Aidan Carey / Aidan Chin
ECE 210 Lab 1 Report

**Introduction**
In this Lab 1 activity, our objective was to collaborate using a signal generator to produce specific types of waveforms and utilize an oscilloscope to capture data related to these waves, including their time period, peak-to-peak voltage, and root mean square (RMS) voltage. The oscilloscope measures voltage (the unit of power generated in the current) and current, and calculates the current (the rate of flow of the voltage).

**Concepts**:

Voltage- Voltage can be defined as the pressure from a power source that pushes the current through a loop. The unit of voltage is Volts (V), and can be defined in Ohm's law V=IR
(current times resistance)
https://www.fluke.com/en-us/learn/blog/electrical/what-is-voltage#:~:text=What%20is%20voltage%3F-,Electrical,measured%20in%20volts%20(V).

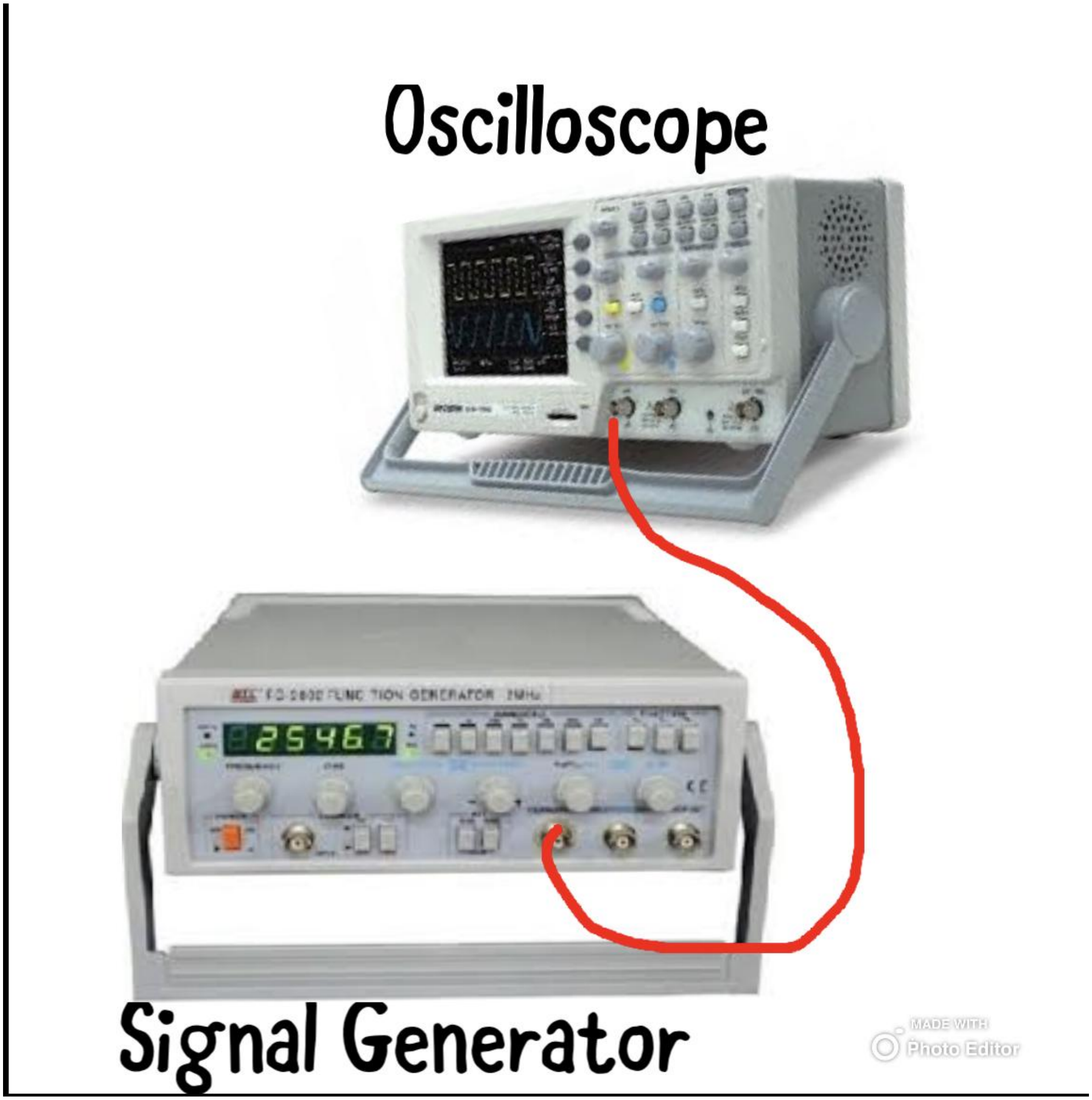
Current- Current can be defined as the flow of energy through a circuit. The unit for current is an Ampere. Current can have a reference, and usually flows to the negative terminal of the power source.
https://www.fluke.com/en-us/learn/blog/electrical/what-is-current#:~:text=Current%20is%20the%20rate%20at,unit%20used%20for%20measuring%20current.

