Fall 2018

California State University, Northridge

Department of Electrical & Computer Engineering

Experiment 1 & 2

1 – Laboratory Instruments and Reports

2 – Oscilloscopes

September 17, 2018

ECE 240L

Professor: Franco Mikhailidis

Group 2: Jonathan Roa

Ridge Tejuco

EXPERIMENT 1 & 2

Introduction:

The purpose of the first and second experiment was twofold - to become familiar with the controls and functions of various lab equipment, as well as read and analyze data that the machines outputted. In order to reach this goal, simple circuits to be analyzed using the machines were constructed that encouraged exploration of the different dials and buttons to see accurate data readings.

Equipment Used:

Type	Model	Serial No.	Calibration Date
DC Power Supply	Agilent E3630	MY40004246	N/A
Function Generator	Agilent 33220A	MY44017172	N/A
Oscilloscope	Tektronix 2213A	LR37158	N/A
Digital Multimeter	Tektronix CDM250	CDM-250TW52380	N/A

Parts Used:

Quantity	Component	Value	Type
1	Resistor	$33*10^2\ \Omega\ \pm 5\%$	Carbon
1	Resistor	$20*10^2\ \Omega\ \pm 5\%$	Carbon

Software Used:

- Microsoft Word
- Microsoft Paint

Theory:

Schematics (circuit diagrams) show the layout of a circuit – physical components, the terminals associated with them, and how each of the components are connected via wiring schemes.

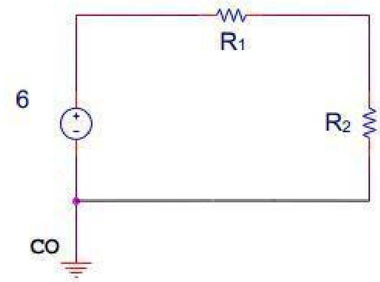


Figure 1.3

This schematic showed how the circuit for the lab was to be constructed, as this follows the requirements that must be met in order for current to properly travel through a circuit – the circuit must be closed and the current must travel from the positive terminal of the power supply to its respective negative terminal. In addition to this, the concept of grounding was implemented in order to take voltage readings. Grounding is the idea that there is a point in a circuit where all voltages are measured from. In the context of this experiment, ground point was the COM terminal of the power supply. (Refer to figure 1.4)

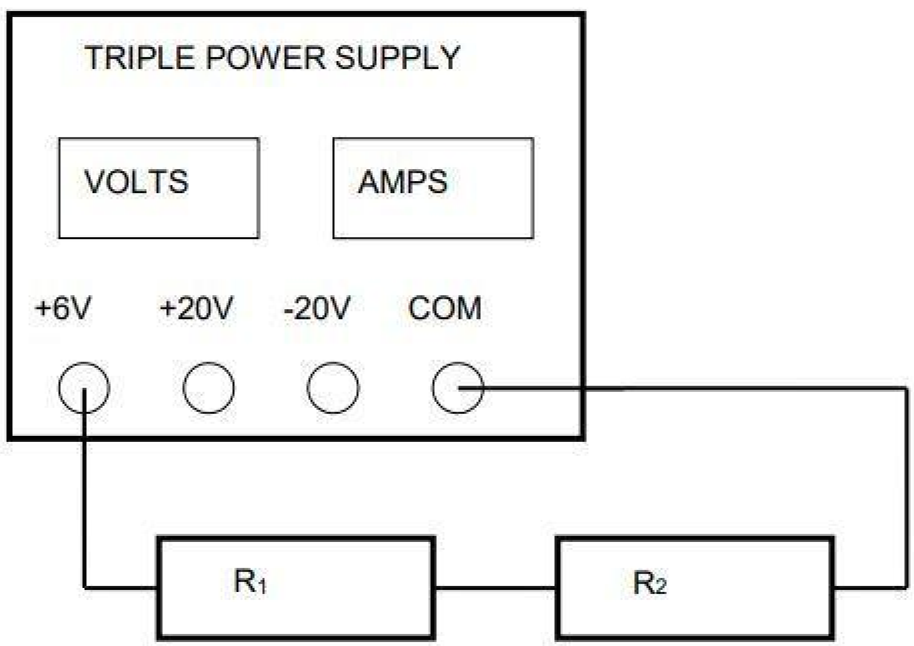


Figure 1.4

Procedure and Results:

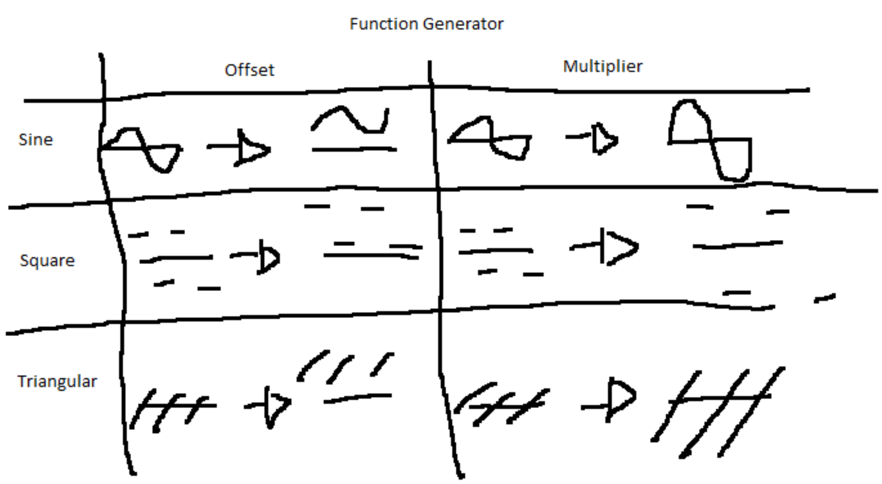
Two resistors of nominal values $R_1 = 33*10^2\ \Omega$ and $R_2 = 20*10^2\ \Omega$ were connected in series according to the schematic diagram (see figure 1.3) and voltage was measured across each resistor for different amounts of supplied voltages to the system using the digital multimeter.

Table 3.1 Voltage Through Resistors

Power Supply Voltage	R_1	R_2
+6V	3.74V	2.26V
+5V	3.12V	1.89V
+3V	1.87V	1.13V
+1V	0.62V	0.37V

The measurements indicated that there was a voltage drop from R_1 to R_2 considering that the resistors were placed in series (due to resistors in series sharing the same current, but not the same voltage). The next two pieces of lab equipment used were the analog oscilloscope and the digital oscilloscopes. No measurements were made using these devices, only exploration of the controls were conducted and the Voltage Sensitivity knobs for channels 1 and 2 as well as the Time Base Modules for each were located and recorded for future reference. The function generator was the last piece of lab equipment used for experiment one – the SINE waveform was selected on the function generator and the AMPLITUDE and FREQUENCY knobs were adjusted until the wave appeared on the oscilloscope screen, and records were made of how the OFFSET knob and MULTIPLIER knob affected the wave. This procedure was repeated for the SQUARE and TRIANGULAR waveforms, and the results can be observed below.

Table 3.2 Function Generator Offset/Multiplier Observation



It can be observed here that the OFFSET knob shifted the waveform up or down, and the MULTIPLIER knob adjusted the amplitude of the waveform.

In the procedure of the 2nd experiment, the Time Base module was used to observe how changes in the time divisions affected the scale of the sine and the square wave (Figure 3.5 and Figure 3.6).

