocks, each of which performs a particular function. A transformer first steps down high voltage AC to low voltage AC. A rectifier circuit is then used to convert AC to DC. This DC, however, contains ripples, which can be smoothened by a filter circuit.

Full wave diode bridge rectifier

A full wave diode bridge rectifier uses 4 diodes connected across the secondary of the transformer. During the positive half cycle of the AC input voltage, diodes D_1 and D_3 are forward biased and they conduct current as shown in the Figure 2. The other two diodes are reverse biased. The voltage developed across the load resistance will be similar to the positive half cycle of the ac input wave.

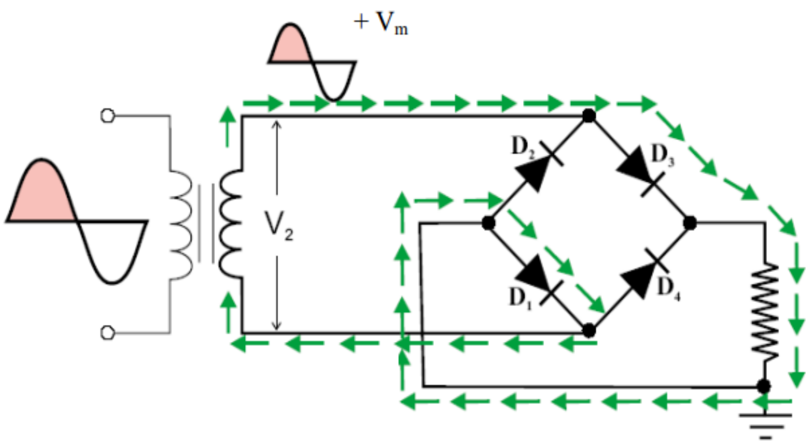

Figure 2.Operation during positive half cycle

During the negative half cycle of the AC input voltage, diodes D_2 and D_4 are forward biased and they conduct current as shown in the Figure 3. The other two diodes are reverse biased. The current through the load resistance will be in the same direction as during the positive half cycle. As a result of this action, a full wave rectified (unidirectional) output voltage is developed across the load resistance and the resulting waveform is shown in the Figure 4.

