EEE 117L Laboratory – Network Analysis
Lab #4: Oscilloscope (Week II)

Lab Day and Time: __Wednesday, 1:30pm - 4:10 pm______

Group Number: # 03__

Group Members: (Last Name, First Name)

Member #1: __Algador, Vigomar Kim________________________

Member #2: __Chan, Casey________________________________

Member #3: __Trinh, Bon_________________________________

General Instructions:

Theoretical analyses and making predictions regarding the behavior of circuits is one of the most crucial, yet underrated and often ignored, jobs among young engineers. This includes the ability to carry out hand calculations in the abstract and running circuit simulations. You may use any technique of circuit analysis in order to obtain the solutions, but you must clearly state which technique of analysis you are using. You must show all work to receive credit. No credit will be given for answers with no justification. Your work should be neat and organized. If I can't follow your work or read your writing, then you will not get full credit. You may attach extra sheets if you need more space to show all your work. Remember that the ability to clearly explain what you are doing to other engineers is one of the most important skills you need to develop.

Total Score: /100

General Directions:

1) Remember Ch1 and Ch2 refer to channels one and two of the oscilloscope, respectively.
2) To help you identify portions of the exercises that you need to address and answer, I have highlighted those portions in boldface for more easy identification.
3) You will definitely need more space than is provided in order to answer all the questions. Edit this document in order to have sufficient space.
4) Remember to take your time and familiarize yourself with the oscilloscope settings and features. This isn't a race to get everything done as much as your opportunity to learn how to use an oscilloscope.

Work Breakdown Structure: It is important that every group member do their share of the work in these labs. Remember that you will receive no credit for the prelab if you did not contribute. Write in the Table provided below, which group member(s) contributed to the solution of each problem in the prelab. Also remember that only on prelab per group will be turned in to Canvas. If there was any group member that did not contribute, then write their name in the space provided below.

Problem Number	Group member(s) that worked on the problem.
Part II.1	Algador, Vigomar Kim
Part II.2	Chan, Casey
Part II.3	Trinh, Bon
Part II.4	Algador, Vigomar Kim
Part II.5	Chan, Casey
Part II.6	Trinh, Bon
Part III.1	Trinh, Bon Chan, Casey Algador, Vigomar Kim
Part III.2	Trinh, Bon Chan, Casey Algador, Vigomar Kim
Part IV	Trinh, Bon Chan, Casey Algador, Vigomar Kim

Absent member(s):____

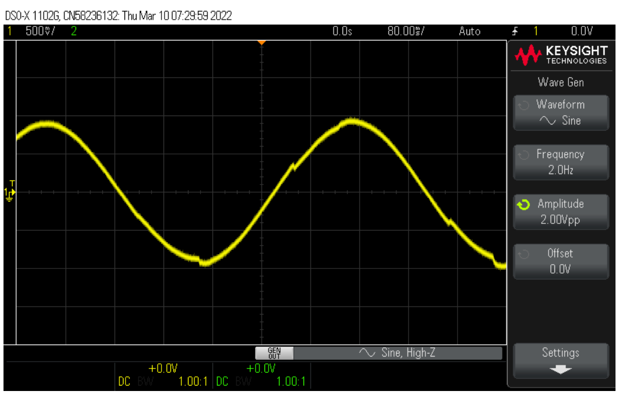
Part II: Trigger Controls Total Score: /45

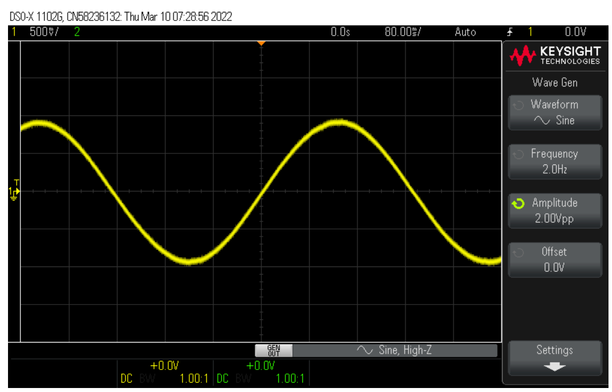
1) Signal with no trigger Score: /5

Under the “Mode” drop down menu in the Oscilloscope controls, you have three choices, called “None”, “Auto”, or “Normal”. Choose the “Auto” option. Connect the waveform generator to Ch1 and choose the following settings for each:

a) W1: Sine, Frequency = 2 Hz, Period = 500 ms, Amplitude = 1 V, Offset = 0 V, Symmetry = 50%, Phase = 0.
b) Ch1: Position = 0 s, Base = 80 ms/div, Offset = 0 V, Range = 500 mV/div.

