CPE 316: Electrical Circuits and Electronic Design Laboratory.

Lab 05

Basic Filters and Frequency Response.

Submitted by: **Dan Otieno.**

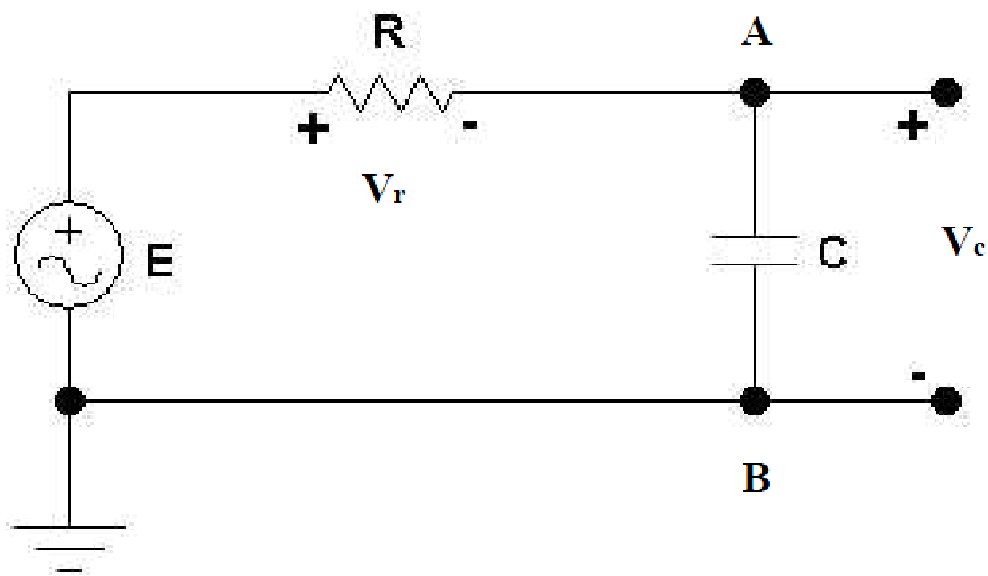
Date of Experiment: 09/26/22.

INTRODUCTION:

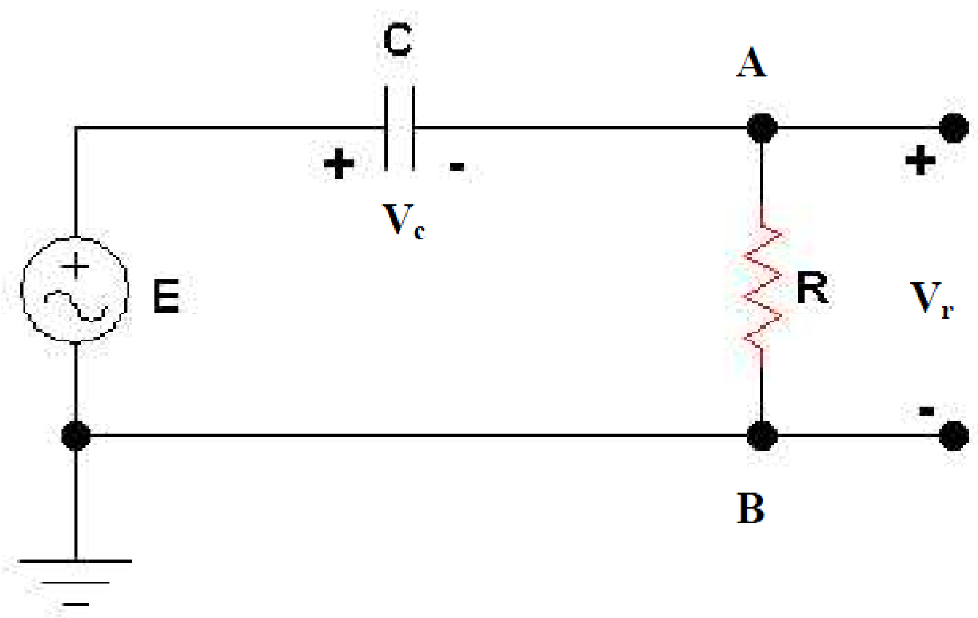
The purpose of this laboratory was to study, design, and understand the characteristics of Low pass and High pass filters. The concepts that were most important were signal amplitude and phase, also studying how those two compared to the input frequency. This lab was completed by designing Low and High pass filters both digitally and experimentally, and testing outputs with various input signals. However, only one frequency was needed for this report.