AC signals- AC is an abbreviation for Alternating Current, which is constantly changing its value (positive and negative) with time. A sine wave is an example of an alternating current, in which the voltage oscillates between positive and negative values with time.
https://byjus.com/physics/ac-circuit/#:~.

RMS voltage- This is a calculation specifically for Alternating currents. RMS stands for “Root-Mean Squared”. Essentially, this calculation accounts for the alternating signs of the alternating current, and produces a positive value which is the positive root magnitude of the signal.
https://www.electronics-tutorials.ws/accircuits/rms-voltage.html

**Motivation**- The motivation for this experiment is to become familiar with the equipment, more specifically the signal generator, which generates AC signals, and the oscilloscope, which measures the signals and plots the voltage over time. Using these tools, we hope to become more comfortable with the meaning of RMS voltage and average voltage by seeing these signals visually.

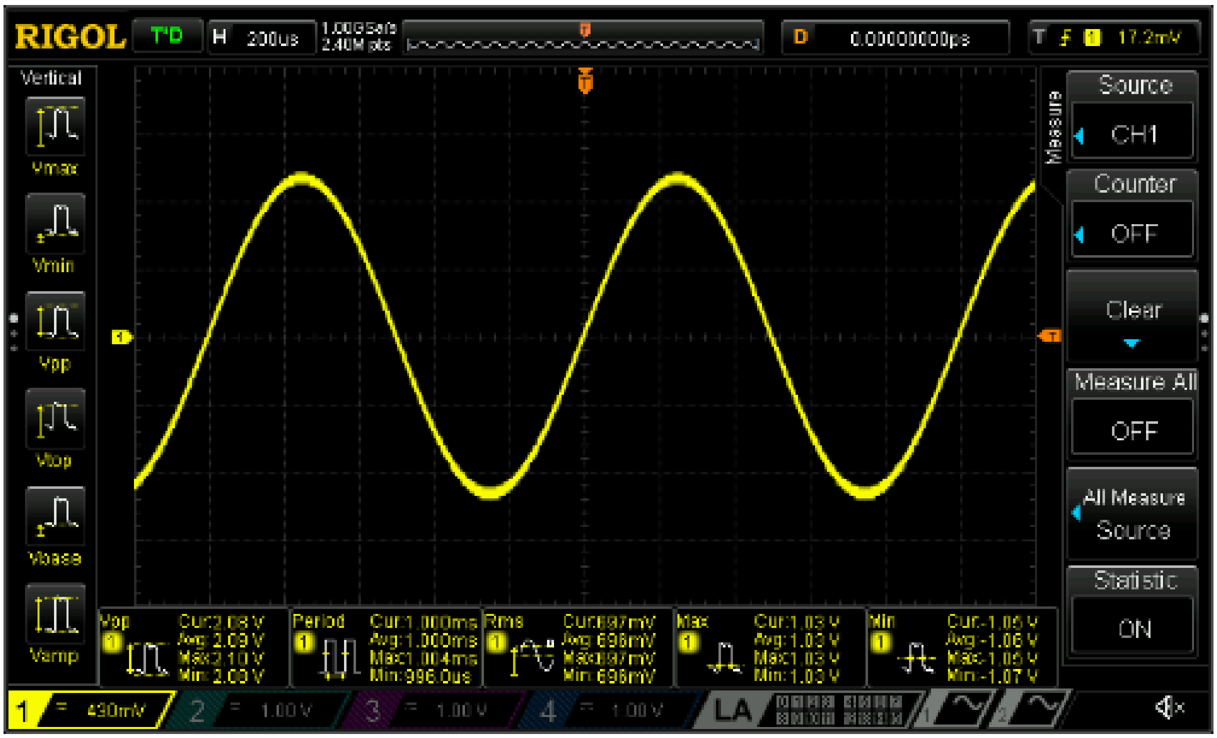
**Experimental Diagram**



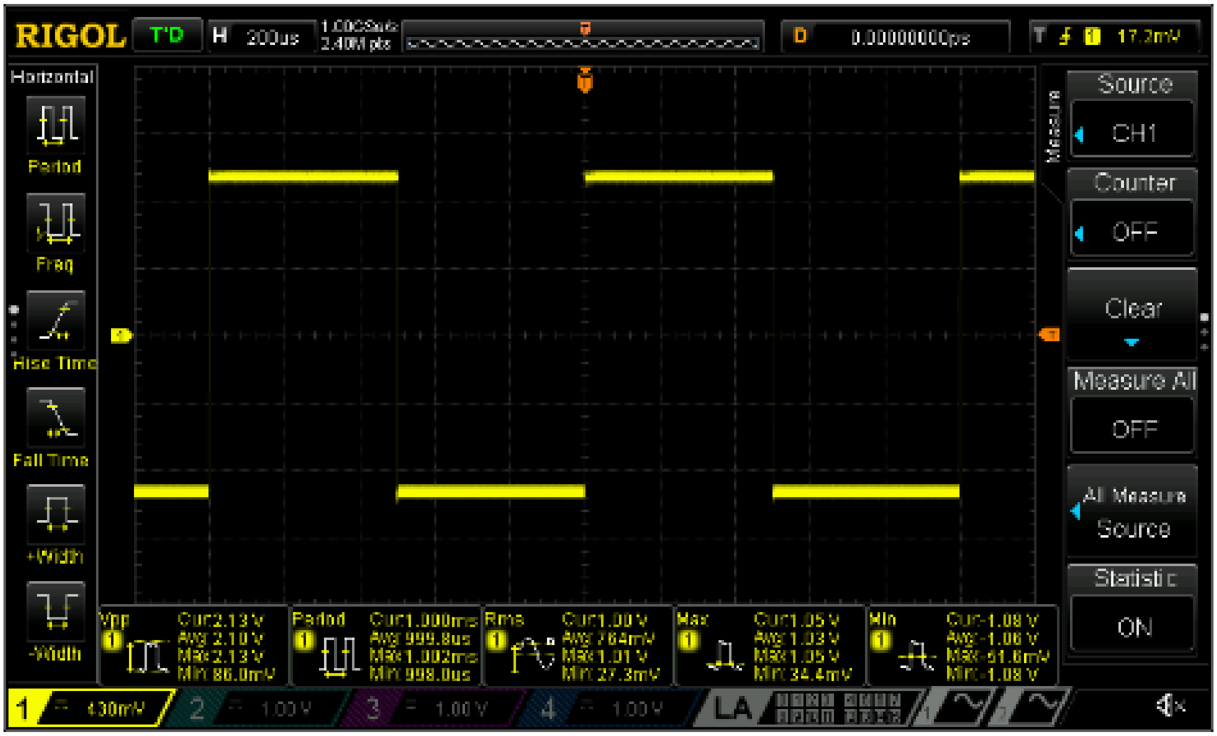
**Equipment Setup**
We began by ensuring that the signal generator was powered on and set to a frequency of 1 kHz, with the maximum voltage at 1V and the minimum voltage at -1V. The oscilloscope was also powered on, and after automatic axis ranging, we adjusted the vertical and horizontal scales to prepare for data collection.Introduction