Explain what you observe. Why are the settings on the oscilloscope inappropriate for taking measurements on this voltage waveform?



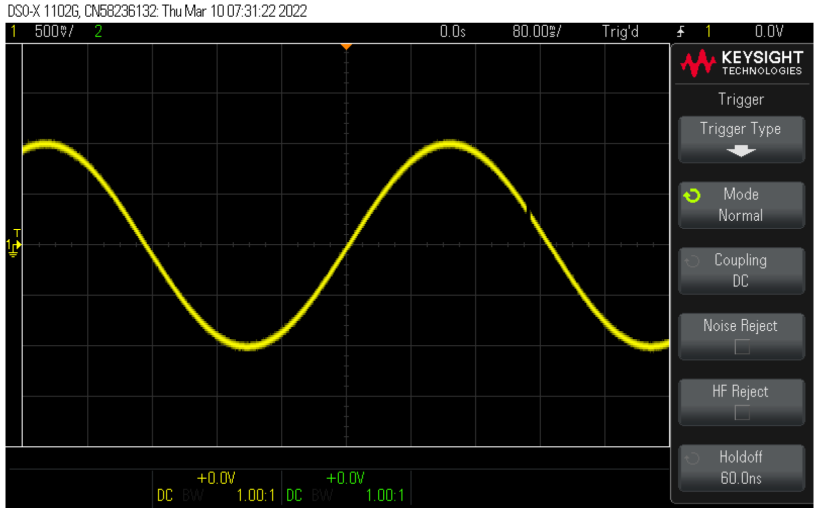


The settings on the oscilloscope are inappropriate for taking measurements due to the setting the trigger control to “auto”. The “auto” makes the wave form inconsistent. From the left, you can see the glitch happened to the wave which is a phenomenon that the wave is changing. The right figure shows a consistent wave, however, positions are different between the two waveforms.

2) Setting the trigger manually Score: /5

By using the “Trigger” button, change the setting from “Auto” to “Normal”, while keeping the settings on waveform generator and Ch1 the same as above.

Explain what you observe. Is it now easier or more difficult to take measurements on the waveform?



We observed the consistency of the wave with the right span of time.

3) Exploring the trigger settings Score: /5

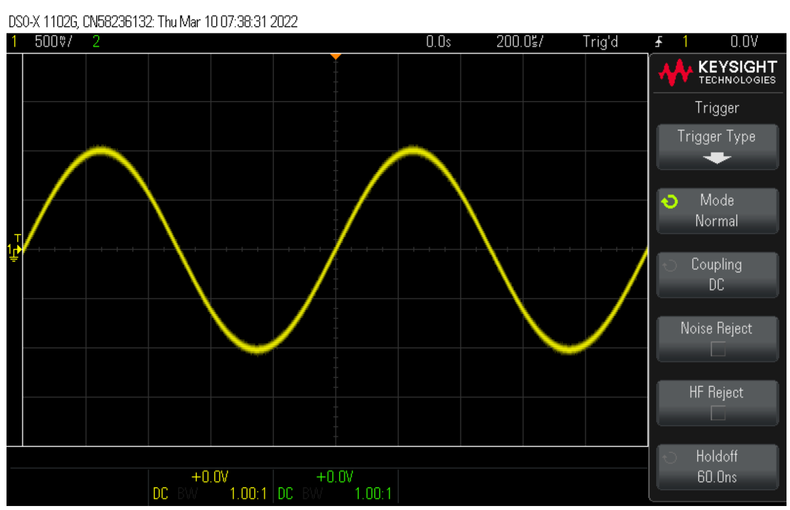
Adjust the setting on the waveform generator to a more realistic waveform, shown in point a) below. Manually adjust the settings on the horizontal and vertical controls so that **two full waveforms** are shown on the oscilloscope.

a) W1: Sine, Frequency = 1 kHz, Period = 1 ms, Amplitude = 1 V, Offset = 0 V.

What settings did you have to choose on the horizontal and vertical controls in order to get two full waveforms on the oscilloscope?

b) Ch1:	**Horizontal**	**Position = 0**	**Base = 200 µs / div**
	Vertical	**Offset = 0**	**Range = 500 mV / div**

Use the snipping tool in order to create a picture of the oscilloscope and include it below.

