PHYS 605 Lab #6

Morgan A. Daly and Evin O'Shea
(Dated: March 28, 2016)

I. INTRODUCTION AND THEORY

A. Purpose

In this lab, the focus was to learn about how diodes can be used in AC circuits. The first part of the lab showed how a single diode can be used as a half-wave rectifier. In the second part of the lab the group made a full wave rectifier. In the third part of the lab the behavior of a zener diode was explored both with DC and AC voltage sources.

B. Background / Theory

The lab revolved around the behavior of diodes in AC circuits. Diodes are an interesting type of passive circuit element which have interesting properties. The most important property of diodes is that they only allow current flow in one direction. When an AC voltage source powers a diode, only the positive or negative voltage will go through the diode.

In the Part A of the lab a diode was used to convert the AC signal into only a positive signal. This demonstrated the diode property of only allowing current flow in one direction. When the AC source supplies a positive voltage the diode would allow current flow through. When the voltage source supplies a negative voltage the diode will not let current flow through. The circuit used for this part of the lab was built in two aprts. First the circuit was built with a resistor and a diode in series with the oscilliscope connected in parallel with the voltage source and the diode. After this circuit was investigated a 3V DC supply was added to the circuit between the resistor and diode. The final circuit for this part of the lab is shown below:

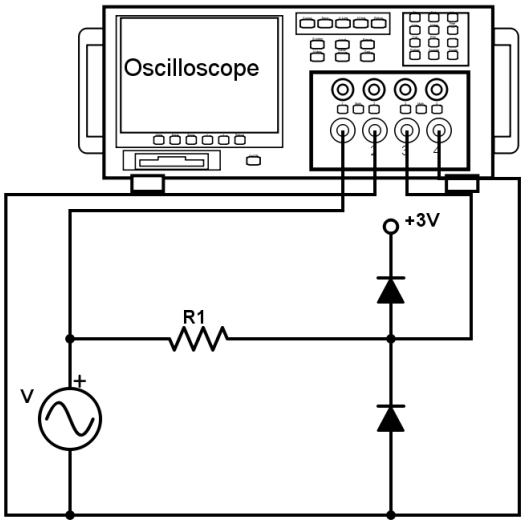

FIG. 1: This circuit only supplies postive voltage to the oscilloscope.

In the second part of the lab, the diode was used to allow the positive and negative voltages through while inverting the negative voltage. The circuit used for this part of the lab is shown below:

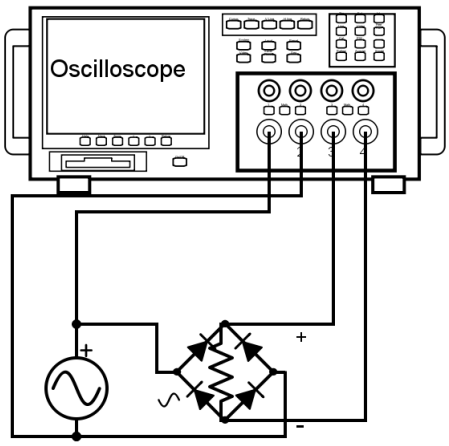

FIG. 2: A full wave rectifier with input and output connected to an ocsilloscope

The circuit makes all the voltage positive. As positive voltage is supplied to the circuit current will pass through the top left diode and not the bottom left because of the orientation of the diode. Current will then flow down through the resistor and not the top right diode. As negative voltage is supplied to the circuit current will flow from the bottom side of the AC source. As the current flows to the right side of the bridge it will pass through the top right diode and not the bottom right. The current will then flow down through the resistor as it did when a positive voltage was supplied. This combination will cause flow in only one direction through the resistor and the output of the bridge.

For the third part of the lab, a zener diode was investigated. The distinction between a regular diode and a zener diode is that a zener diode will allow voltage to pass in both directions, but in the reverse-bias direction, there is a minimum voltage required to cause current flow. This voltage is called the zener voltage. A diagram

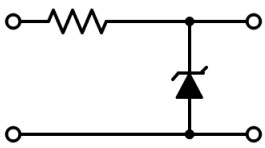

FIG. 3: This circuit only supplies postive voltage to the oscilloscope.

of the circuit for this part of the lab is shown below:

The left side was connected to both DC and AC sources to invesitage different properties of the zener diode.