Alternating Current Plots:

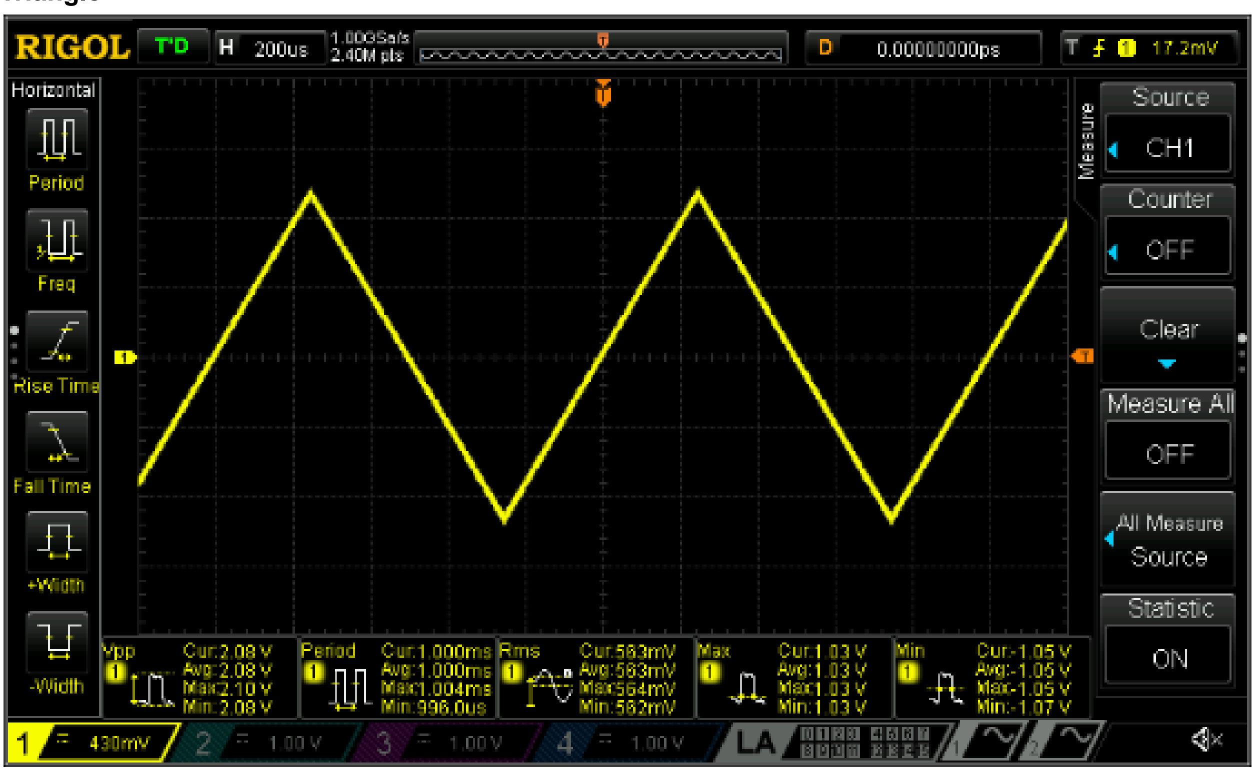
**Sine**




**Square**


RIGOL
T'D
H 200us
1.00GSa/s
2.40M pts
D 0.00000000ps
T 17.2mV
Horizontal
Period
Freq
Rise Time
Fall Time
+Width
-Width
Measure
Source
CH1
Counter
OFF
Clear
Measure All
OFF
All Measure Source
Statistic
ON
Vpp Cur:2.13 V Avg:2.10 V Max:2.13 V Min:86.0mV
Period Cur:1.000ms Avg:999.8us Max:1.002ms Min:998.0us
Rms Cur:1.00 V Avg:764mV Max:1.01 V Min:27.3mV
Max Cur:1.05 V Avg:1.03 V Max:1.05 V Min:34.4mV
Min Cur:-1.08 V Avg:-1.06 V Max:-51.6mV Min:-1.08 V
1 430mV
2 1.00 V
3 1.00 V
4 1.00 V
LA

**Triangle**


RIGOL
T'D
H 200us
1.00GSa/s
2.40M pts
D 0.00000000ps
T 17.2mV
Horizontal
Period
Freq
Rise Time
Fall Time
+Width
-Width
Measure
Source
CH1
Counter
OFF
Clear
Measure All
OFF
All Measure Source
Statistic
ON
