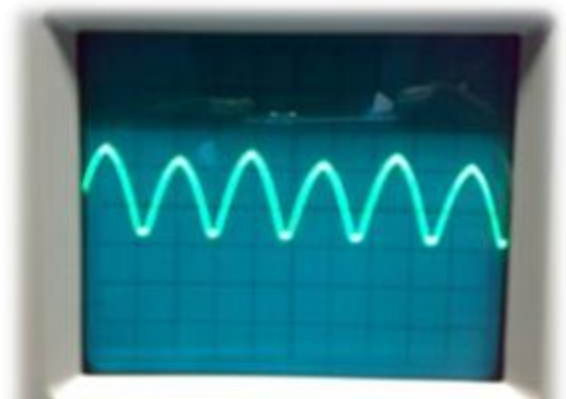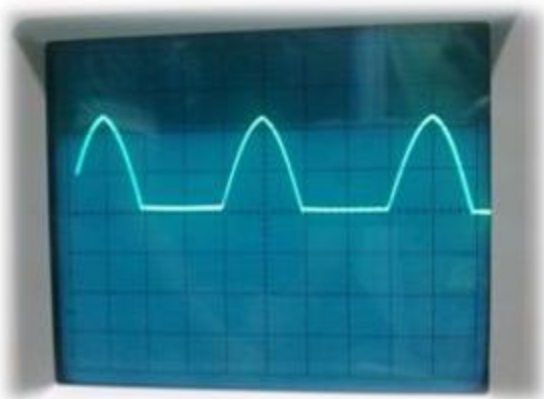# HALF-WAVE & FULL-WAVE RECTIFICATION

# HALF-WAVE & FULL-WAVE RECTIFICATION

Objectives:

- To recognize a half-wave rectified sinusoidal voltage.
- To understand the term 'mean value' as applied to a rectified waveform.
- To understand the effect of a reservoir capacitor upon the rectified waveform and
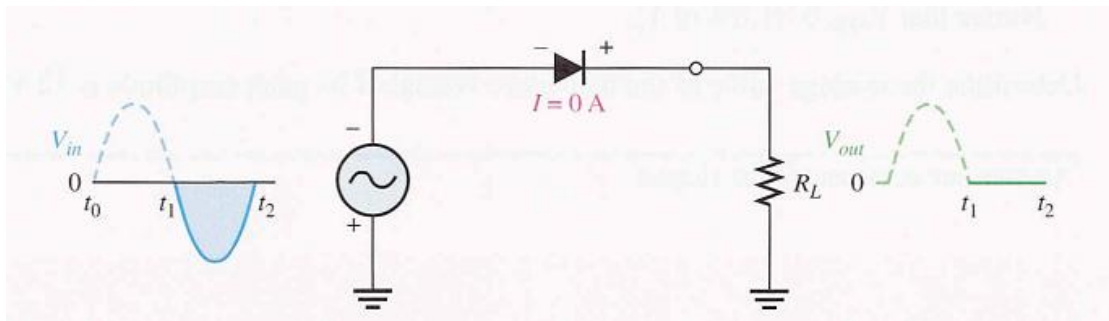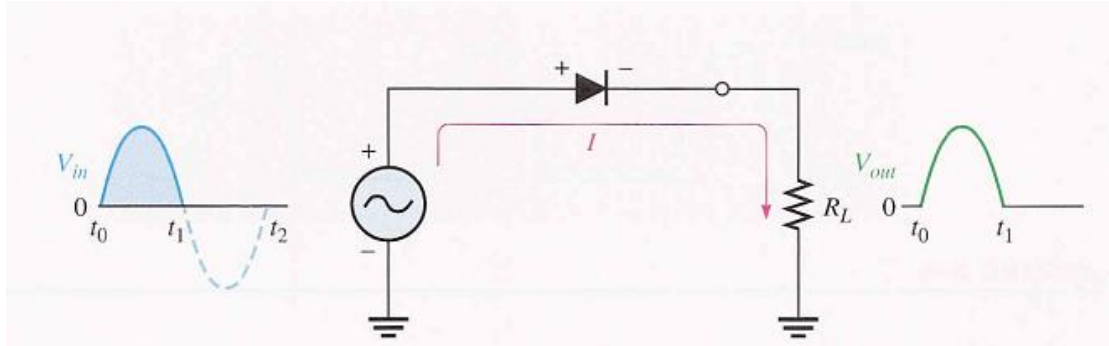 its mean value.

