EE281/EE285 - Diode Characteristics and Applications

Department of Electrical and Electronic Engineering
Faculty of Engineering
University of Peradeniya

TITLE: DIODE CHARACTERISTICS

OBJECTIVE: 1. To determine the characteristics of a semiconductor diode.
2. To investigate the function of diodes in half wave and full wave rectifier circuits.

PART 1: UNDERSTANDING THE CHARACTERISTICS OF A DIODE

APPARATUS: List the apparatus as you find in the practical in your worksheet. (Diode given for the experiment is IN4001. Refer the data sheet for specifications).

PROCEDURE: The circuit arrangement shown in Figure I is used to measure the volt-ampere characteristics of any two terminal non-linear device.

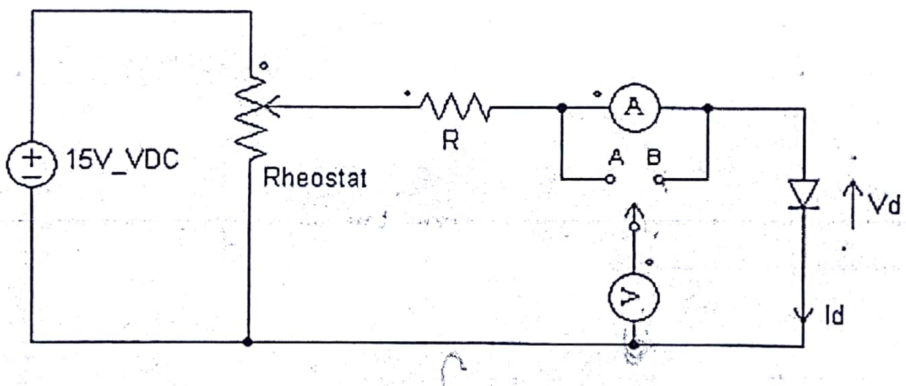


Figure 1 - Diode Characteristics Test Circuit

If position A is used; the voltmeter reads the total voltage drop across the ammeter and the diode, whereas the ammeter reads the true current through the diode.

If position B is used; the ammeter reads the current through the diode and the voltmeter whereas the voltmeter reads the true voltage across the diode.

Note that, in the above diagram the diode is connected to take the forward biased measurements. By interchanging the diode terminals in the circuit, we can take the reverse biased measurements. In the practical we are concerned about forward biased behavior only.

1. What is the purpose of the resistor, R in this circuit? Comment about the value of R required.
2. Under the reverse biased condition what is the most suitable circuit arrangement? (From settings A and B). Explain the reason for your preference.

3. Connect the circuit diagram with the diode forward biased as shown above.
4.
    a. By adjusting the rheostat obtain voltages of OV to 0.7V in the voltmeter reading (in O. IV steps). At each step obtain the ammeter reading. ***i.e. voltmeter reading is the independent parameter while ammeter reading is the dependent parameter.***
    b. Beyond 0.7V, while adjusting the rheostat to give ammeter reading of 10mA to 100mA (in 10mA steps), obtain the voltmeter reading. ***i.e. ammeter reading is the independent parameter while the voltmeter reading is the dependent parameter.***

PART 2: FULL BRIDGE DIODE RECTIFIER

OBJECTIVE: To study the load characteristics of a full bridge diode rectifier.

APPARATUS: Multimeter (Analog or Digital)
Transformer, 12V ac center tapped (6-0-6 is available)
Oscilloscope
Resistors – 1kΩ, 500Ω

PROCEDURE:

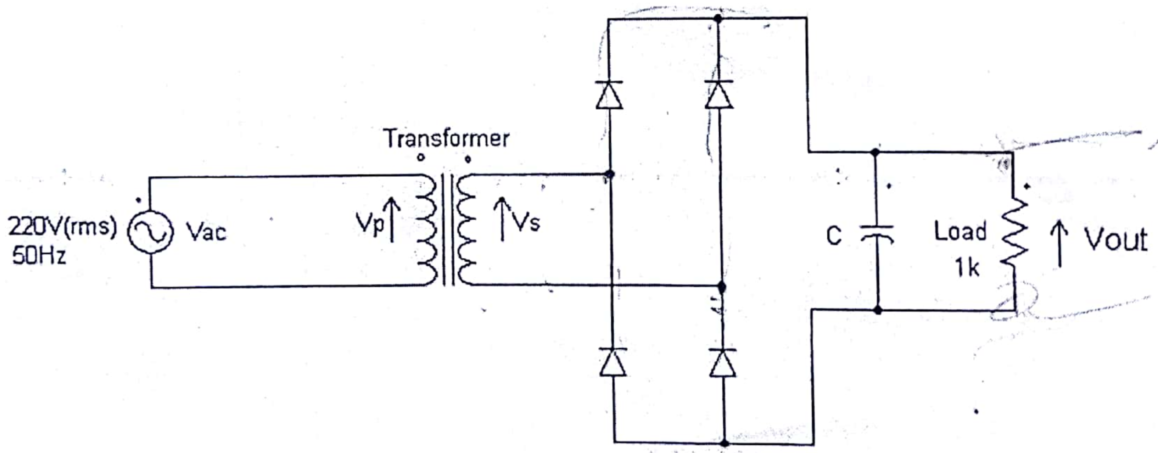


Figure 2 - Full Bridge Diode Rectifier Circuit

1. Assemble the circuit omitting the capacitor. Estimate the peak voltage of Vs and check for the Peak Inverse Voltage (PIV) rating of the diodes. Observe and sketch Vo. Find the peak value of the load voltage from the oscilloscope trace.
   Note: Peak reverse voltage or peak inverse voltage is the maximum voltage that a diode can withstand when reverse biased without breaking down. (i.e. The peak inverse voltage is the maximum voltage that a diode can block). Diode may be destroyed if this voltage is exceeded. Diodes must have a peak inverse voltage rating that is higher than the maximum voltage that will be applied to them in a given application.

2. Using a multimeter measure the ac voltage across the secondary winding of the transformer.
   Note: the multimeter, when in the ac voltage mode gives you the rms value of the applied

3. Measure the average value of the load voltage (vo) by using a Multimeter.

   Note: for this measurement the dc voltage mode of the multimeter should be used.

4. Connect a 470μF capacitor to the circuit. (Note: It is important to note that the polarity marking of the electrolytic capacitor corresponds to the polarity of its terminal voltage.) By using the oscilloscope with ac coupling, observe and sketch the ripple voltage of V_o Find the peak to peak ripple voltage.

   Make sure that the voltage rating of the capacitor is greater than the output peak voltage. Otherwise the capacitor may get damaged.

5. Change the load resistor to 500Ω and repeat part 4. Also Observe the effect of connecting a second 470μF capacitor in parallel. (First make sure that the first capacitor is fully discharged.)

6.
   a. Calculate the voltage drop across a diode while conducting.
   b. Calculate the theoretical average and the peak to peak value of Vo.

PART 3: DIODE APPLICATIONS-CLIPPING AND CLAMPING CIRCUITS

THEORY: Clipping circuits (also known as limiters, amplitude selectors, or slicers), are used to remove the part of a signal that is above or below some defined reference without distorting the other part of the signal. Clipping requires a minimum of one diode (either in parallel or series) and one resistor. A power supply is often used to set the various clipping levels.

Clamping circuits, also known as dc restorers or clamped capacitors, shift an input signal by an amount defined by an independent voltage source.

i.e. The clipping circuit clips off some of the portions of the input signal and uses the clipped signal as the output signal. The clamping circuit or clamper keeps the amplitude of the output signal same as that of the input signal except that the D. C. level (offset) has been changed

PROCEDURE:

1. Rig up the circuits as per the circuit diagrams. Assume R=1kΩ (except for circuit 5 and circuit 6) and $V_\gamma = 0.7v$ for the diodes.

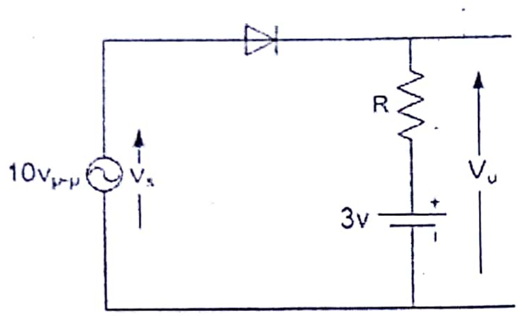
2. For circuit 5 and 6, estimate a suitable time constant, hence select R and C values which are practically available while satisfying the time constant requirement.

   Figure 5 and 6 represents clamper circuits. The magnitude of R and C are chosen so that the time constant, RC is large enough to ensure that the voltage across the capacitor does not discharge significantly during the diode's "Non-conducting" interval. So the RC time constant must be much larger than the periodic time of the ac input signal (at least ten times).