PART A:

The first part of the lab was to design both Low and High pass filters digitally as shown below:



Low Pass Filter

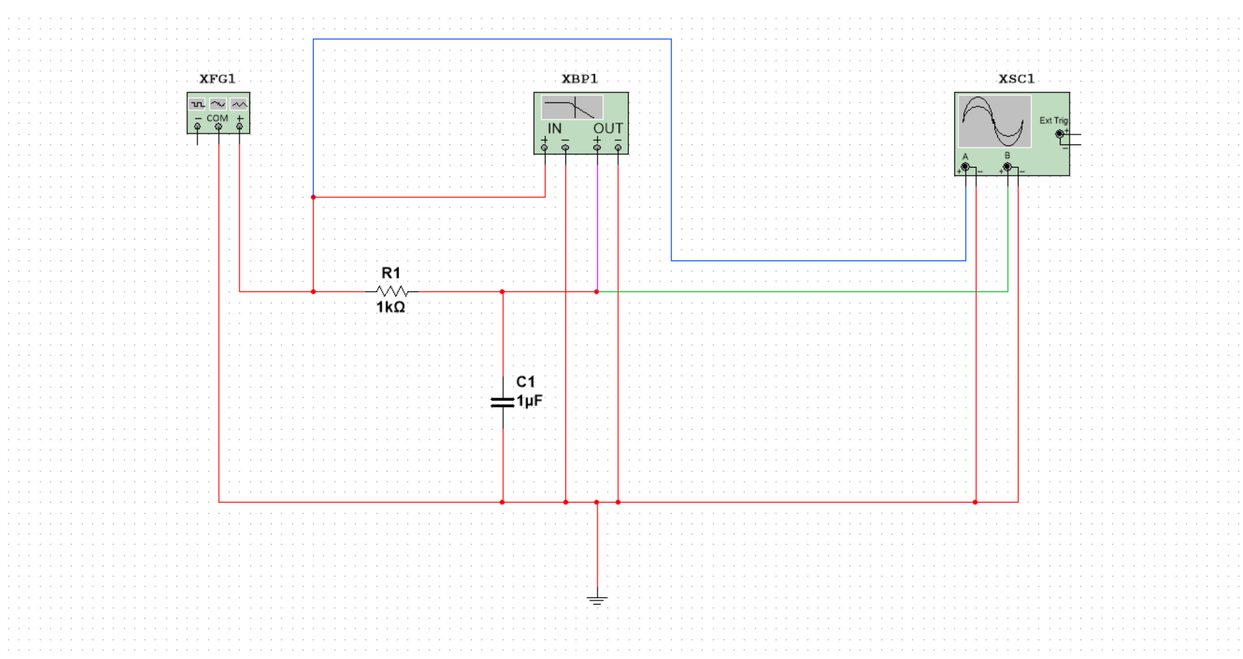


High Pass Filter.