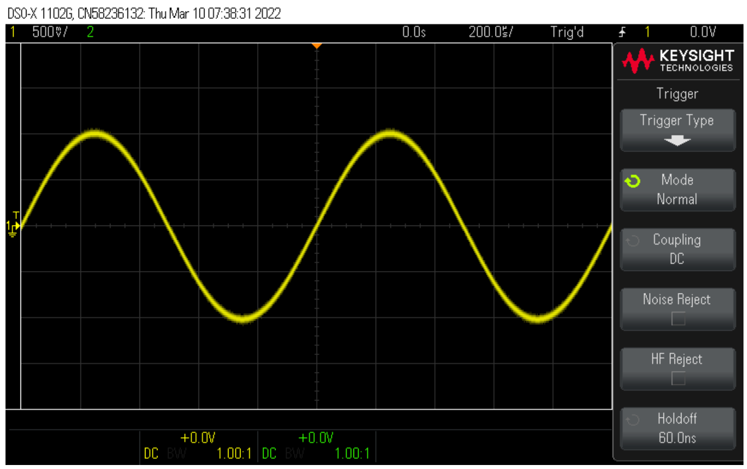


4) Changing the trigger level Score: /10

a) Keeping the settings the same as in part 3) above, observe and record the voltage value at time $t = 0\ s$.

$V(t = 0\ s) =$ **0 V**

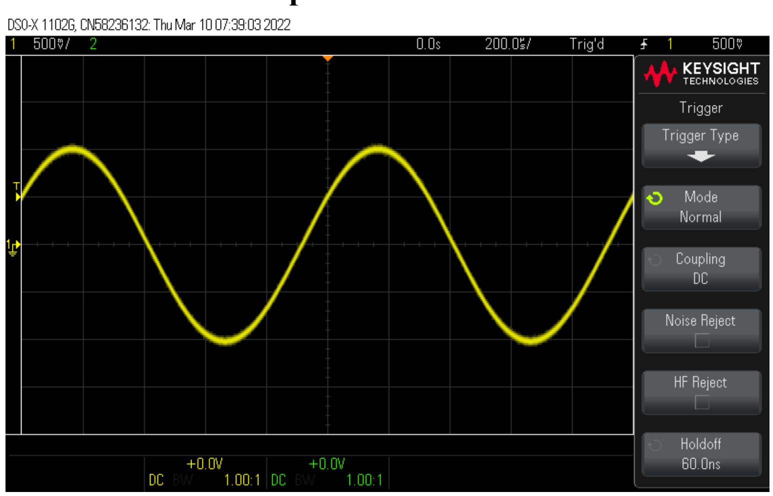
Include a picture of the oscilloscope below:



b) Under the oscilloscope controls, change the "Level" value from the 0 V default, to 0.5 V and **describe** how the waveform on the oscilloscope has changed. Observe and record the voltage value at time $t = 0\ s$.

$V(t = 0\ s) =$ **500mV**

Include a picture of the oscilloscope below.

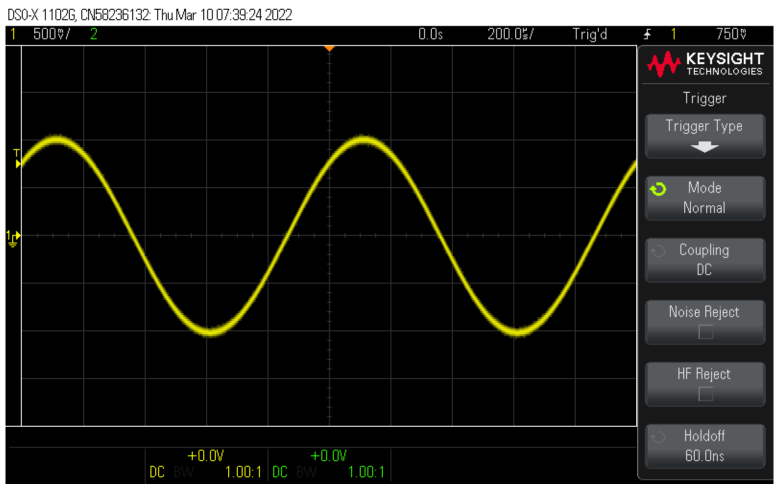


The waveform was moving to the left. The waveform at the peak is approaching t = 0 seconds.

c) Change the "Level" value from the 0.5 V to 0.75 V and **describe** how the waveform on the oscilloscope has changed. Observe and record the voltage value at time $t = 0\,s$.