Vpp Cur:2.08 V Avg:2.08 V Max:2.10 V Min:2.08 V
Period Cur:1.000ms Avg:1.000ms Max:1.004ms Min:996.0us
Rms Cur:583mV Avg:583mV Max:584mV Min:582mV
Max Cur:1.03 V Avg:1.03 V Max:1.03 V Min:1.03 V
Min Cur:-1.05 V Avg:-1.05 V Max:-1.05 V Min:-1.07 V
1 430mV
2 1.00 V
3 1.00 V
4 1.00 V
LA

**Analysis**

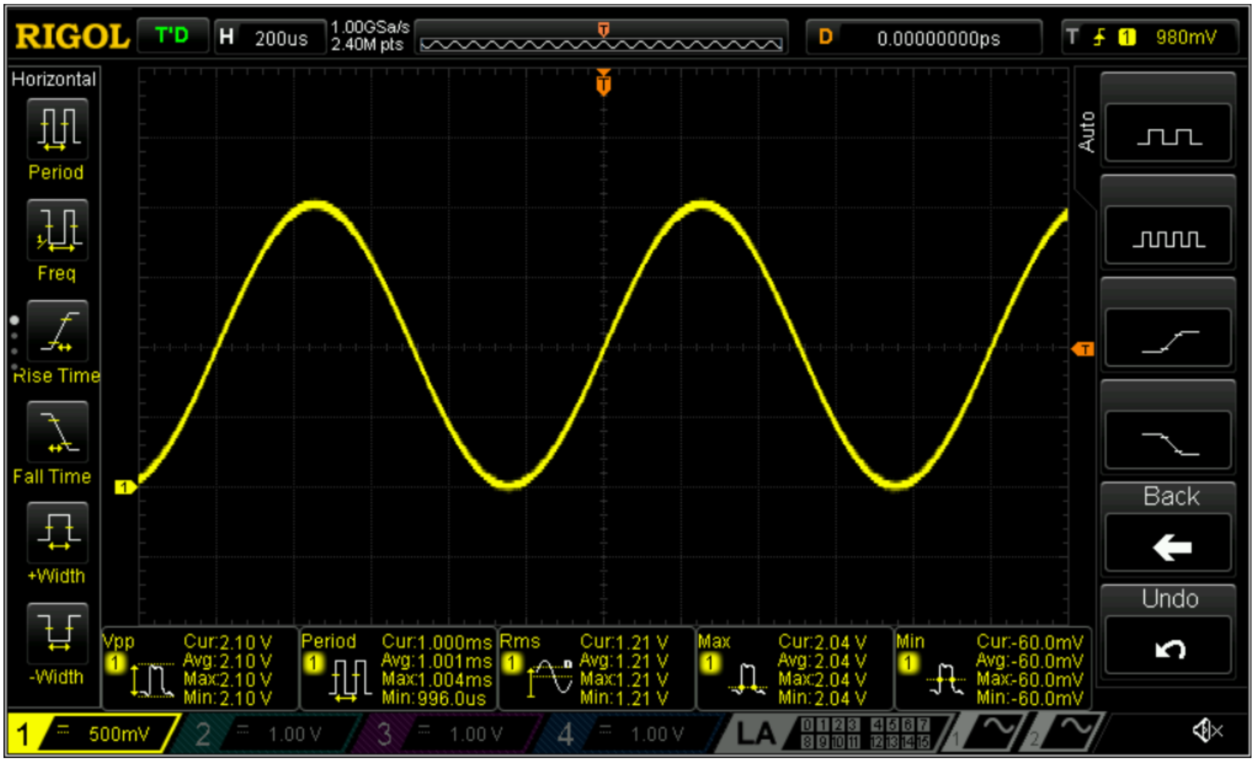
Sine
-The sine wave displayed the expected oscillation characteristic of a sine wave. It exhibited a period of 1 ms and had a peak-to-peak voltage ranging from 1.05V to -1.07V.
-The oscilloscope measured the RMS voltage as 0.697V
-Our own calculation: The formula for the RMS value of a sine wave is $Vp$ / $\sqrt{2}$ which in this case equals $1.05V$ / $\sqrt{2}$ = 0.74V.
These two values are relatively close, our calculation just 43mV larger than the measurement of the oscilloscope.