Introduction:

One of the very important applications of diode is in DC power supply as a rectifier to convert AC into DC. DC Power supply is the important element of any electronic equipment. This is because it provides power to energize all electronic circuits like oscillators, amplifiers and so on. In electronic equipments, D.C. Power supply is must. For example, we can't think of television, computer, radio, telephone, mobile as well as measuring instruments like multi-meter etc. Without DC power supply. The reliability and performance of the electronic system proper design of power supply is necessary. The first block of DC power supply is rectifier. Rectifier may be defined as an electronic device used to convert ac voltage or current into unidirectional voltage or current. Essentially rectifier needs unidirectional device. Diode has unidirectional property hence suitable for rectifier. Rectifier broadly divided into two categories: Half wave rectifier and full wave rectifier.
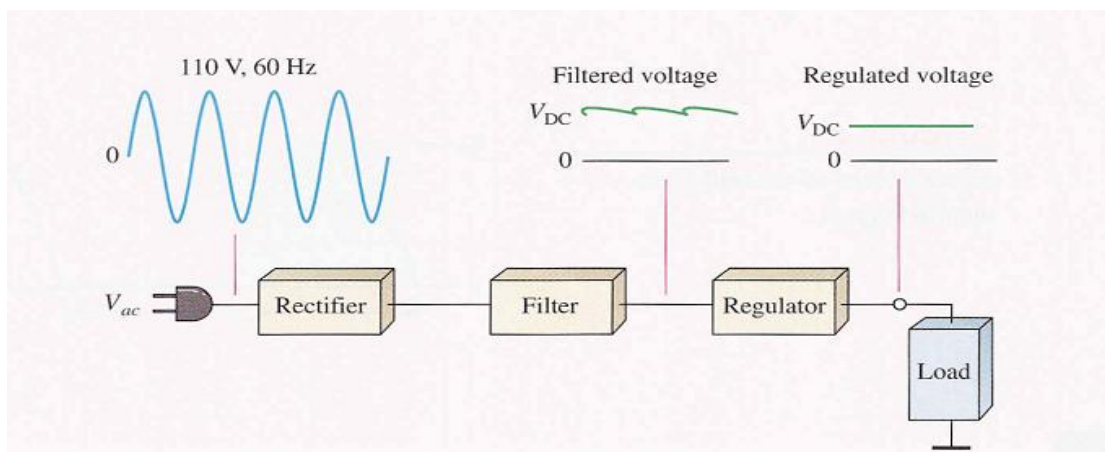
Working principle of half wave rectifier:

In half wave rectifier only half cycle of applied AC voltage is used. Another half cycle of AC voltage (negative cycle) is not used. Only one diode is used which conducts during positive cycle. The circuit diagram of half wave rectifier without capacitor is shown in the following figure. During positive half cycle of the input voltage anode of the diode is positive compared with the cathode.

Diode is in forward bias and current passes through the diode and positive cycle develops across the load resistance RL. During negative half cycle of input voltage, anode is negative with respected to cathode and diode is in reverse bias. No current passes through the diode hence output voltage is zero.

$$\text{Average or mean value(dc value)} = \frac{\text{area under the curve}}{\text{length of base}}$$

$$V_{av} = \frac{\int_0^{\pi} V_p \sin(\theta)}{2\pi} = \frac{V_p}{2\pi}(-\cos(\theta))\Big|_0^{\pi} = \frac{2V_p}{2\pi} = \frac{V_p}{\pi} = .318V_p$$

$$V_{rms} = \frac{V_p}{2}$$

Full-Wave Rectifier

The bridge rectifier

The Bridge rectifier is a circuit, which converts an ac voltage to dc voltage using both half cycles of the input ac voltage. The Bridge rectifier circuit is shown in the following figure.