$V(t = 0\,s) =$ ____**750 mV**____________________

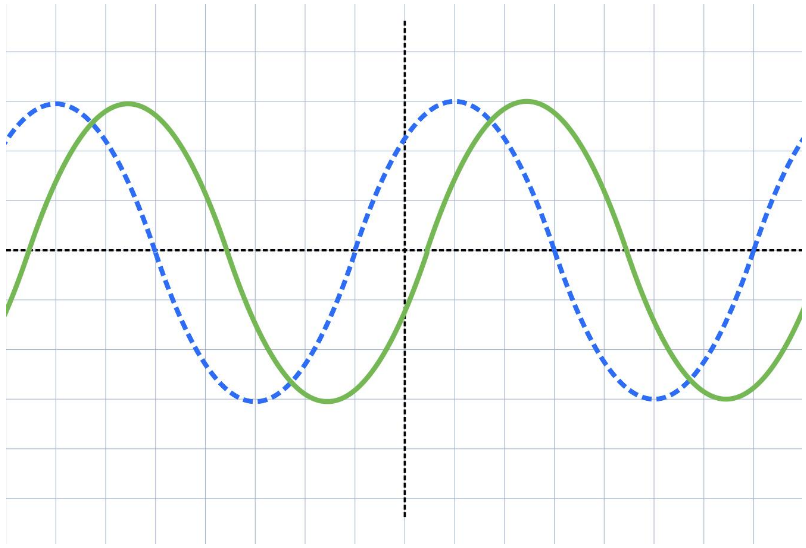
Include a picture of the oscilloscope below.



The waveform moved to the left again. Since our amplitude is 1V, the waveform at the peak is approaching t = 0s.

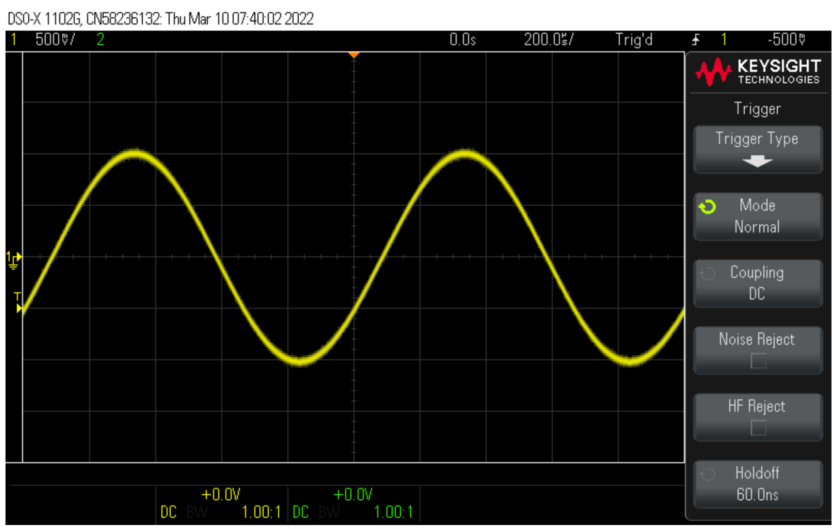
5) Predictions Score: /10

a) Predict what will be observed when you change the trigger level from 0.75 V to – 0.5 V. **Describe your prediction below. Include a sketch if it helps the description.**



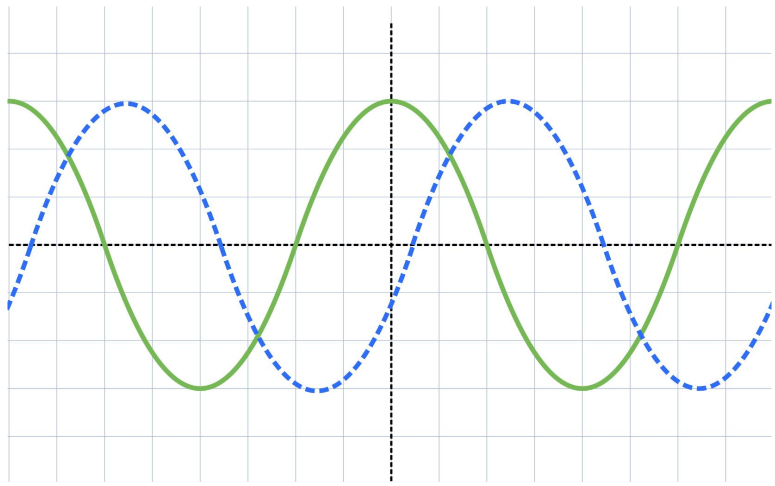
From the figure above, the wave with 0.75V is in the dotted line and the wave with -0.5V is the solid line. As the trigger level is going from 0.75 V to -0.5 V, we observed how the wave shifted to the right.