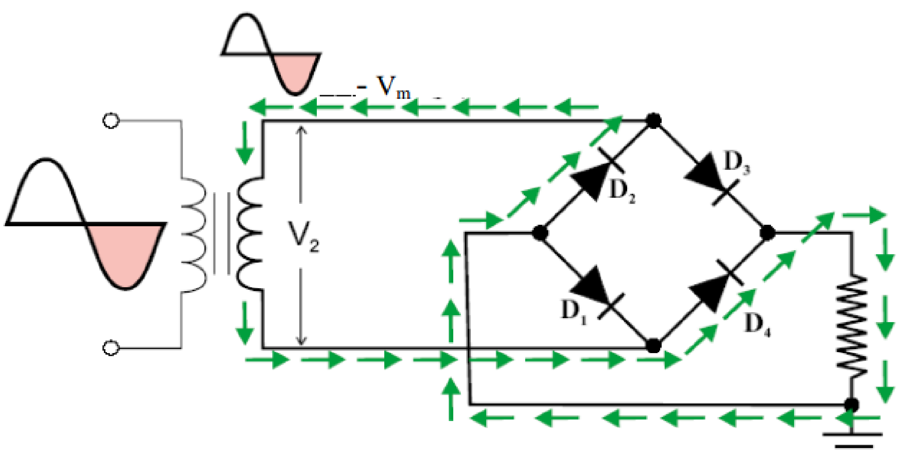

Figure 3.Operation during negative half cycle

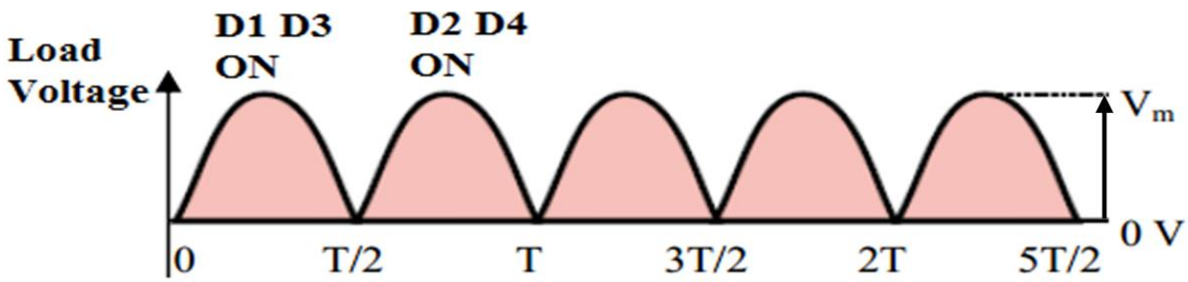

Figure 4.Full wave rectified output voltage across the load

The output of the rectifier contains dc as well as ac component. The presence of ac component (ripple) is undesirable and hence can be removed with a help of a capacitor filter as shown in Figure 1 (b). The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output. The filtered output will be as shown in Figure 5.

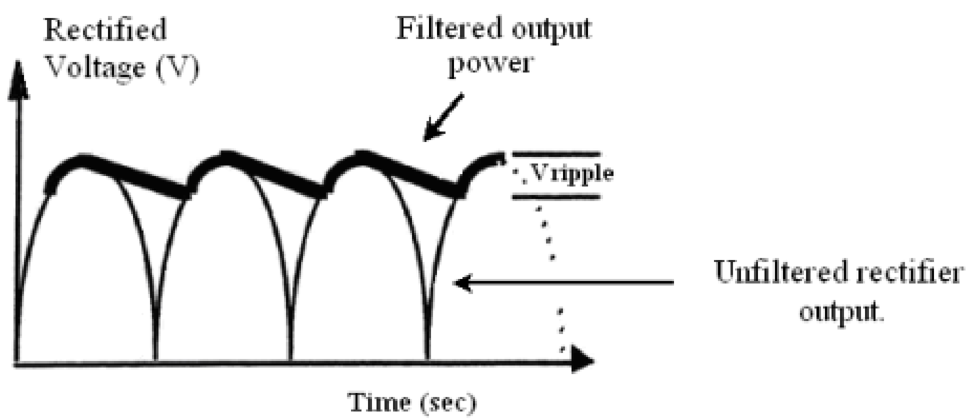

Figure 5. Bridge Rectifier output waveform (Bold line is filtered output and thin line is unfiltered output)

The RMS and average values of the output voltage (across load) without the filter is given by

$V_{rms} = V_m/\sqrt{2}$

$V_{avg} = 2V_m/\pi$

The RMS value of the filtered output is calculated assuming that the wave as a triangular wave and it is

$V_{rms} = (V_{ripple})/2\sqrt{3}$

where V_{ripple} is the peak to peak value of the filtered output voltage.

$V_{avg} = V_m - (V_{ripple}/2)$

Ripple factor $r = V_{rms}/V_{avg}$

Ripple factor is also given by the expression, $r = 1/(4\sqrt{3}fRC)$,

where f is the mains supply frequency 50 Hz, R is the load resistance and C is the filter capacitance.

Experimental Procedure:

1. Plug the transformer in to the AC power socket and measure the voltage at the secondary side of the transformer using oscilloscope.
2. Build the rectifier circuit along with resistive load using 4 diodes, 1 resistor and the transformer as shown in the circuit diagram.
3. Observe and measure the load voltage V_L with the help of an oscilloscope. Record the resulting waveform.
4. Repeat the experiment with filter capacitor by connecting the capacitor across the resistive load as shown in the circuit diagram. Now, observe and measure the load voltage V_L again with the help of an oscilloscope. Record the resulting waveform.

Observations:

Without Filter					
S.No	$\mathbf{V_m}$		$\mathbf{V_{rms} = V_m/\sqrt{2}}$	$\mathbf{V_{avg}=2V_m/\pi}$	$\mathbf{r=\sqrt{[(V_{rms}/V_{avg})^2-1]}}$
1					
With Filter					
S.No	$\mathbf{V_m}$	$\mathbf{V_{ripple}}$	$\mathbf{V_{rms} = (V_{ripple})/2\sqrt{3}}$	$\mathbf{V_{dc}=V_m-(V_{ripple}/2)}$	$\mathbf{r=V_{rms}/V_{avg}}$
1					