The circuit has four diodes connected to form a bridge. The ac input voltage is applied to the diagonally opposite ends of the bridge. The load resistance is connected between the other two ends of the bridge. For the positive half cycle of the input ac voltage, diodes D1 and D2 conduct, whereas diodes D3 and D4 remain in the OFF state. The conducting diodes will be in series with the load resistance RL and hence the load current flows through RL. For the negative half cycle of the input ac voltage, diodes D3 and D4 conduct whereas, D1 and D2 remain OFF. The conducting diodes D3 and D4 will be in series with the load resistance RL and hence the current flows through RL in the same direction as in the previous half cycle. Thus a bi-directional wave is converted into a unidirectional wave.
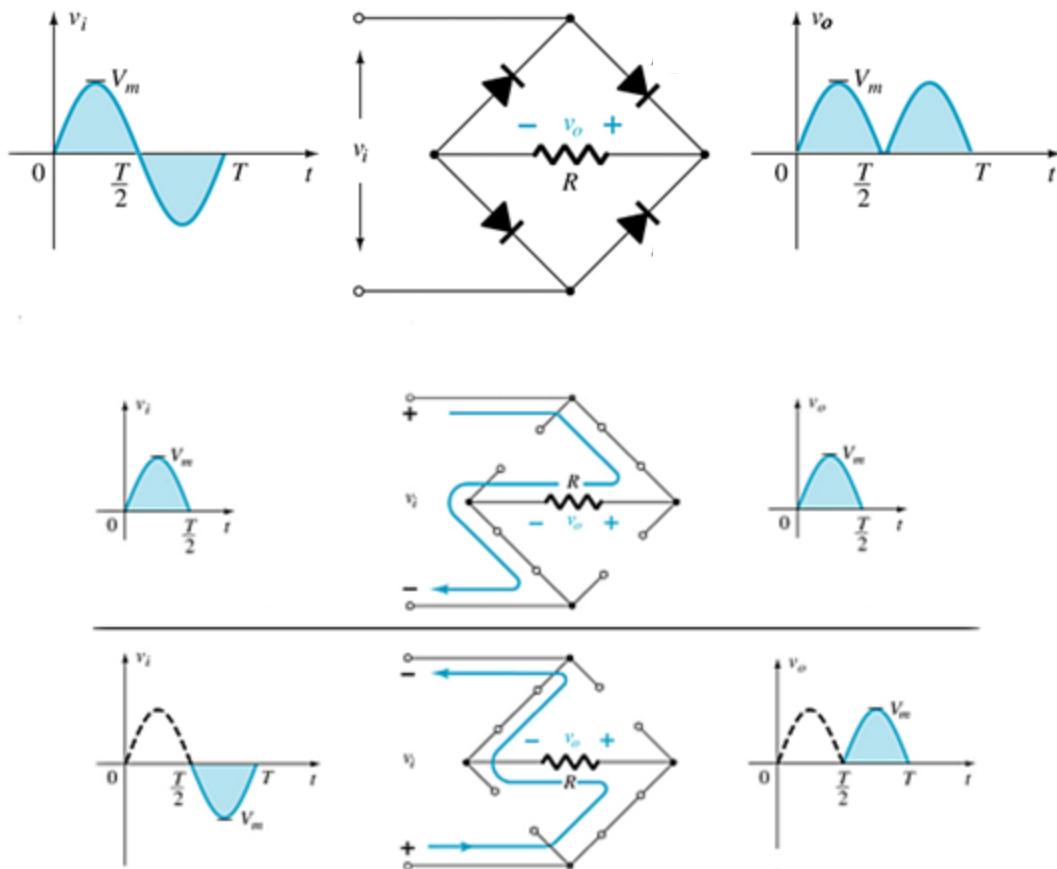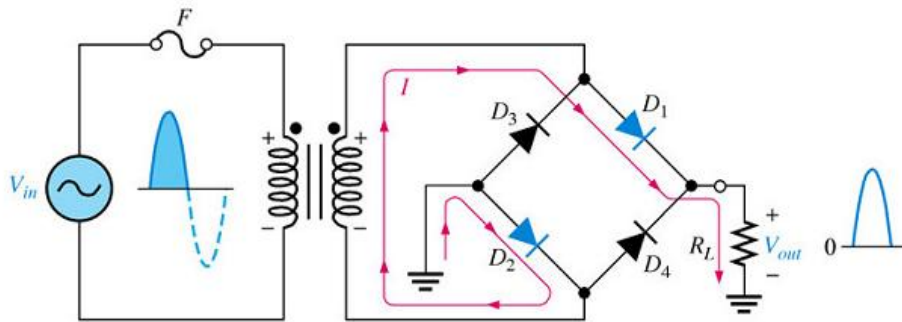
(a) During positive half-cycle of the input, D_1 and D_2 are forward-biased and conduct current. D_3 and D_4 are reverse-biased.
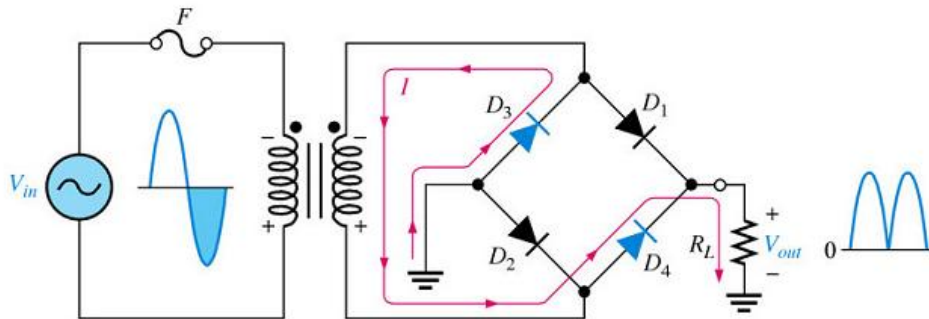
(b) During negative half-cycle of the input, D_3 and D_4 are forward-biased and conduct current. D_1 and D_2 are reverse-biased.

