EE 316: Electrical Circuits and Electronic Design Laboratory.

Lab 06

AC Signals, Transformers and Bridge Rectifiers.

Submitted by: **Dan Otieno.**

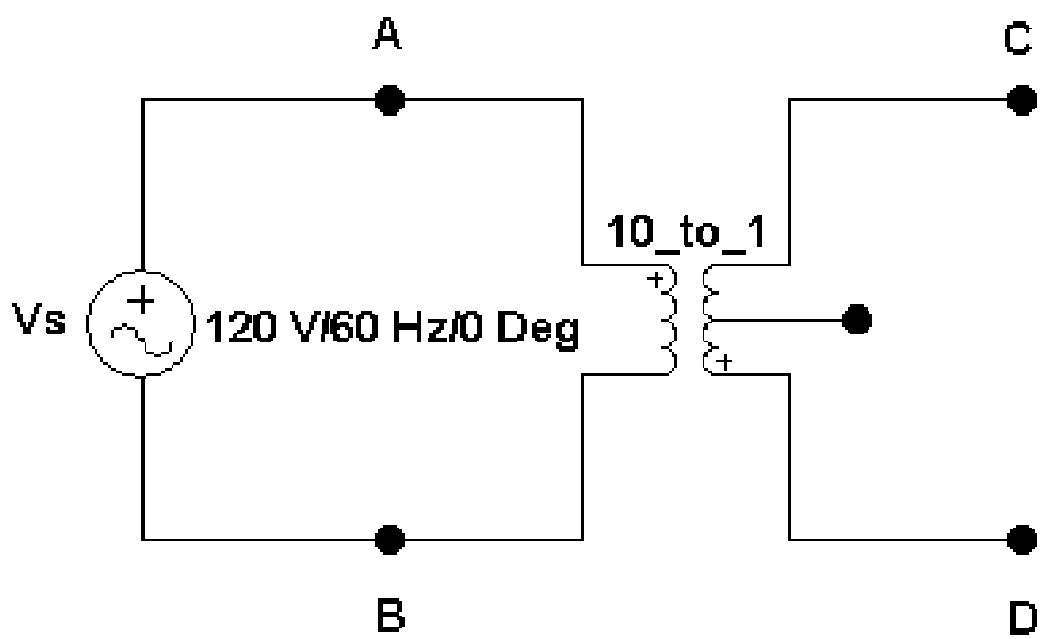
Date of Experiment: 10/03/22.

INTRODUCTION:

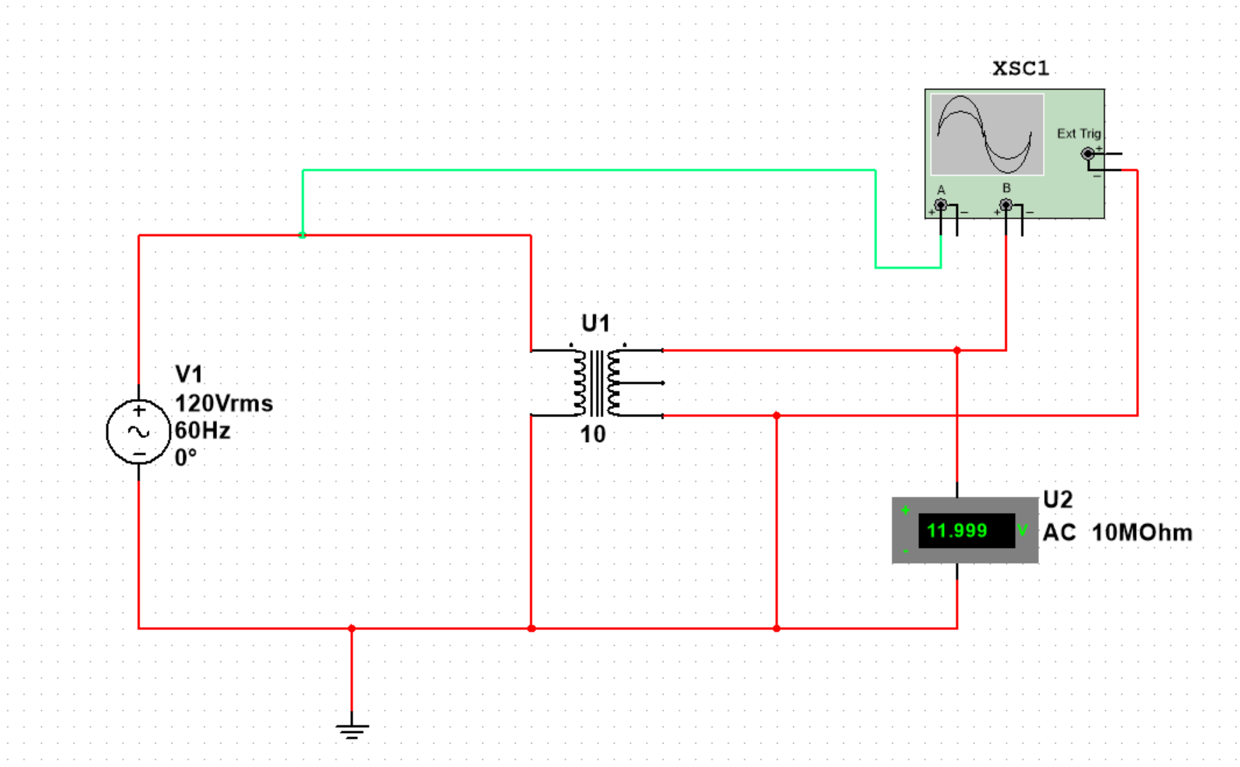
The purpose of this laboratory was to study, design, and understand the different methods of reporting AC voltages and using transformers and diodes to rectify sinusoidal signals. This lab involved designing circuits with transformers and diodes both digitally and in the laboratory using physical components.