Change the "Level" value from the 0.75 V to – 0.5 V. How do your observations match with your predictions? Include a picture of the oscilloscope below.



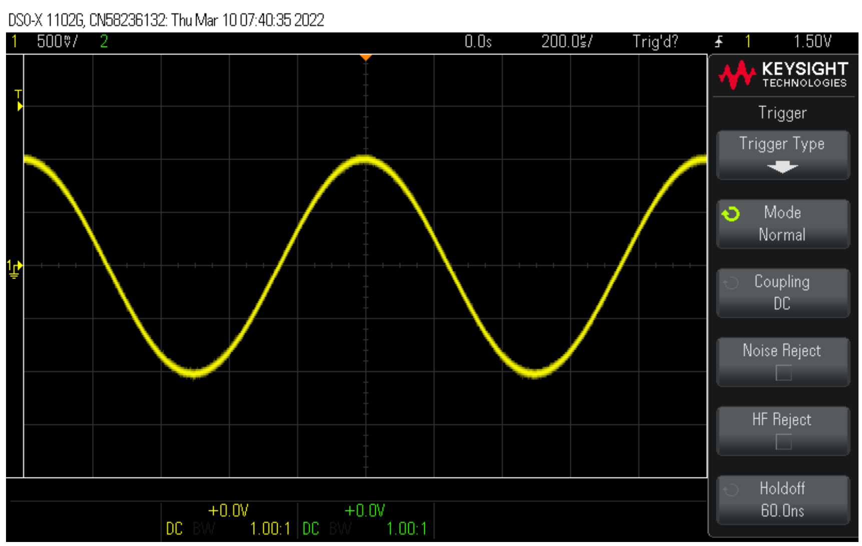
Our prediction is correct. The waveform is moving as we expected.

b) Predict what you will observe when you change the trigger level from – 0.5 V to 1.5 V. **Describe your prediction below. Include a sketch if it helps the description.**



From the figure above, the wave with -0.5V is in the dotted line and the wave with 1.5V is in the solid line. As the trigger level is going from -0.5 V to 1.5V, we observed how the wave shifted to the right. Additionally, we can see that the voltage value at time = 0s will be 1V since it's our peak value.

Change the "Level" value from the – 0.5 V to 1.5 V and wait a few seconds. Describe how the waveform on the oscilloscope has changed. Why do you think this is happening based on what you have learned about the trigger level setting?



- The voltage at t = 0 is the amplitude, which is equivalent to 1 V. Since we are changing the level to 1.5 V, the Level will reach 1.0 V then the waveform will stop moving. Since the amplitude is 1 V, it cannot go beyond that.

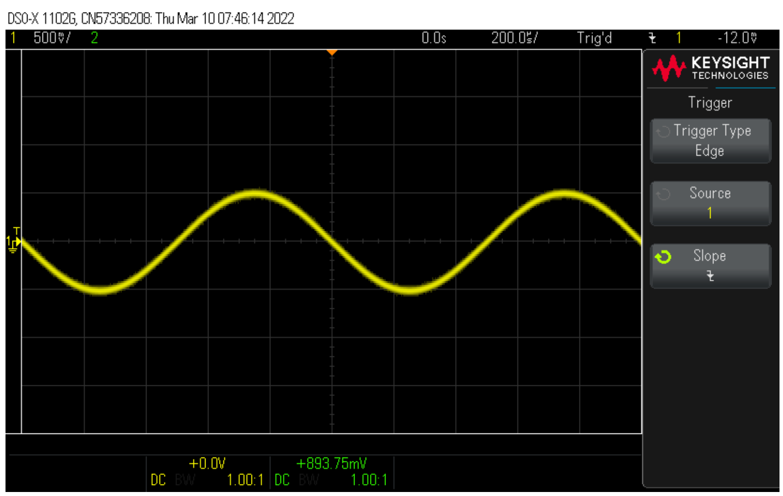
6) Rising/Falling edge condition Score: /10

Adjust the setting on the waveform generator to the waveform described in point a) below. Manually adjust the settings on the horizontal and vertical controls so that two full waveforms are shown on the oscilloscope. Also choose the trigger level to be 0 V.

a) W1: Sine, Frequency = 1 kHz, Period = 1 ms, Amplitude = 1 V, Offset = 0 V, Symmetry = 50%, Phase = 0.