$$V_{av} = \frac{2V_p}{\pi} = .636V_p$$

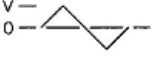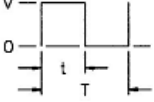$$V_{rms} = \frac{V_p}{\sqrt{2}}$$

Reading of Dc meter ?

If a D.C. Ammeter is connected in the rectifier output circuit ,what reading will it indicate ?

The dc meter will read the average value .

Reading of AC meter ?

The RMS value will be read , but the AC multimeter is calibrated to read the exact rms value of pure sine wave ,other shape will give incorrect reading .

See the figure bellow to see the amount of error

Waveform Shape	Crest Factor (C.F.)	AC RMS	AC+DC RMS	Average Responding Error
	1.414	$\dfrac{V}{1.414}$	$\dfrac{V}{1.414}$	Calibrated for 0 error
	1.732	$\dfrac{V}{1.732}$	$\dfrac{V}{1.732}$	−3.9%
	$\sqrt{\dfrac{T}{t}}$	$\dfrac{V}{C.F.} \times \sqrt{1-\left(\dfrac{1}{C.F.}\right)^2}$	$\dfrac{V}{C.F.}$	−46% for C.F. = 4

Crest Factor is the ratio between the R.M.S. value and the Peak value of the waveform and is given as.

$$\text{Crest Factor} = \frac{\text{Peak value}}{\text{R.M.S. value}}$$

Work sheet

Part a : Half wave rectifier

1-Connect the half wave rectifier circuit as shown in the above figure Set the function generator to 50 Hz, 8 Vp-p sinusoidal voltage using the oscilloscope

2- Connect the oscilloscope terminals across the resistor and measure

Vp=……………………..

3-Calculate the DC level of the half-wave rectifier signal using **eq.1** and the RMS using **eq.2**

$$V_{dc_{calculated}} = \text{…………………}$$

$$V_{rms_{calculated}} = \text{…………………}$$

4-Measure the average value and the RMS value of the wave across the resistor using digital multimeter .

$$V_{dc_{measured}} = \text{…………………}$$

$$V_{rms_{measured}} = \text{…………………}$$

Part b : Full wave rectifier.

1-Connect the full wave rectifier circuit as shown in the above figure Set the function generator to 50 Hz, 8 Vp-p sinusoidal voltage using the oscilloscope

2- Connect the oscilloscope terminals across the resistor and measure

Vp=……………………..

3-Calculate the DC level of the full-wave rectifier signal using **eq.3** and the RMS using **eq.4**

$$V_{dc_{calculated}} = \text{…………………}$$

$$V_{rms_{calculated}} = \text{…………………}$$

4-Measure the average value and the RMS value of the wave across the resistor using digital multimeter.

$$V_{dc_{measured}} = \dots\dots\dots\dots\dots$$

$$V_{rms_{measured}} = \dots\dots\dots\dots\dots$$

Now

Answer these questions (explain and *draw* if it is required)

1-Why will Vp not be exactly equal to the peak value of the supply?

2- How much is the difference between the peak value of the source and the peak value of half wave and full wave ?

Half wave :…………………………………………………………………………………………….

Full wave :…………………………………………………………………………………………….

3- How much is the difference between the measured and calculated mean (dc) voltage? and why this difference ?

4- How much is the difference between the measured and calculated rms voltage ? and why this difference ?

5-In full wave rectifier why we get a half wave when we connect the two channels of oscilloscope ?

7-Draw the voltage a cross the diode in the half wave rectifier ?

6-Use Orcad to implement all parts ,plot Vin and Vout for full and half wave ?

Comment your results