II. METHODOLOGY

1. Construct RC circuit with oscilloscope as show in figure (1) without the 3V DC source and diode attatched.
2. Take record of the plot from the oscilloscpe.
3. Adjust frequency and amplitude of input source and repeat step 2.
4. Build diode brdge shown in figure (2).
5. Connect input source (one that is external from the protoboard) and connect the oscilloscope as shown in figure (2).
6. Repeat steps 2 and 3 to get data about the bridge.
7. Construct the circuit shown in figure (3).
8. Add an adjustable DC input to the left side of the circuit and connect a measurement device to the right side of the circuit.
9. Make recordings of the output voltages as the input voltage is modified.
10. Swap the DC input for an AC input and swap the measurement device for one suited for AC voltages (oscilloscope) if necessary.
11. Take record of the plot shown on the oscilloscope.
12. Swap the zener diode out for another one and repeat step 11.
13. Combine the two diodes in series in the same direction and make record of the plot on the oscilloscope.
14. Combine the two zener diodes in parallel in opposite directions to "clip" both positive and negative voltages from the AC input.

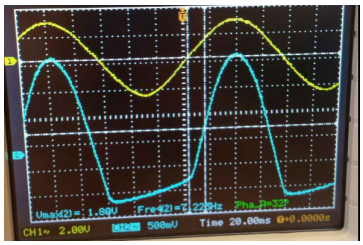

FIG. 4: This circuit only supplies postive voltage to the oscilloscope.

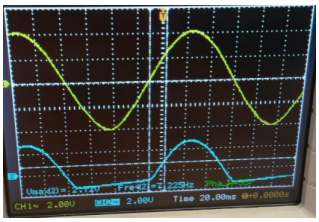

FIG. 5: This circuit only supplies postive voltage to the oscilloscope.

III. RESULTS AND ANALYSIS

A. Data

For part A of the lab, first only part of the circuit was built as described previously. This setup was investigated with varying voltages and frequencies for the input source.

The input source was initially set to an amplitude and frequency of 2.64V and 7.225Hz respectively. The V_{max} for the diode was 1.80V.

second amplitude: 4.08V f=7.225Hz -V2(max) 2.72V

third frequency: 2.64V f=75.19Hz -V2(max) 1.76V

After adjusting the amplitude and frequency of the input voltage a 3.065V DC source was added to the circuit attatched by another diode as shown in figure (1).

The input voltage and frequency were first set to 2.64V and 731.0mHz respectively. The V_{max} for the diode was 464mV. V2 464mV

second: 2.64V 74.63Hz V2 480mV

third: 1.48V f=7.225 v2 460mV

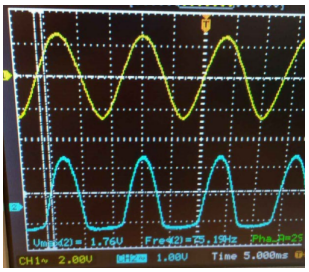

FIG. 6: This circuit only supplies postive voltage to the oscilloscope.

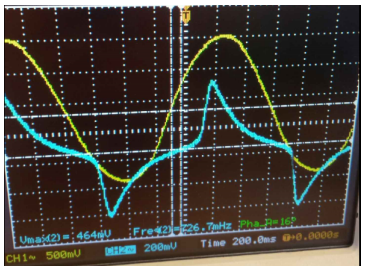

FIG. 7: This circuit only supplies postive voltage to the oscilloscope.

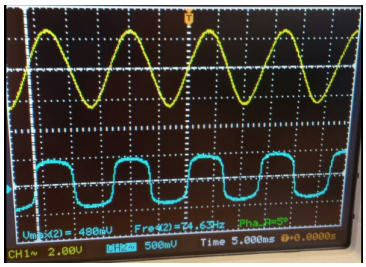

FIG. 8: This circuit only supplies postive voltage to the oscilloscope.

B. Analysis

IV. CONCLUSION

The relationship between frequency, impedance, and voltage was made obvious, and observations matched expectations based on known equations. The resulting improved understanding and intuition for a new type of circuit makes this successful.

Measured values of gain were compared to calculated values with some error, which seemed to increase at extreme values. The roll off was calculated, and the group was able to observe the behavior of a RC circuit in frequencies that were a part of the filtered frequencies.

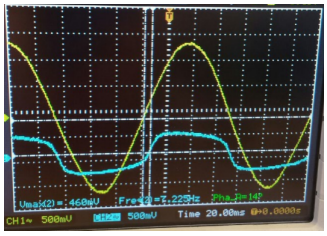

FIG. 9: This circuit only supplies postive voltage to the oscilloscope.