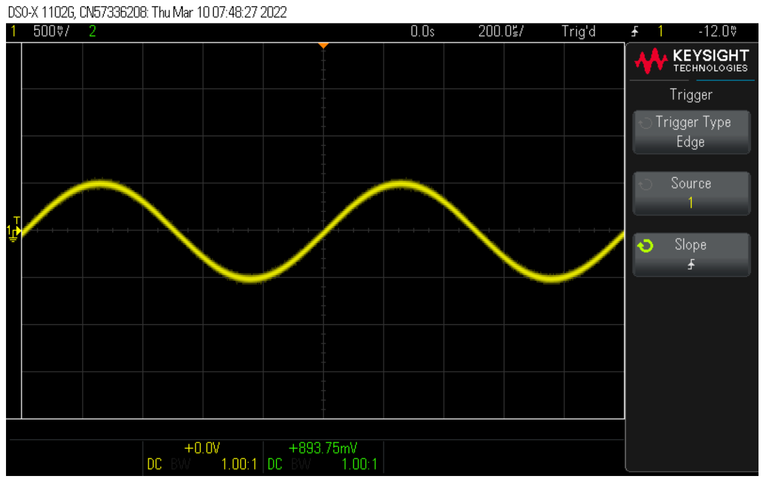
By default, the “Condition” setting is chosen to be “Rising”. Observe the effect on this waveform if the setting is chosen to be “Falling”. Take a particular look at the value of the voltage immediately after the trigger level. Are they getting bigger or smaller compared to the trigger level? **Describe what the “Rising/Falling” settings affect how the voltage waveform is displayed. Include a picture of the waveform when the “Falling” setting is chosen.**

Falling:



- If we are looking at the waveform from left to right, we see the waveform go downwards through the point of origin.

Rising:



- If we are looking at the waveform from left to right, we can see the waveform go upwards through the origin.

Part III: Measurements Total Score: /45

1) Measurements Score: /20

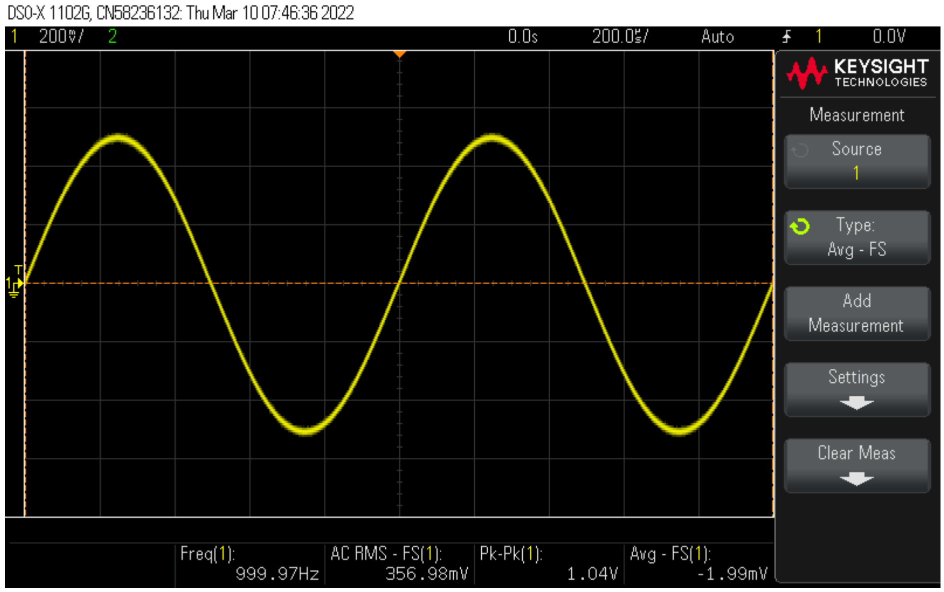
Adjust the setting on the function generator to the waveform described in point a) below. Manually adjust the settings on the horizontal and vertical controls so that two full waveforms are shown on the oscilloscope. Also choose the trigger level to be 0 V.

a) W1: Sine, Frequency = 1 kHz, Period = 1 ms, Amplitude = 0.5 V, Offset = 0 V, Symmetry = 50%, Phase = 0

Given these settings, calculate the AC (RMS) voltage of the waveform, as well as the average and peak-to-peak voltages. Use the “Meas” button to add these measurements into the display. Record your values in Table 1 below.

	Theoretical Value	Experimental Value
AC RMS Voltage	353.55 mV	356.98 mV
Average Voltage	0 V	-1.99 mV
Peak-to-peak Voltage	1 V	1.04 V

Table 1. Measurements using the oscilloscope



Using your DMM, measure the AC (RMS) voltage and the DC voltage. Record your values in Table 2.