PART A:

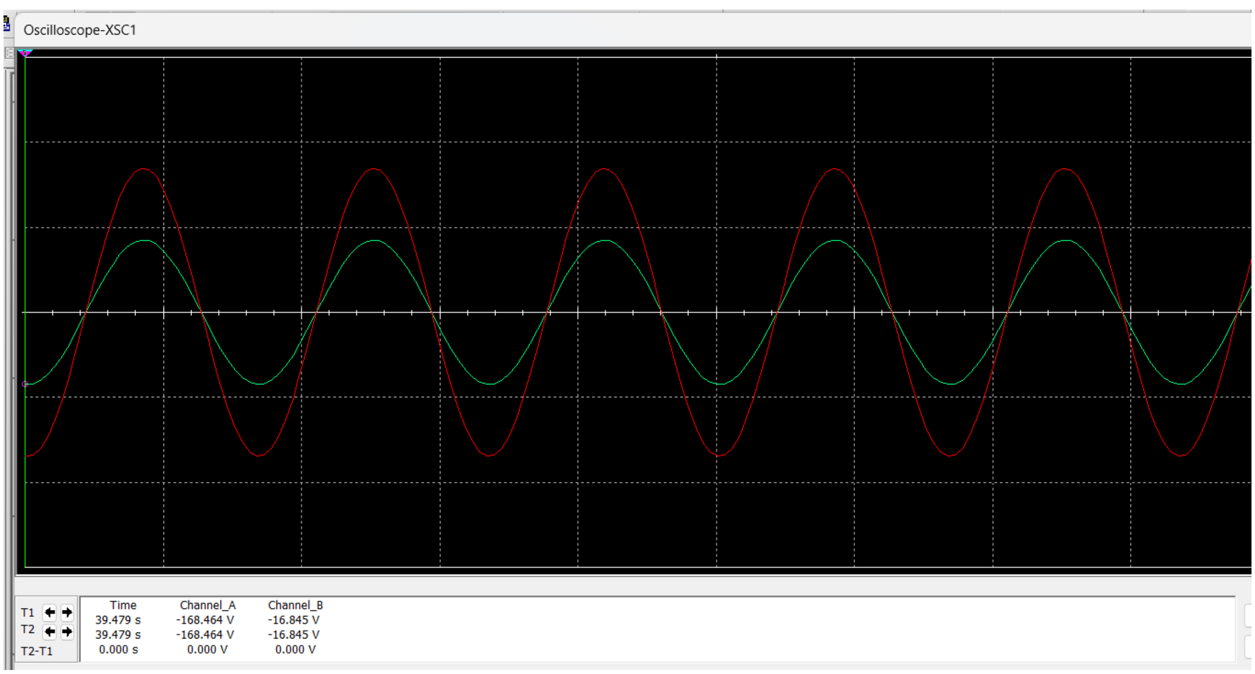
The first part of the lab was to design and simulate the circuit shown below:



For the simulation, we needed a primary coil inductance of 100mH and a secondary coil inductance of 1mH, using a 120 Vrms, 60Hz input source. The circuit was also to be connected to an Oscilloscope, such that channel A was connected to node A of the circuit, and channel B connected to node C of the circuit. The completed design is shown below:

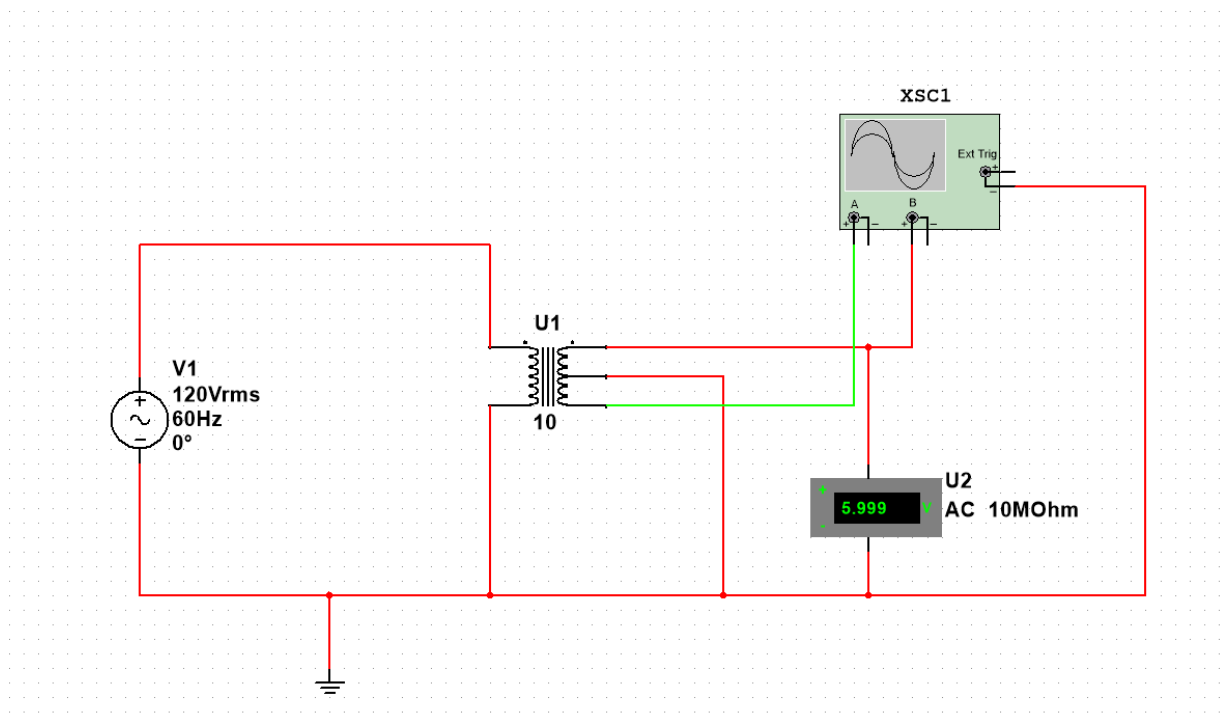


The resulting sinusoidal signal from the simulation is shown below:

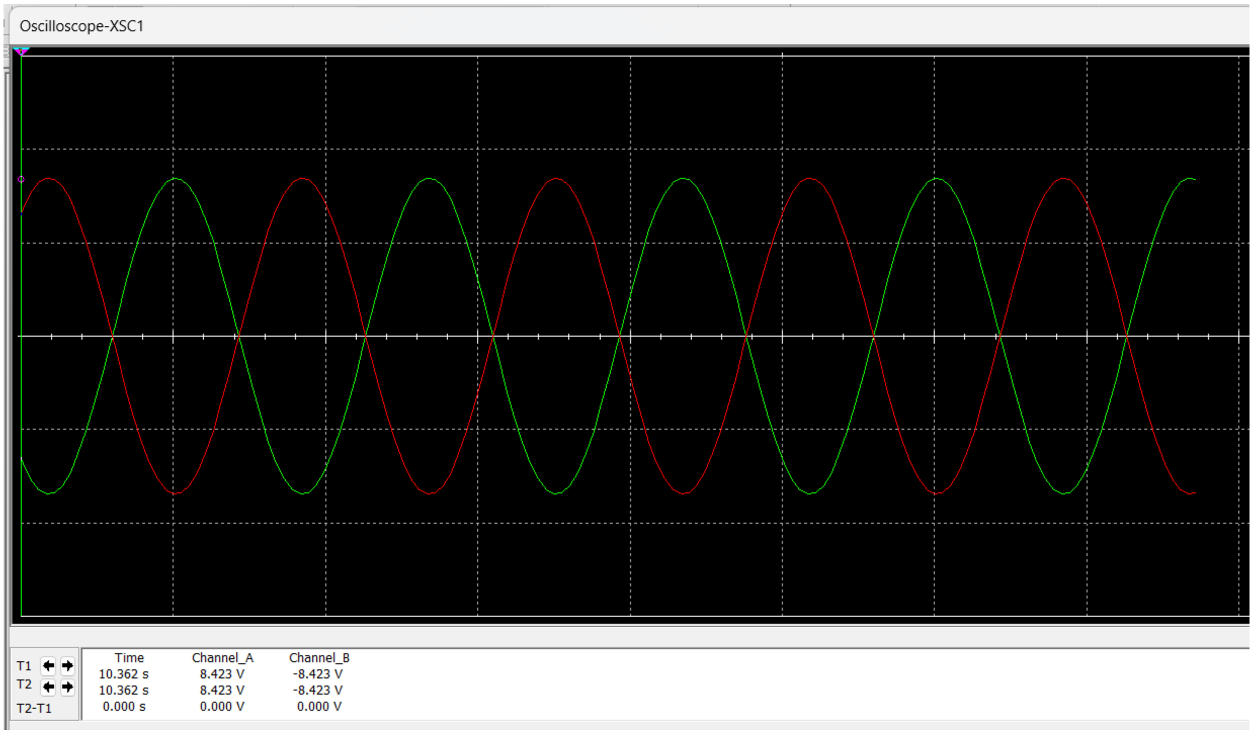


From the Oscilloscope readings, if we compare the values in channel A and channel B, we can see that the 10 to 1 ratio is maintained (-168.464 / -16.845 = 10). We can also confirm that the frequency is 60Hz. If T = |16.845|, then frequency = 1 / T = 1/16.845 = 60Hz. We can also use the same output to confirm the Vms value: Vrms = ((1 × 16.845) / sqrt(2)) = 11.9V, a value which matches the reading on the Voltmeter that's connected to the circuit.

Next, we are asked to modify the circuit, such that channel A of the Oscilloscope is switched from node A of the circuit to node D, while channel B remains connected to node C. The resulting design is shown below:

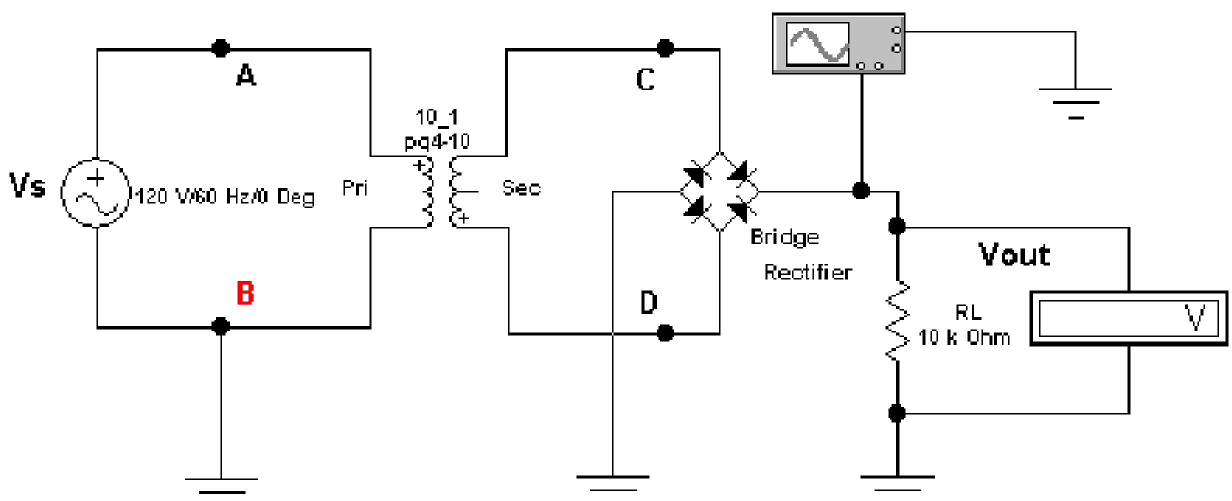


When this circuit is simulated, we get the following output and readings from the Oscilloscope:

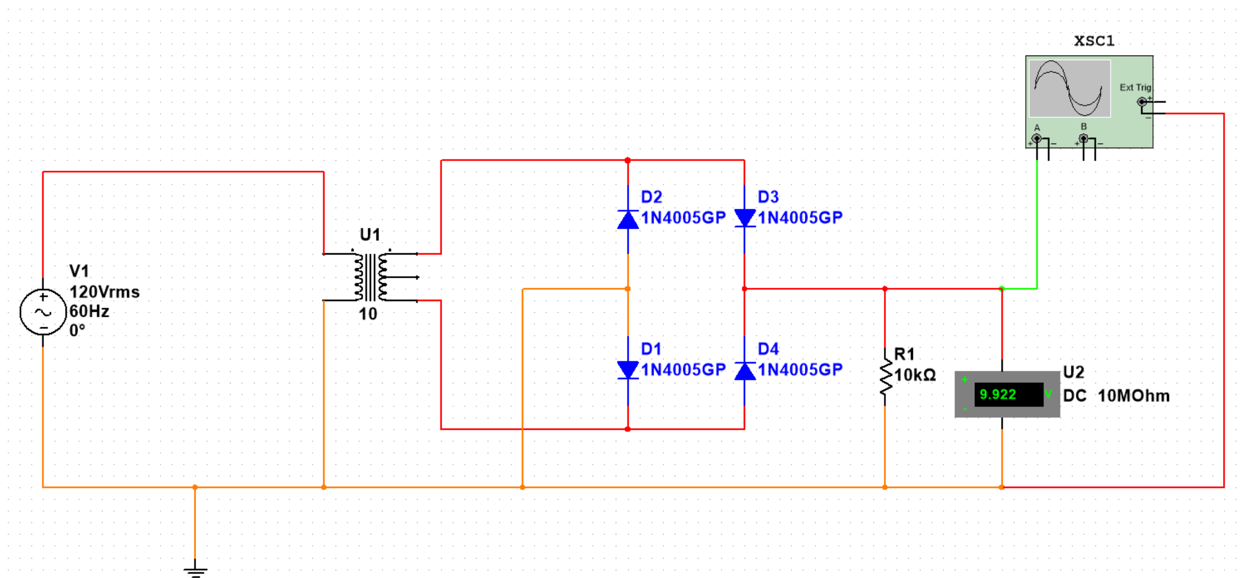


Peak voltages from the output channels are half of the total DC voltage. The waveforms are also in phase.

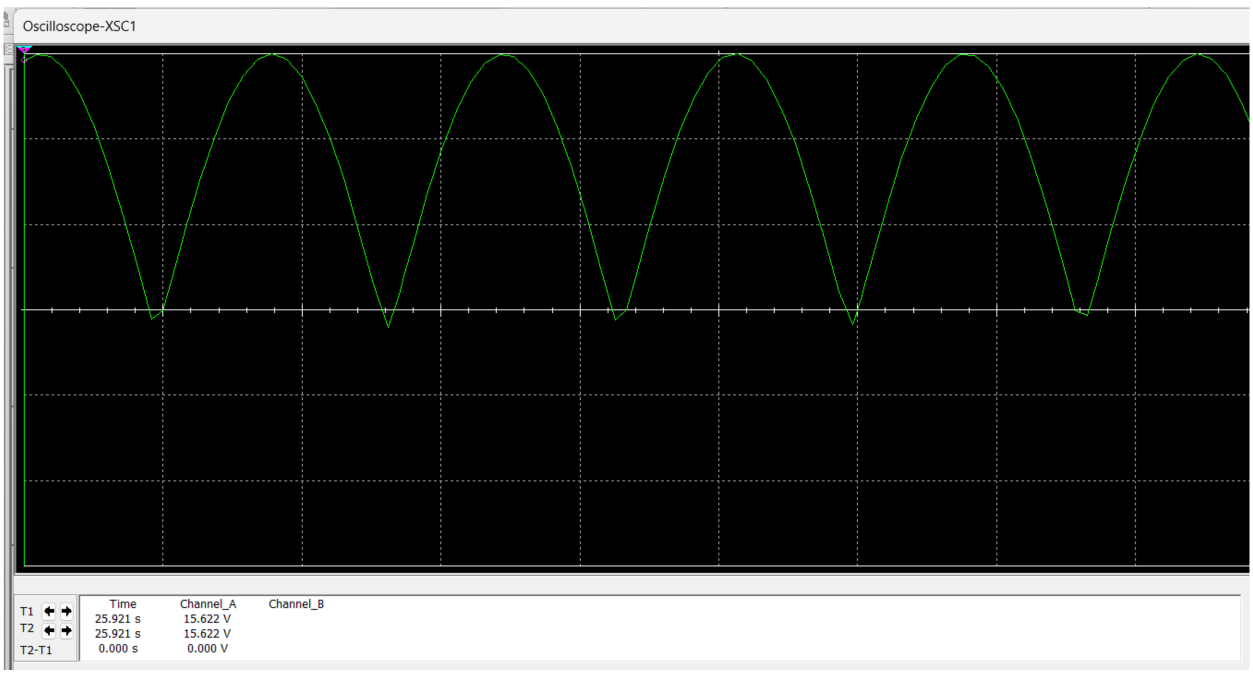
The next part of the simulation lab section is to design and simulate the following circuit:



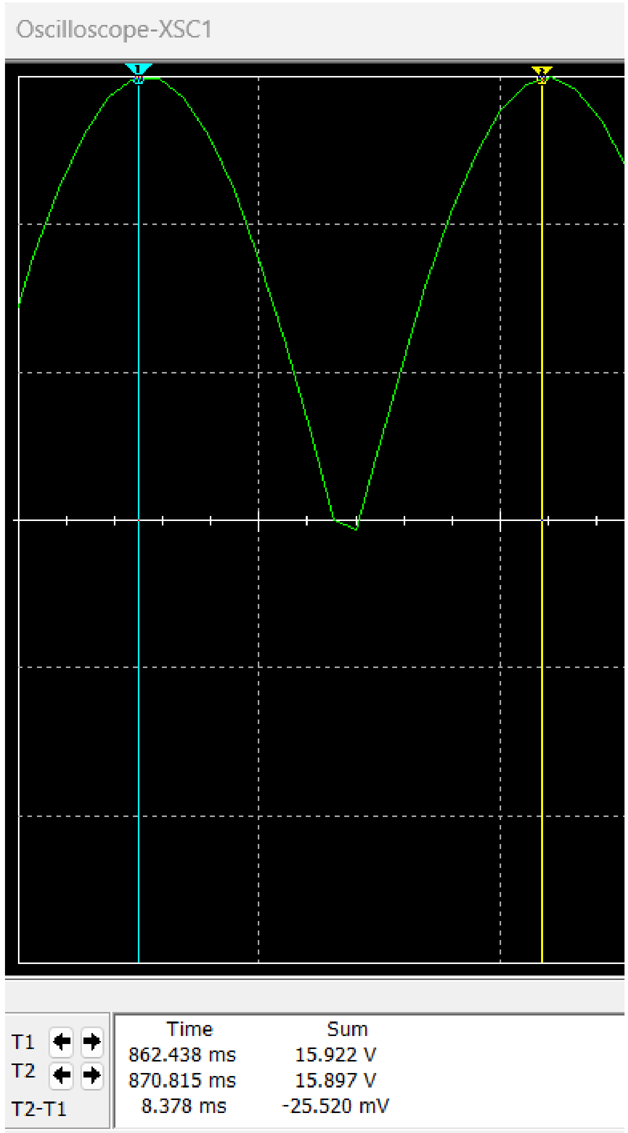
The completed simulation is shown below:



The following output is achieved from the Oscilloscope when the circuit is simulated:



Comparing the Oscilloscope and Voltmeter results, we have the peak voltage from the Oscilloscope as 15.622. So overall Voltage (DC) = $(2\times15.622) / \pi = 9.95$, approximately the same as the voltage reading from the voltmeter in the circuit. We can also determine the T_ripple value from the Oscilloscope wave by looking at one period:

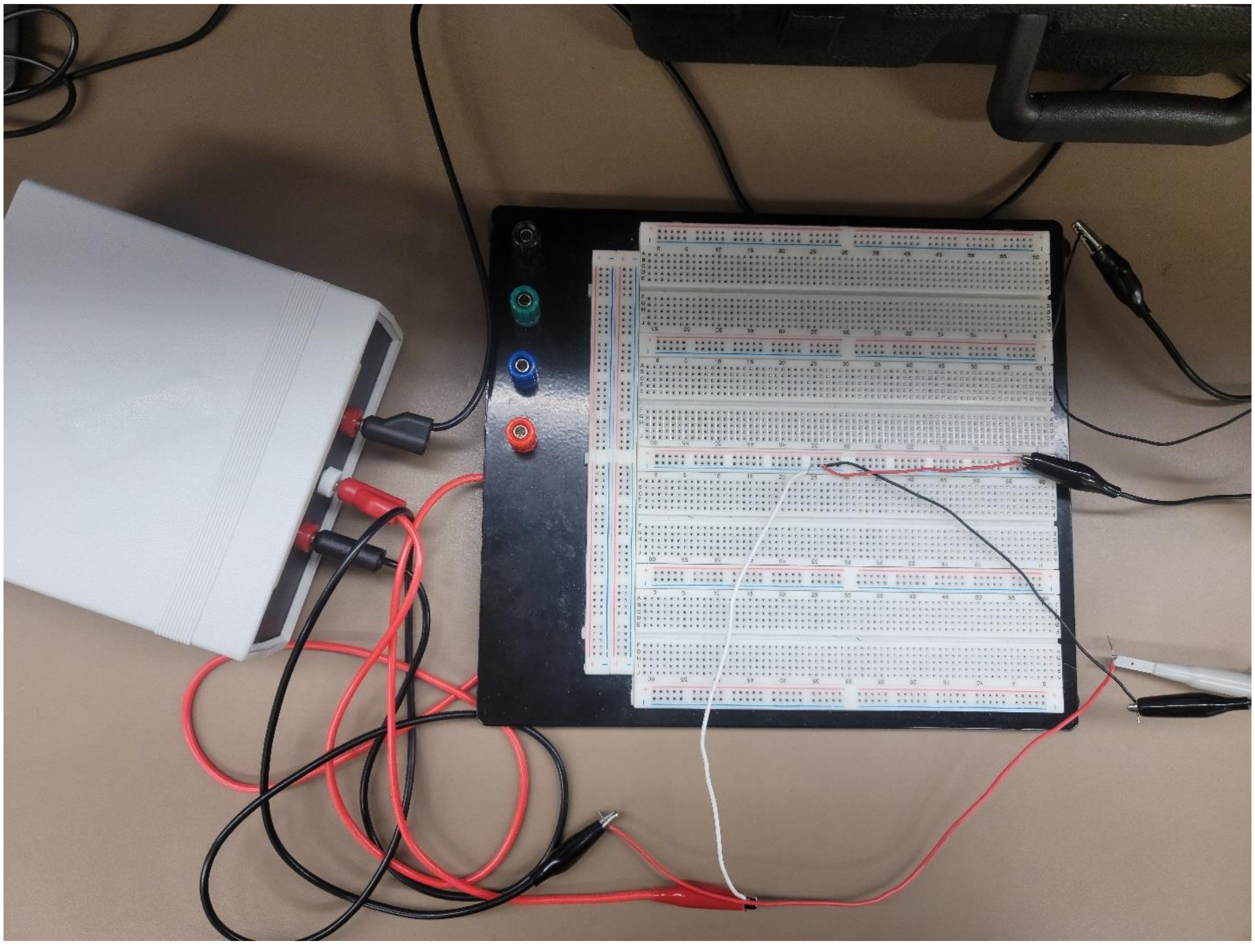


We can see from the measurement above, that a single period is 8.378ms, from here, we can determine the f_ripple, which is just 1/ T_ripple, therefore, we get, f_ripple = 1 / 8.378 = 119Hz.

