MEMO TO: Siming Zhang

FROM: Seth Strayer

DATE: September 13, 2018

SUBJECT: Lab #1 – Introduction to Instrumentation, Data Acquisition, and Breadboarding

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On September 13, 2018, Noah Sargent and I conducted an experiment to understand and analyze some of basic instrumentation that will be used throughout the MEMS1041 labs. In Part 1 of the lab, we acquired and analyzed signals obtained from oscilloscopes, function generators, and multimeters. In Part 2 of the lab, the relative accuracy of a digital multimeter (DMM) in recording voltage and current values obtained from a breadboard circuit was analyzed. In Part 3 of the lab, voltage signals were obtained using Matlab along with a standard data acquisition unit (DAQ). We wish to observe that there are several different methods of obtaining data using basic instrumentation provided in the lab. Furthermore, we wish to show the accuracy of these instrumentation devices and prove that they yield acceptable results.

Results from Part 1 of the lab are listed in Table 1. We noted that the values obtained from the oscilloscope and multimeter closely correspond with the values from the function generator. Table 2 displays our results from Part 2 of the lab. These results indicate that the DMM measures values which are close to the expected circuit values. Finally, Figure 1 displays the voltage plot obtained with data acquired from the function generator using the DAQ and plotted via Matlab. We observed that we could use the DAQ along with Matlab to easily plot data obtained from the function generator.

In Part 1 of the lab, we observed that we have the capability of transmitting a signal from the function generator to the oscilloscope and DMM. The measurements found on the oscilloscope and DMM correspond to those on the function generator when the devices were correctly configured. We wish to note that the DMM displays RMS voltage, and not peak-to-peak voltage (see footnote 1); see these results in Table 1.

In Part 2 of the lab, resistor values were first verified using the digital multimeter. The measured values had less than 2% percent error (see equation 4) from their expected values. Next, we measured the voltage and current values present in our circuit and observed if they correspond to the theoretical (calculated) values. See equations 1, 2, and 3 for the voltage and current formulas and their respective results in Table 2. All the measured values had less than 0.1% error (see equation 4) from their theoretical values. Thus, we conclude that the DMM can record very accurate measurements from several different sources and that it is a valuable tool to have in the lab.

Finally, in Part 3 of the lab, we learned that we can plot voltage signals obtained from the function generator using the DAQ in coherence with a Matlab script. We were able to correctly install the function generator to the DAQ (and the DAQ to the computer) to plot the $2V_{PP}$, 10 Hz frequency sine wave. See Figure 1 for an output of this plot.

These devices have a very high accuracy and are very useful for plotting sinusoidal waves (i.e., any type of sinusoidal input/response), measuring resistance, voltage, and current values from a circuit, etc. They have little disadvantages considering the small amount of error obtained from the measurements.

Table 1: Recorded Values for Function Generator and Multimeter

Quantity	Units	Function Generator	Multimeter
Frequency	Hz	1.000,000,0	.999,999
Voltage	V	1	V_{RMS} = .35487[1]

[1]We note that the multimeter displays $V_{RMS} = V_P/\sqrt{2}$, for which V_P = .50186 V, V_{PP} = 1.0037 V

Table 2: Recorded Values of Breadboard from Multimeter

Quantity	Units	Theoretical Value	Measured Value	Percent Error
R_1	kΩ	1.000	0.983	1.700
R_2	kΩ	3.300	3.245	1.667
V_0	V	5.000	5.001	-0.020
V_1	V	1.1625	1.162	0.043
V_2	V	3.8375	3.838	-0.013
i	A	1.1827	1.182	0.059

Equations:

$$V_1 = \frac{R_1}{R_1 + R_2} V_0 \tag{1}$$

$$V_2 = \frac{R_2}{R_1 + R_2} V_0 \tag{2}$$

$$i = \frac{V_2}{R_2} \tag{3}$$

$$Percent\ Error = \frac{Theoretical - Measured}{Theoretical} \tag{4}$$

where,

V = Voltage [V]
R = Resistance [Ω]
i = Current [A]

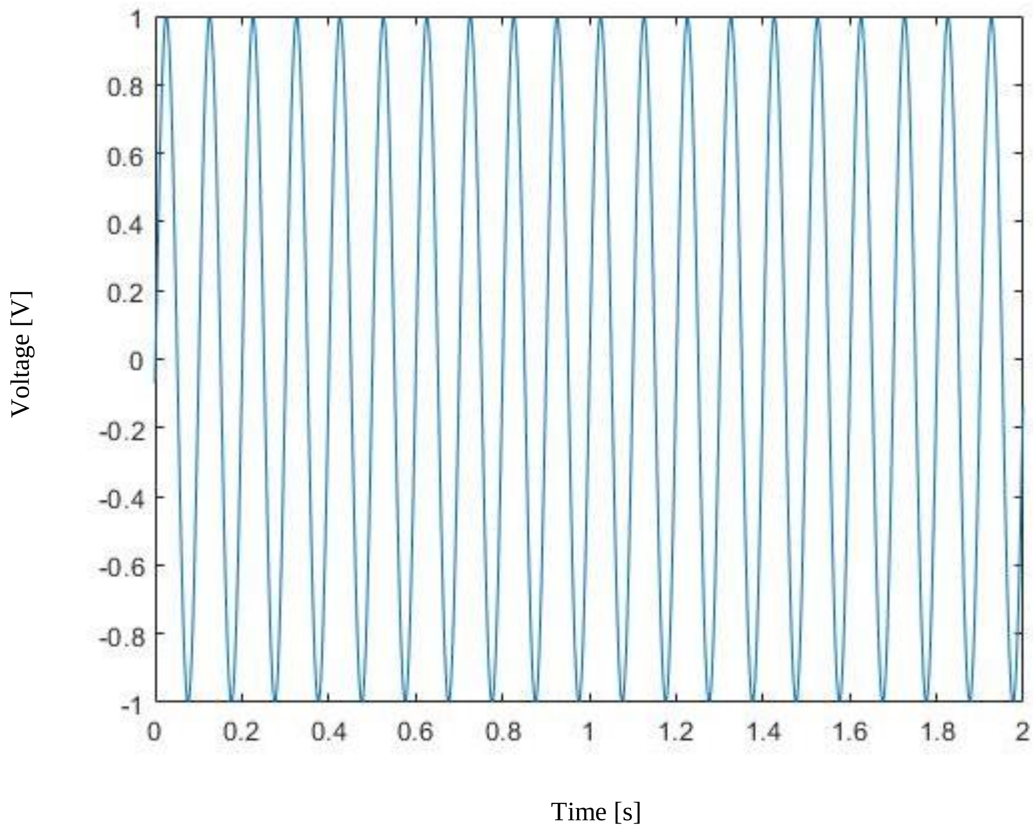

Figure 1: Matlab Plot of a $2V_{PP}$, 10 Hz Frequency Sine Wave