	Theoretical Value	Experimental Value
AC RMS Voltage	0.353 V	0.354 V
DC Voltage	0 V	-1.2 mV

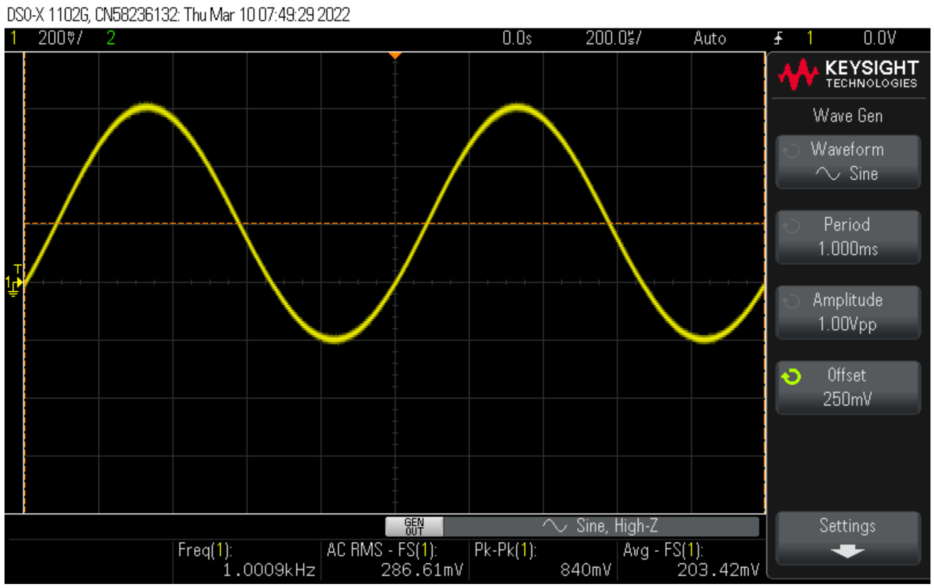
Table 2. Measurements using the DMM

Change the "Offset" from 0 V to 0.25 V and repeat the predictions and measurements above, keeping all other settings on the function generator the same.

Given these new settings, calculate the AC (RMS) voltage of the waveform, as well as the average and peak-to-peak voltages. Use the "Meas" button to add these measurements into the display. Record your values in the Table 3 below.

	Theoretical Value	Experimental Value
AC RMS Voltage	353.55 mV	286.61 mV
Average Voltage	0 V	203.42 mV
Peak-to-peak Voltage	1 V	840 mV

Table 3. Measurements using the oscilloscope with 0.25 V offset



Using your DMM, measure the AC (RMS) voltage and the DC voltage. Record your values in Table 4.

	Theoretical Value	Experimental Value
AC RMS Voltage	0.353 V	0.354 V
DC Voltage	0 V	64.3 mV

Table 4. Measurements using the DMM with 0.25 V offset

Based on the data coming from the four tables, how do the parameters change when an offset is added? Which parameters are the same when measured by the oscilloscope as when measured by the DMM? Discuss.

- The parameters seem to change a lot when an offset is added.
- The parameter that is in a similar range is the AC RMS voltage.

2) RC circuit measurements Score: /25

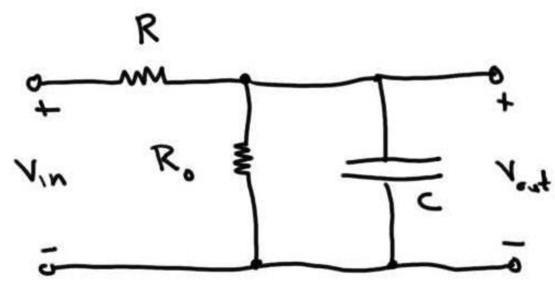


Figure 1. RC Circuit

Now connect the RC circuit of Figure 1 shown above, using the same resistor and capacitor values as measured during the first week of this lab. Recall that V_{in} was a sine wave set for 1 volt p-p, 1 kHz, and 0 volts DC offset. Measure the voltage amplitudes of both waveforms, V_{in} and V_{out} using the oscilloscope. Use the cursors to measure the period of the waveform and to measure the time delay between the two waveforms. Verify that the frequency and the period measurements are consistent. Use sinusoidal steady state techniques to calculate the relationship (magnitude and phase) between the input and output voltages, as was done on problem 3) of the prelab for the first week. Do the measured and calculated values agree? The measured phase shift may be found from the period and the time delay between the two waveforms as follows:

$$phaseshift = 360 * timedelay / period$$

Show your work on additional pages.