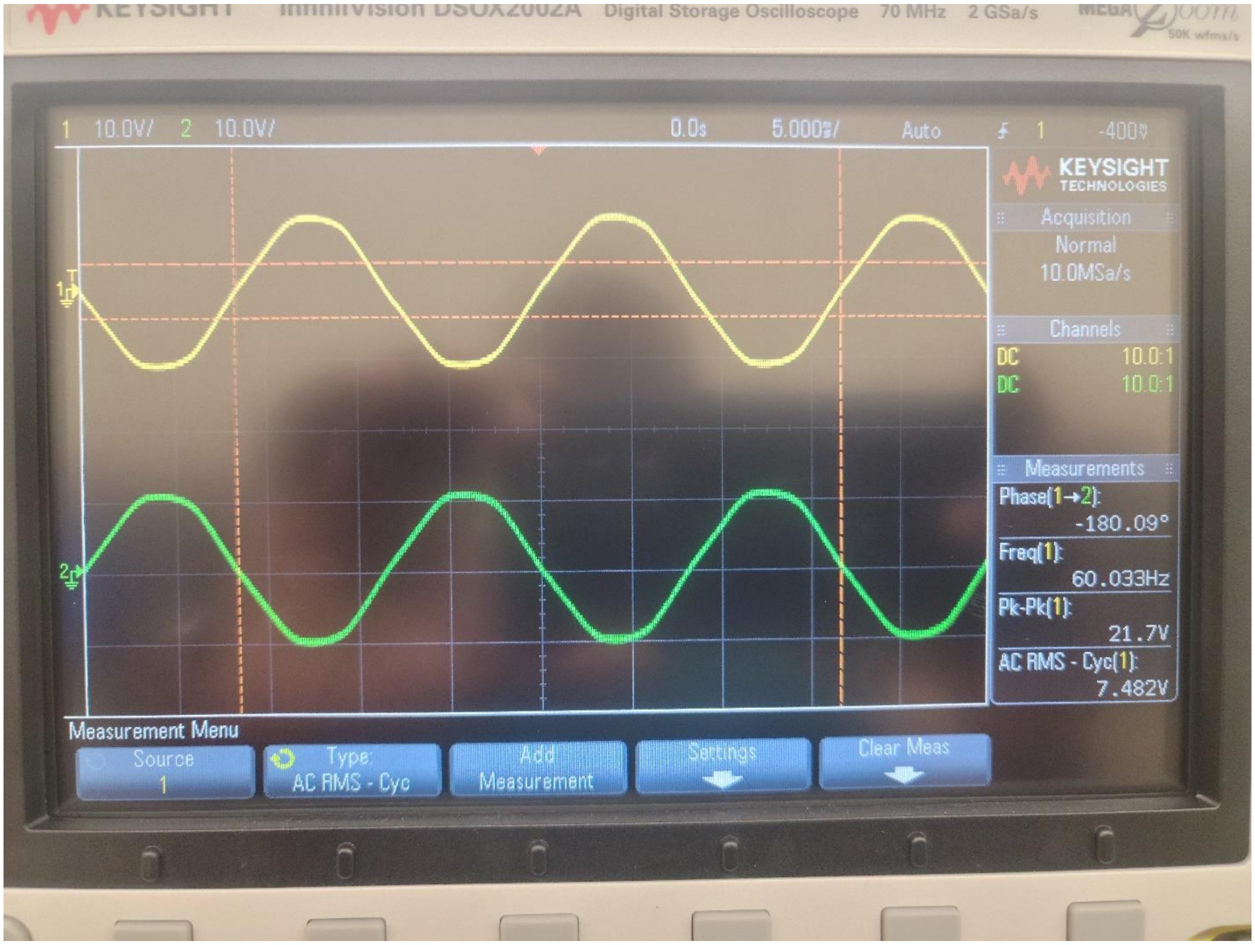
PART B:

The next part of this laboratory was to design the circuits above using hardware components. The designs were completed, and sinusoid outputs generated as shown below:

Lab design for the circuit in figure 6.3 (channel A of Oscilloscope connected to node C, channel B connected to node D):