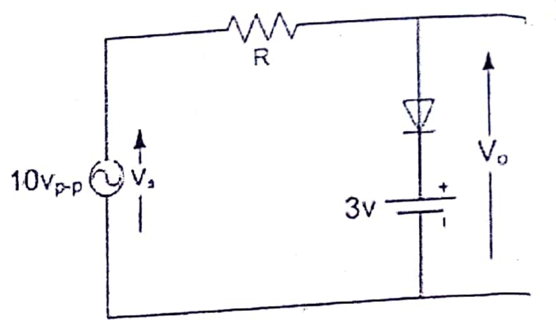
3. Set input signal to a $10V_{p-p}$, lkHz sinusoidal signal using the signal generator.

4. Observe the waveforms of Vo using CRO (with DC coupling)

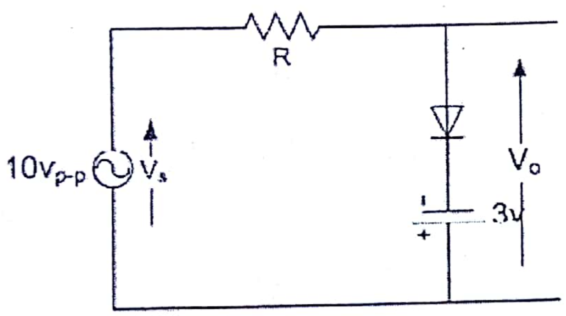
5. Sketch all the wave form Sin a graph sheet to the same scale.



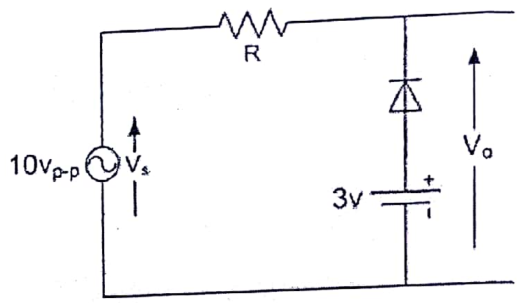
Circuit 1



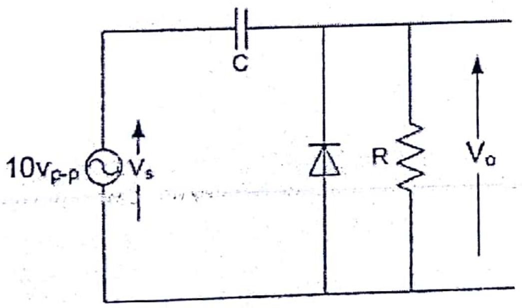
Circuit 2



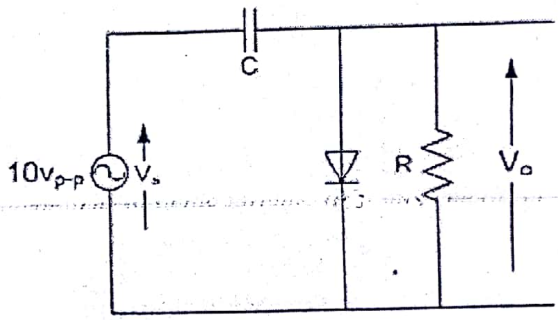
Circuit 3



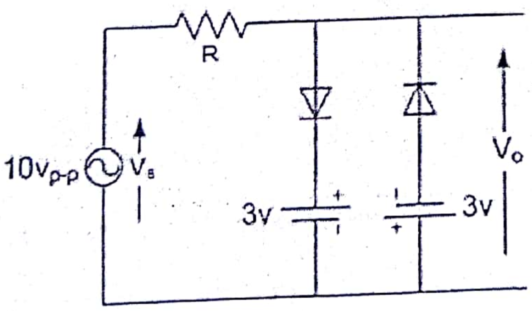
Circuit 4



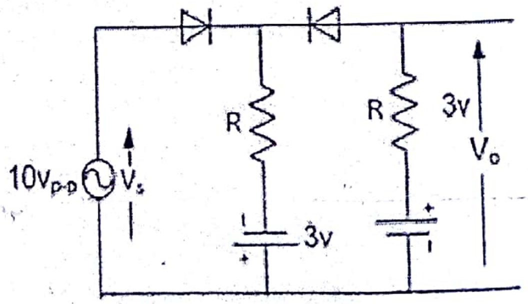
Circuit 5



Circuit 6



Circuit 7



Circuit 8