	Theoretical Value	Experimental Value	Percent Error
R	1.6kΩ	1.565 kΩ	4.0625%
R_0	100 kΩ	101.404 kΩ	1.404%
C	100 nF	99.52 nF	0.48%
Input voltage amplitude, V_{in}	0.5 V	0.555 V	11%
Output voltage amplitude, V_{out}	0.34794 V	0.41 V	17.8634%
Frequency, f	1 kHz	999.6 Hz	0.4%
Period, T	0.001s	999.6 µs	0.04%
Time delay, t_{delay}	N/A	121 µs	N/A
Phase shift, θ	45°	43.57°	3.17778%

Table 5. RC Circuit Data

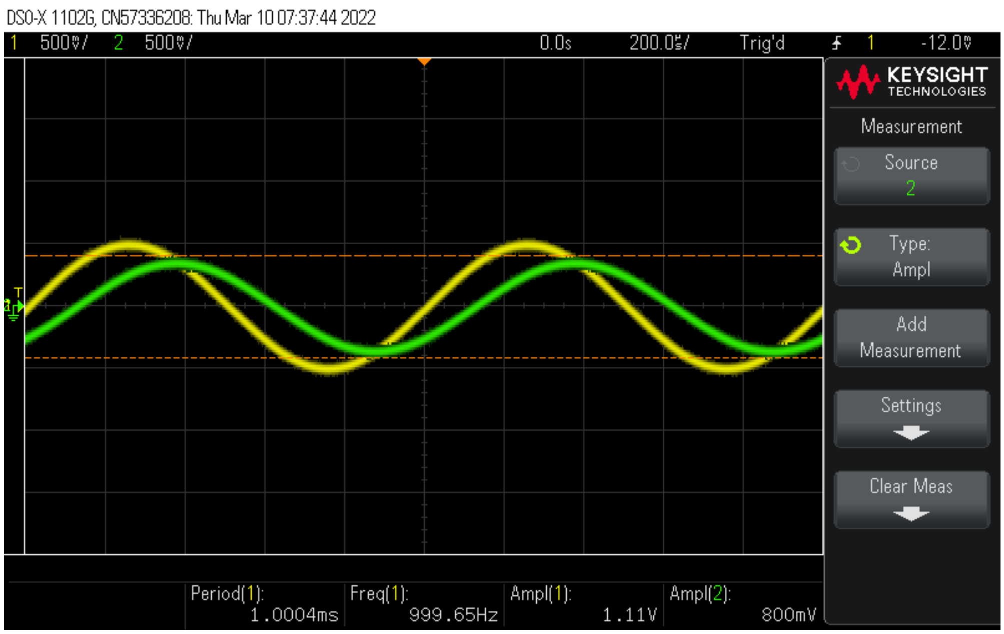
$$T_{out} = 0.0009996 \text{ s}$$

$$f_{out} = \frac{1}{0.0009996} = 1000.40\ Hz$$

$$Z = \frac{-j}{(2\pi * 1000\ Hz)(1*10^{-7}\ F)} = -\ j1591.549\ \Omega$$

$$V_{out} = \frac{0.5\angle 0°}{1+\frac{1600}{100000}+\frac{1600}{j1591.549}} = \frac{0.5\angle 0°}{1+0.016+j1.0053}$$

$$= 0.34794\ \angle -\ 45°$$



Part IV: Conclusions Total Score: /10

Explain in a few paragraphs the purpose of the lab, the experimental set up and methodology, and central results of the lab and these experiments. **You should be quantitative** in this summary. Include any important equations used and explain their significance. Write the conclusion as if you were writing an English essay. This is an important portion of the lab, so make sure to do a good and thorough job.

The purpose of this lab is to further learn about the various settings on the oscilloscope. This week, we learned about trigger controls. We observed the differences in the waveforms when changing the trigger controls from auto to normal. We changed the "Level" on the trigger level and noticed the waveform would shift left or right depending on the "Level" value. We learned how to display measurement values on the oscilloscope. We were able to display different readings on the oscilloscope. Some readings we were able to display are AC RMS voltage, average voltage, and peak-to-peak voltage, input/output voltage amplitude, frequency, period, and time delay.

Some of the equations that were necessary for the completion of this lab includes solving for the period, frequency, impedance, and the voltage output. Additionally, we used the equation for percentage error after completing the calculations for both the theoretical values and the experimental values.