Square
-The peak to peak voltages of the square wave are highlighted in yellow, with values 1.05V and -1.08V and a period of 1 ms.
-The oscilloscope measured the RMS voltage at 1V
-Our calculated value of 1.05V. The RMS formula for a square wave is simply equal to the peak value (Vp+), so in this case, our calculated RMS voltage is 1.05V due to the oscilloscope measuring that as the peak voltage.
These values are again, relatively close. Our calculated RMS was 50mV higher than the measured amount.

Triangle
The signal generator produced triangular waves with a period of 1 ms and a peak-to-peak voltage ranging from 1.05V to -1.07V.
The oscilloscope measured the RMS voltage as 0.563 V
-Our calculated value of 0.606V. The formula for the RMS value of a triangular wave is $Vp$ / $\sqrt{3}$, resulting in our calculation being $1.05V$ / $\sqrt{3}$ ≈ 606 mV or 0.606V
These values are different by 43mV, which is consistent with our previous calculations of the sine and square waves.

Sine wave with offset:

Prior to recording, we adjusted the signal generator to set the maximum voltage to 2V, the minimum voltage to 0V, and raised the trigger adjustment from 0V to 1V for symmetry. This creates an offset, where the Alternating current revolves around 1V opposed to 0V.




**Analysis**:
-The oscilloscope measured the peak-to-peak voltage of this wave as 2.04V to 0.06V with a period of 1 ms.
-The measurement of the RMS voltage by the oscilloscope is 1.21V
-The formula for the RMS value of a sine wave with an offset can be written as

$\sqrt{offset^2 + ((Vp/2)/\sqrt{2})^2}$ so, plugging in our recorded values, $\sqrt{1^2 + ((2.04/2)/\sqrt{2})^2}$ = 1.23V. This calculation is only 20mV larger than the measured RMS.

Overall, this lab involving the signal generator and the oscilloscope helped us practice getting used to using the equipment, recording data, and calculating things like RMS. Being the first lab of the year, we also got a sense for the new environment, asking questions, and writing our lab report. This experiment helped us grasp the concepts of RMS voltages by considering the peak voltages and the unique RMS voltage formula for different waves. Our calculated RMS was at most 5% larger than the measured RMS from the oscilloscope. This is not completely ideal. A potential way to improve measurements is to run the wave a few times to ensure the values from the oscilloscope are true.