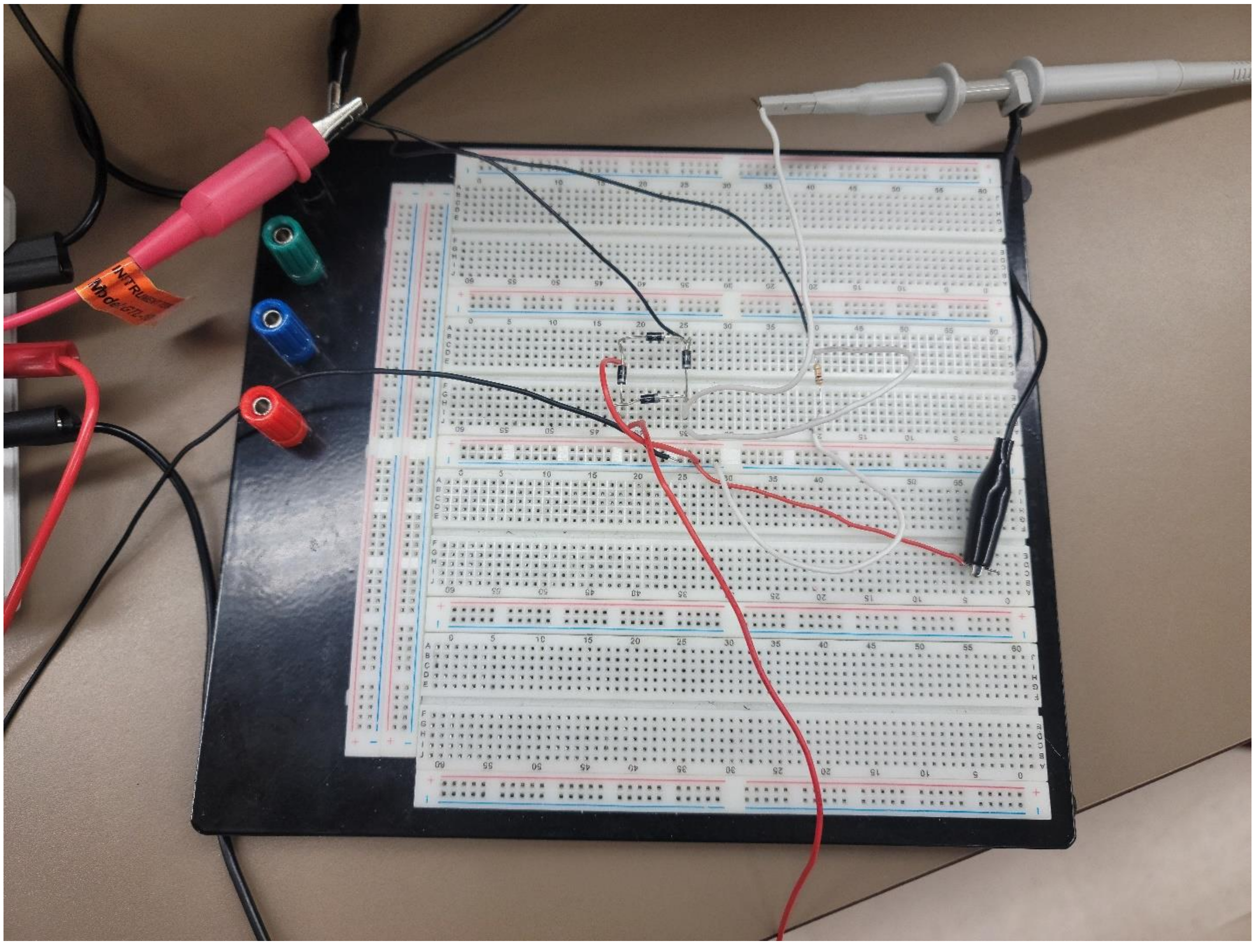


This circuit generates the following Oscilloscope wave output:

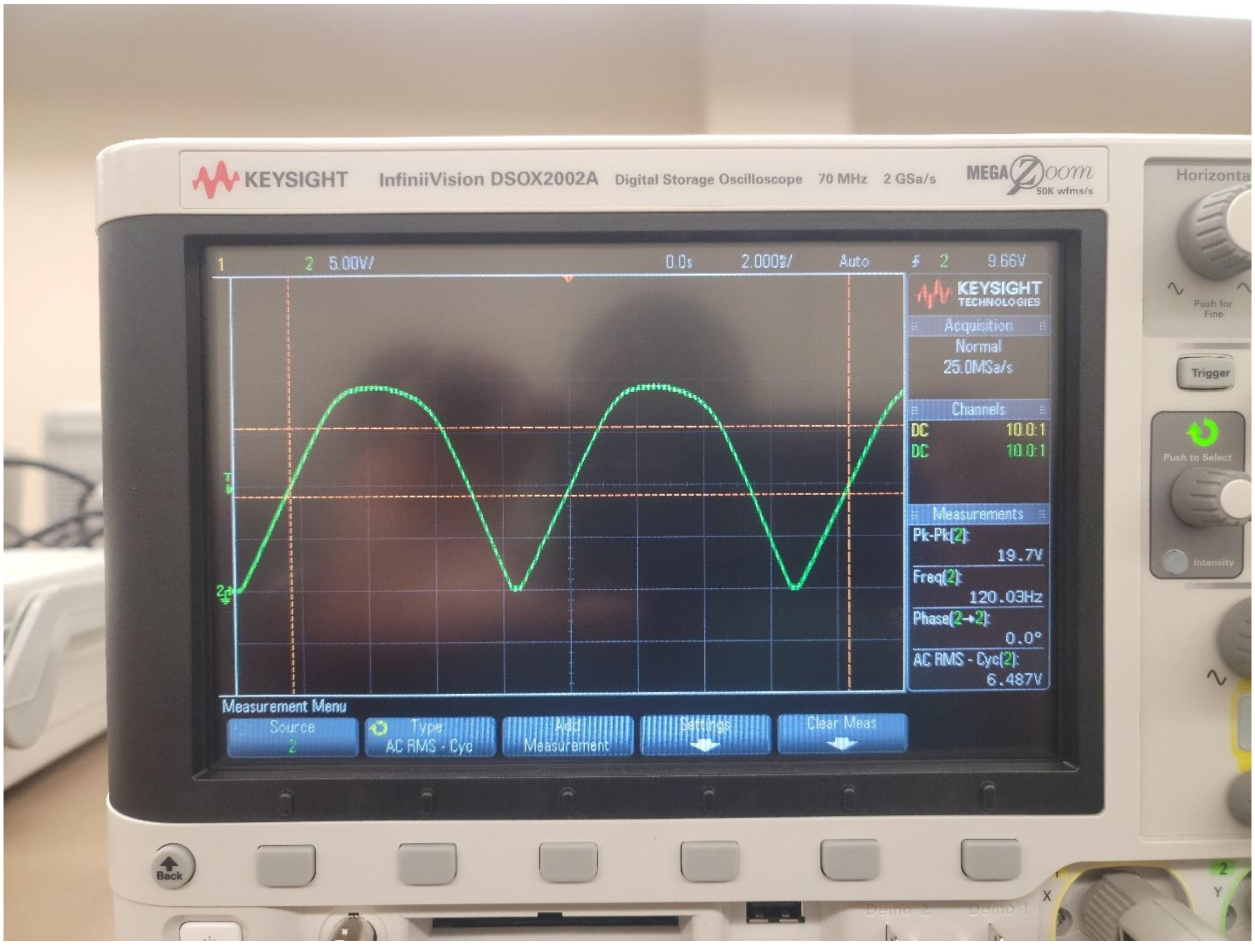


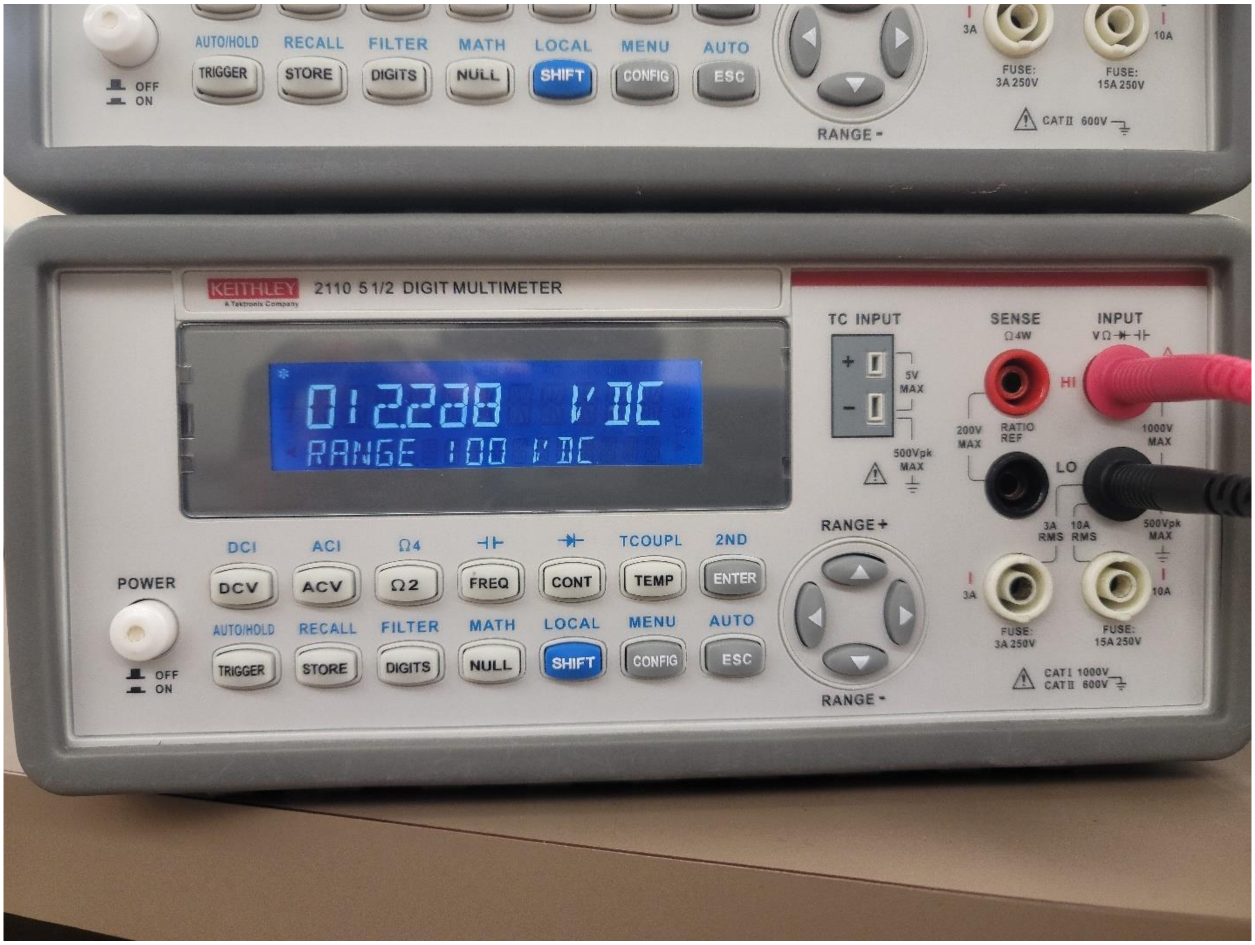
The peak-to-peak voltage is 21.7V, Vrms = (21.7 / sqrt(2)) = 15.3V and the frequency is 60Hz. We can also see that the two waveforms are 180° in phase.

The next circuit designed in the laboratory is for the second circuit with diodes, the design was completed as below:



For this circuit, we measured the DC voltage using a Voltmeter, the same way we did in the digital simulation. The resulting Oscilloscope and voltmeter values are shown below:


KEYSIGHT
InfiniiVision DSOX2002A Digital Storage Oscilloscope 70 MHz 2 GSa/s
MEGA Zoom
50K wfms/s
1 2 5.00V/ 0.0s 2.000ms/ Auto 2 9.66V
KEYSIGHT TECHNOLOGIES
Acquisition
Normal
25.0MSa/s
Channels
DC 10.0:1
DC 10.0:1
Measurements
Pk-Pk(2):
19.7V
Freq(2):
120.03Hz
Phase(2→2):
0.0°
AC RMS - Cyc(2):
6.487V
Measurement Menu
Source
2
Type:
AC RMS - Cyc
Add
Measurement
Settings
Clear Meas
Horizontal
Trigger
Push to Select
Back



From the readings above, we can determine the output voltage and the ripple frequency. We can see, from the Oscilloscope, that the peak-to-peak voltage is 19.7V. Therefore, the output voltage (Vout) = $(2 \times 19.7) / \pi = 12.5V$, and that is roughly equal to the DC voltage value measured using the Voltmeter. The frequency is 120Hz, we can use this value to determine the T_ripple. We know that, to determine the f_ripple, we use the formula 1 / T_ripple, therefore, we can calculate the T_ripple, by substituting the value for the frequency and solving. T_ripple is equal to 1/f_ripple = 1 / 120Hz = 8.333V.