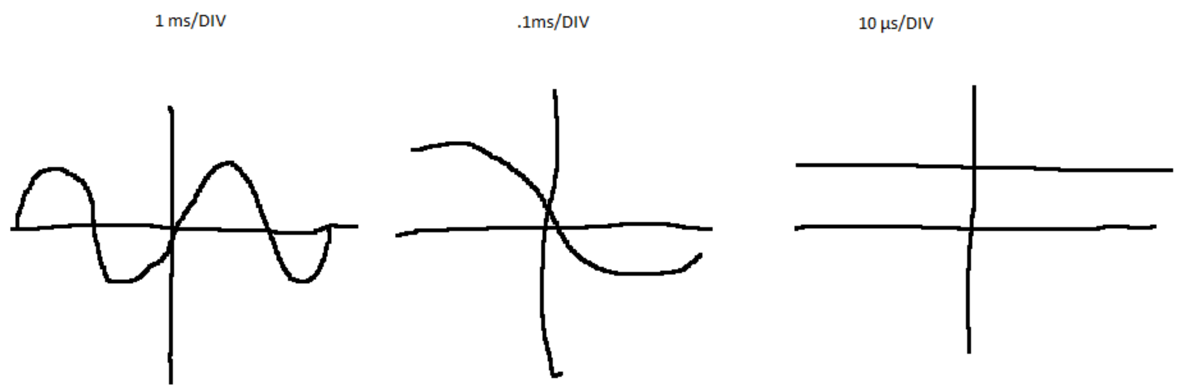


Figure 3.5 Sine Wave

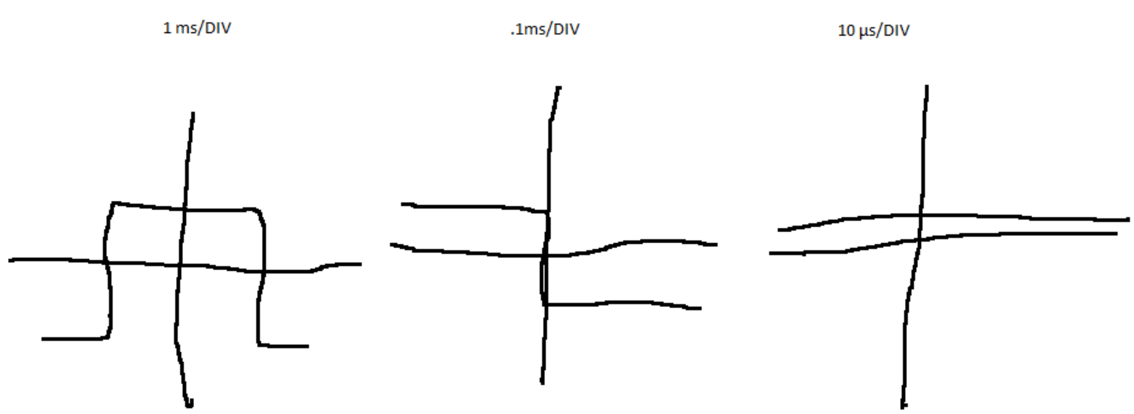


Figure 3.6 Square Wave

Based on these graphs it was seen that the use of smaller and smaller time divisions scaled the graph in such a way similar to “zooming in” on an interval of the waveform. The period of the waveform was then measured and recorded as T_{meas}. The frequency of the oscillation was recorded as $f_{meas,}$ which can be calculated as number of oscillations/sec. This f_{meas} was then compared to the frequency on the function generator f_{dial} and the percent error was calculated using the following formula:

$$\%\ error = \left(\frac{f_{meas} - f_{dial}}{f_{dial}}\right) \times 100\% \qquad (2.1)$$

The results of these percent errors are shown in figure 3.7:

Figure 3.7 Percent Error

Waveform	f_{dial}	f_{meas}	% Error
Sine	1 kHz	1 kHz	0%
Square	1 kHz	1 kHz	0%

The output of the function generator was then connected to the AC voltage input of the digital multimeter and the measurement was recorded as the RMS voltage of the sine and square wave. Using this information, the conversion factor K was calculated using Equation 2.2 (4V peak-to-peak):

$$K = \frac{V_{peak}}{V_{RMS}} \qquad (2.2)$$

The results of the K calculations from the V_{peak} and V_{rms} values are shown below in figure 3.8:

Figure 3.8 Sine and Square K Values

Waveform	V_{peak}	V_{rms}	$K_{theoretical}$	K_{calc}
Sine	2V	1.399V	1.41421	1.42959
Square	2V	2.13V	1	0.93897

As shown, K_{calc} was approximated very closely to the theoretical K value, which indicated correct execution of the calculation procedure. The final section of the second experiment called for the construction of the circuit shown in figure 2.1:

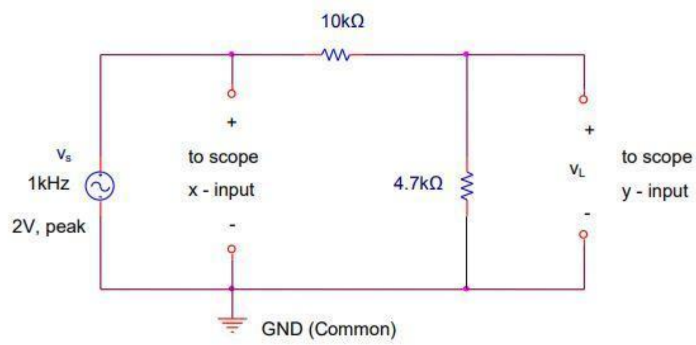
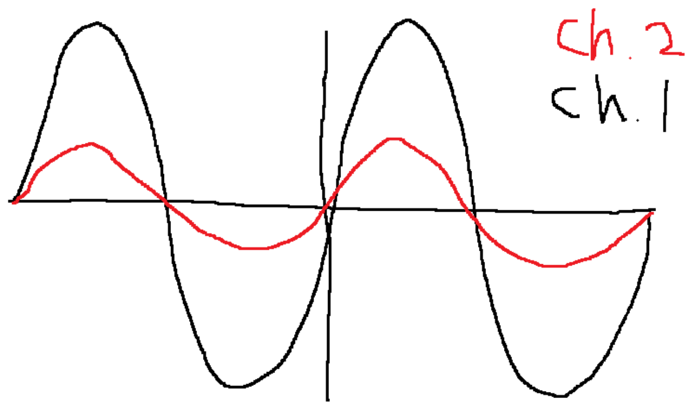


Figure 2.1

From this diagram, V_L was connected to channel two and V_S was to channel one. Shown below in figure 4.1 is the oscilloscope display to scale:

Figure 4.1: Oscilloscope Display



The lower amplitude of the channel 2 output was expected due to the scope probe measuring the voltage across the resistor, so naturally a voltage drop had occurred. The slope of the graph was measured by the straight line display on the oscilloscope, but the actual value of the slope was calculated from the following formula (Equation 2.7).

$$m = \frac{V_L}{V_S}$$

Equation 2.7

The observed value versus the calculated value of the slope is seen in figure 4.2:

Figure 4.2: Calculated Slope/Observed Slope

V_L/V_S (m_{calc})	0.319835
V_L/V_S (m_{obs})	0.307692

Based on the values, the calculation process can be assumed to be void of errors because the values are very closely approximated to one another.

Conclusion:

The objective of the lab was to practice using the lab equipment and become accustomed to their controls as well as how to interpret data taken from them. Proper application of the lab equipment is not only necessary for future circuit analysis, but also a key to enforce understanding of theory. Looking at the tables above, the objective of becoming more accustomed to the controls of the equipment was met as the procedures were correctly executed.