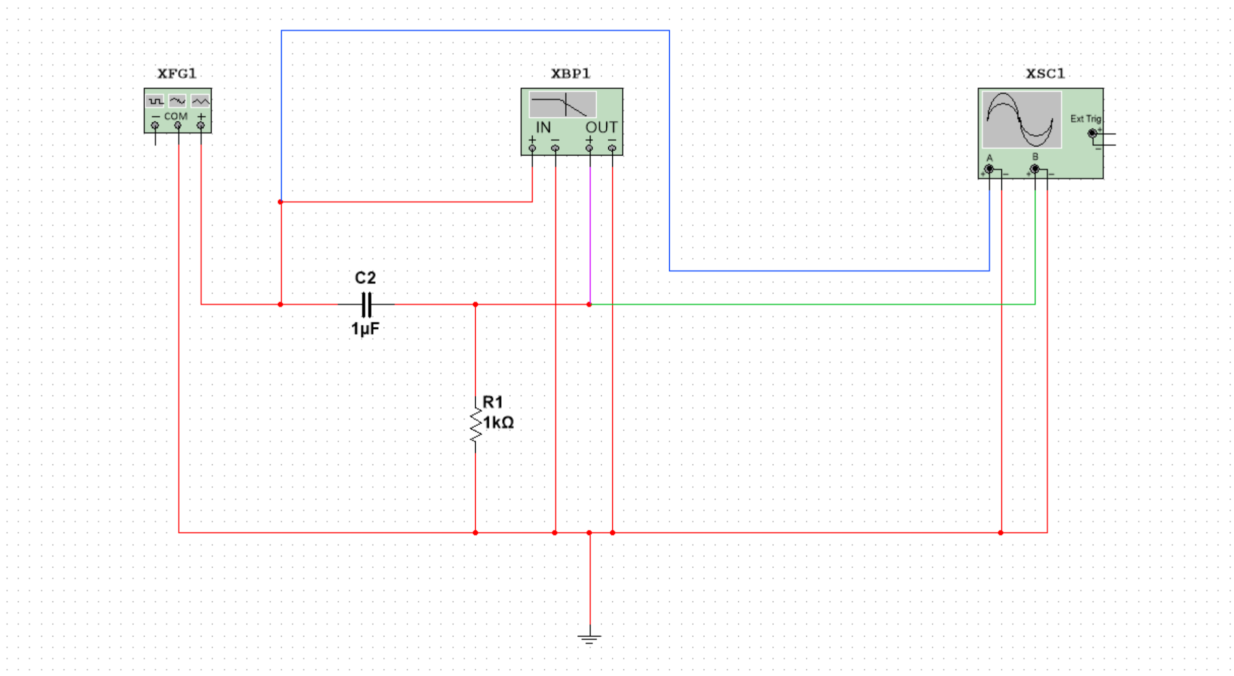
The criteria for designing the circuits were an input signal of 4V peak-to-peak sinusoid, with Resistance R = 1K and Capacitors of 1uF.

The designs were completed as shown below:

LOW-PASS FILTER DESIGN:

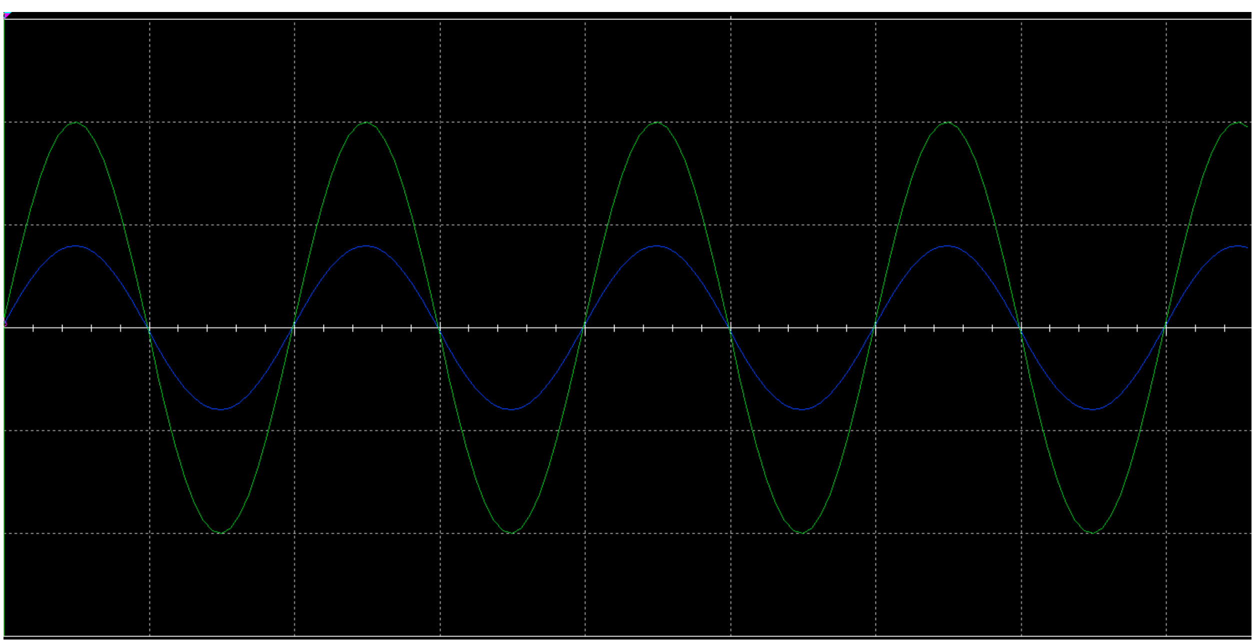


HIGH-PASS FILTER DESIGN:

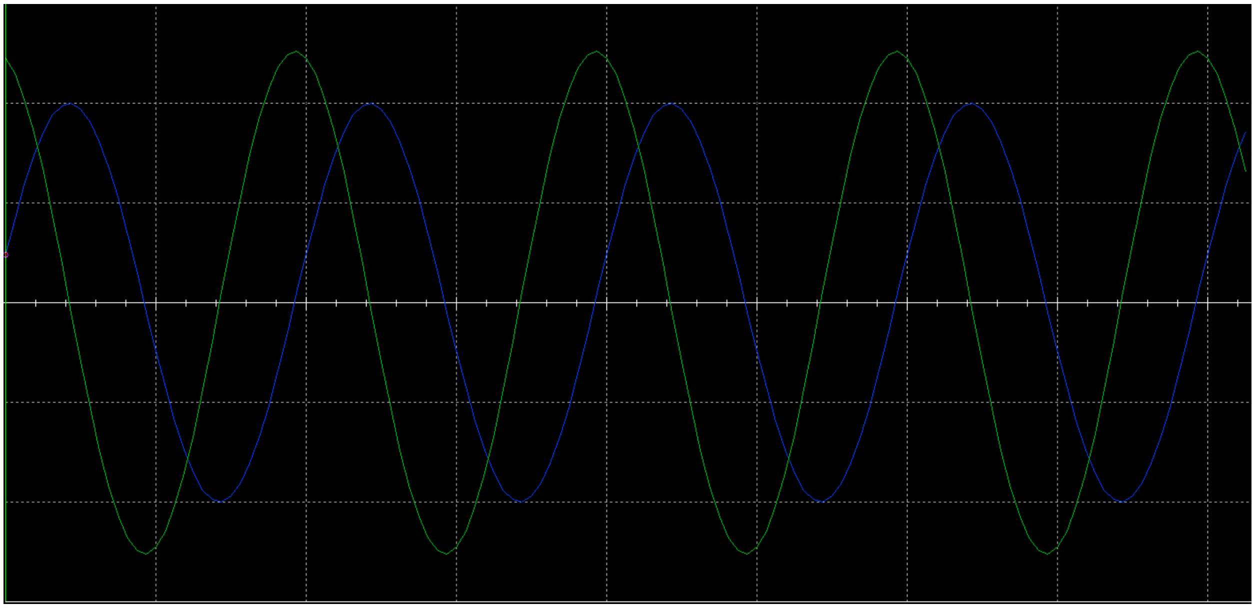


Below are the wave outputs for LPF and HPF designs with a sinusoid input:

LPF WAVE:



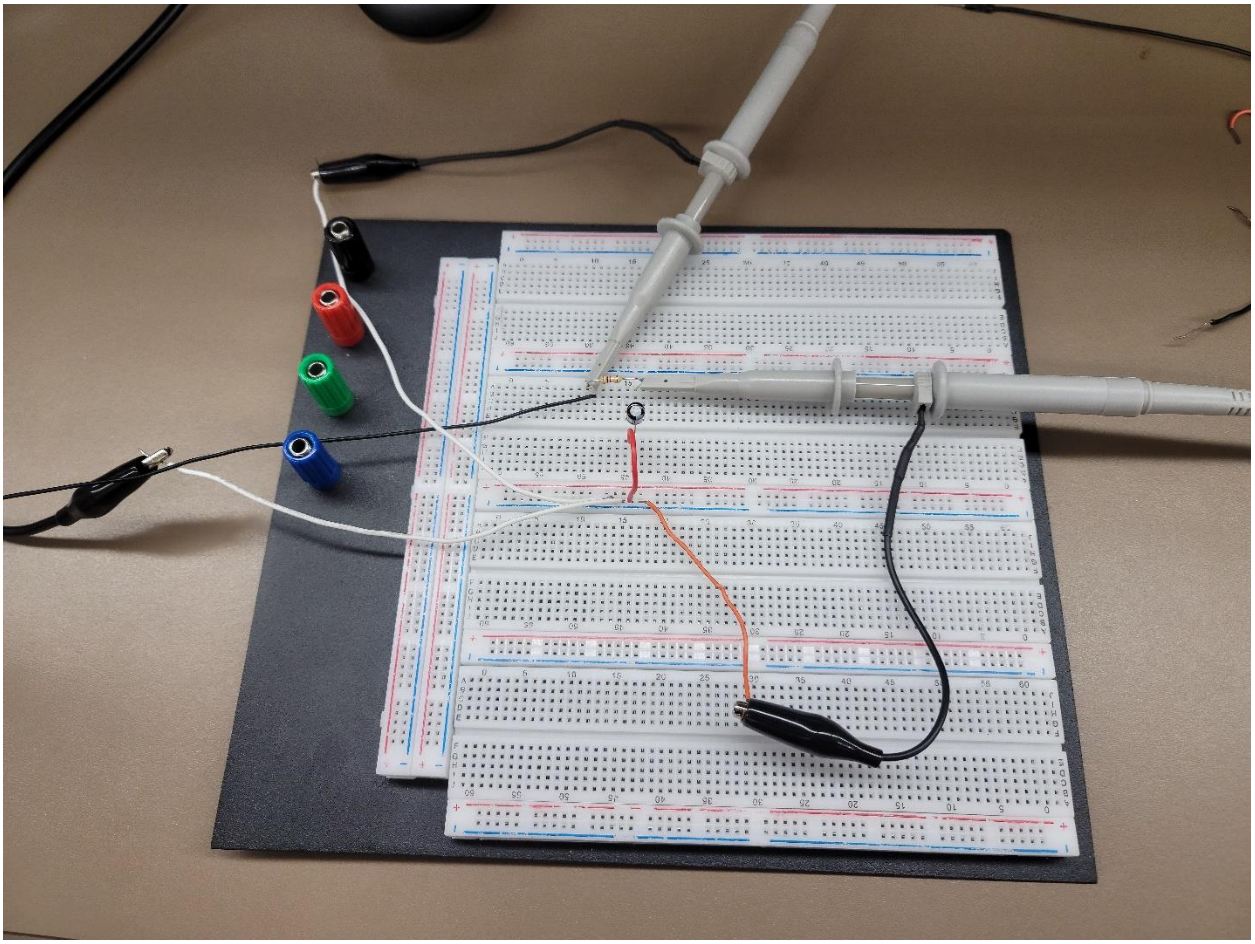
HPF WAVE:

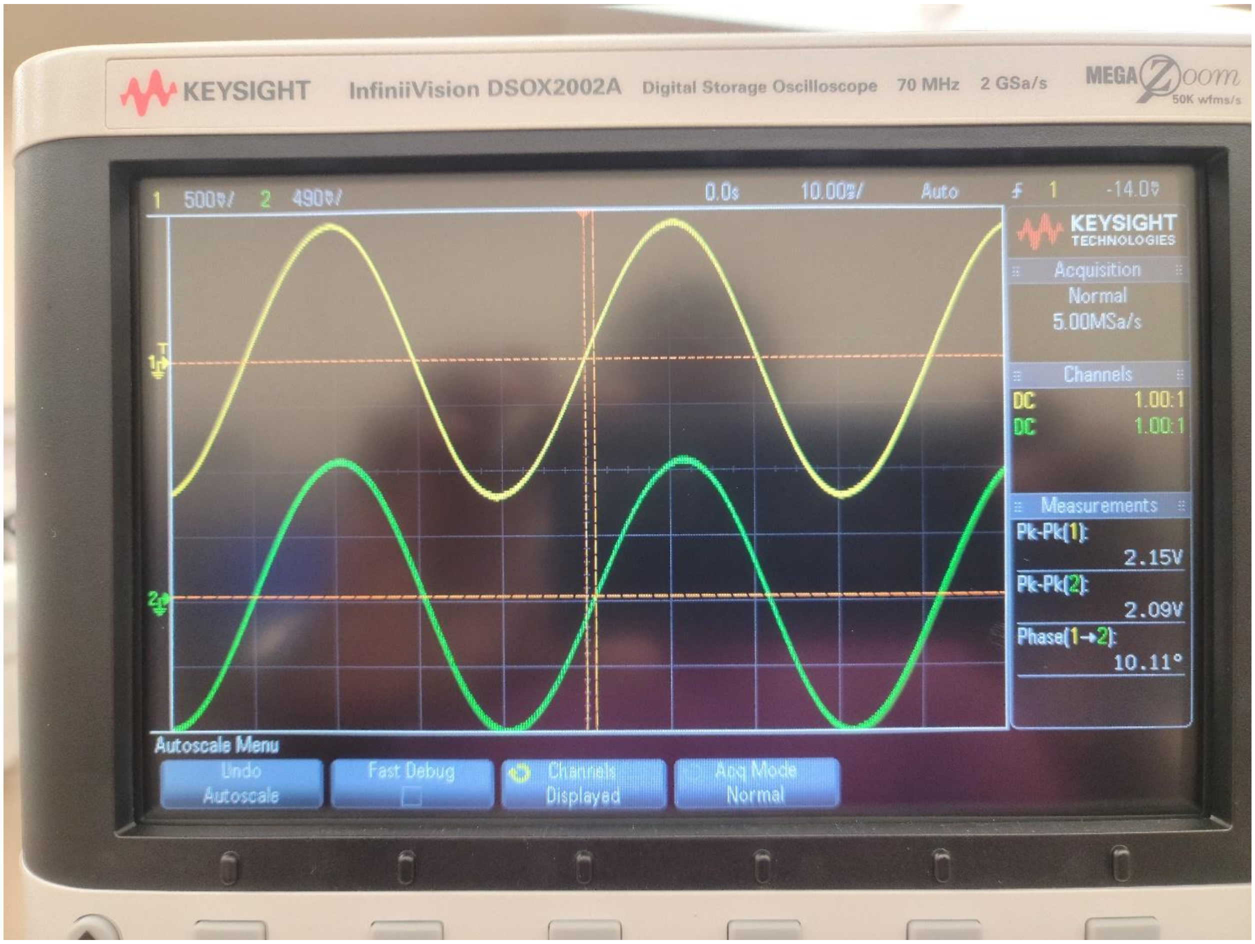


PART B:

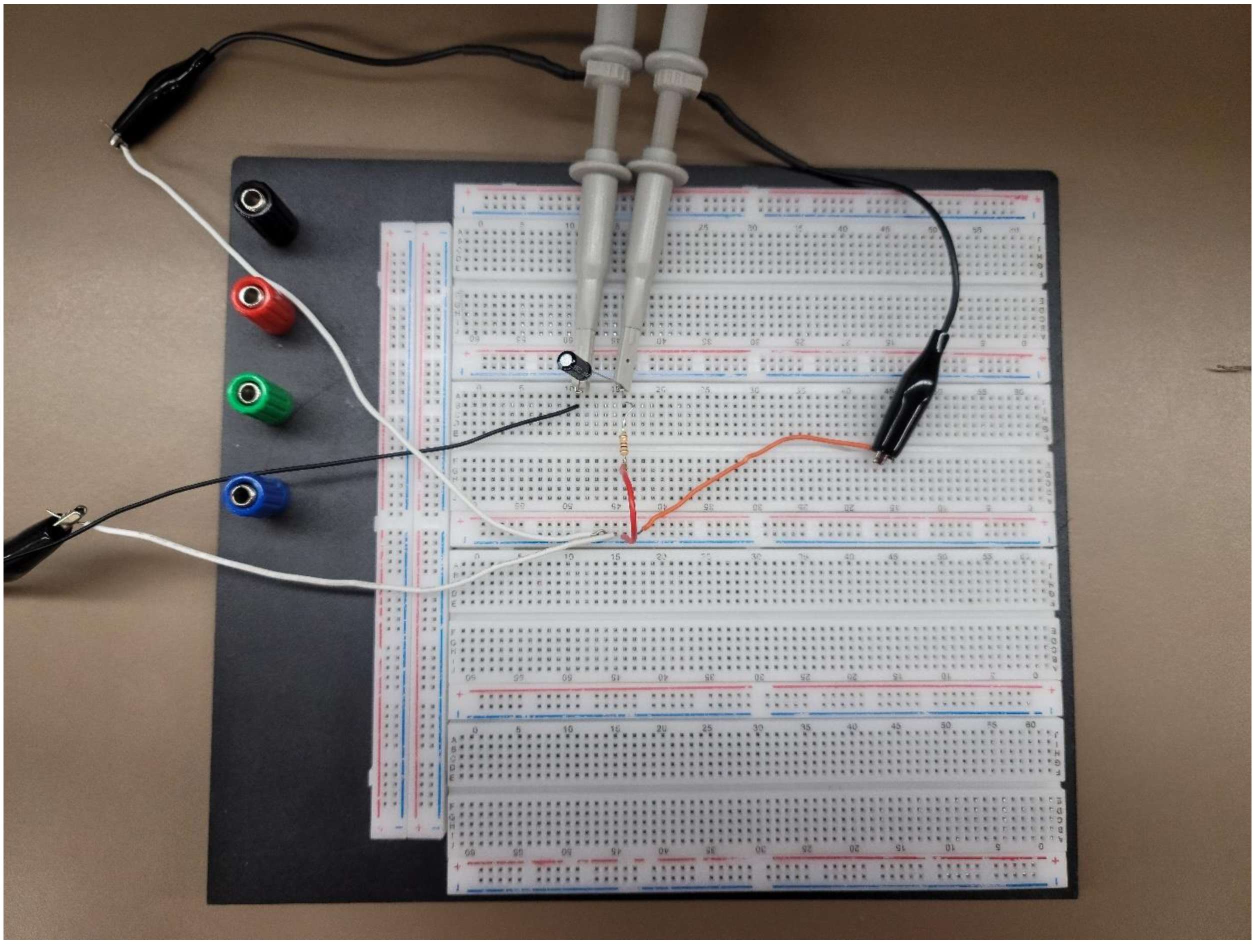
The next part of this laboratory was to design the circuits above using hardware components. The designs were completed, and sinusoid outputs generated as shown below:

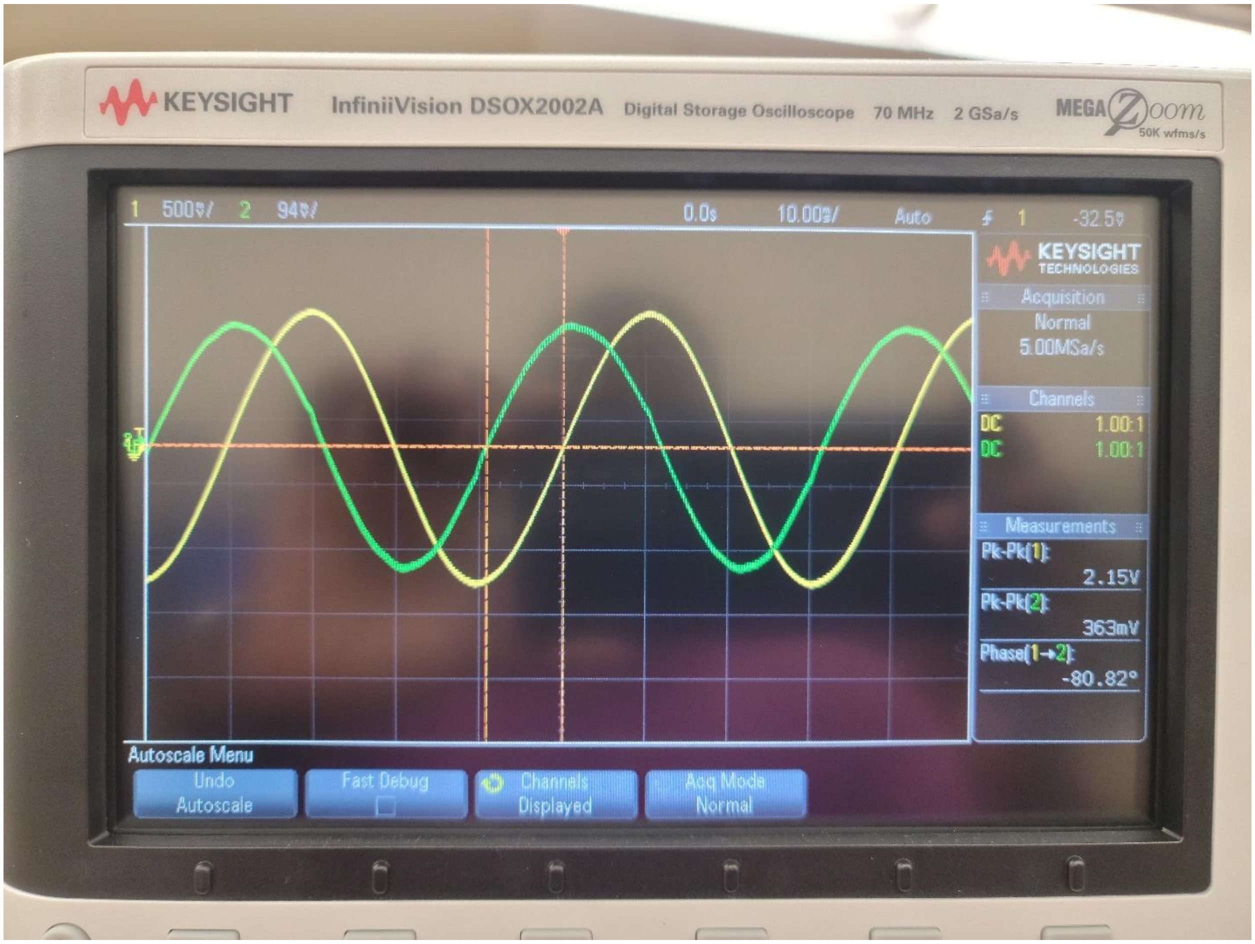
LPF CIRCUIT AND SINUSOID WAVE:





HPF CIRCUIT AND SINUSOID WAVE:





The theoretical analysis table was completed using the calculations provided in the lab manual.

For LPF Gain and phase angle formulas are as follows:

$$\left|\frac{V_c}{E}\right| = \frac{1}{\sqrt{(1+(2\pi f RC)^2)}}$$

LPF Gain Formula.

$$\tan(\phi) = -2\pi f RC$$

LPF Phase Angle formula.

For HPF, Gain and phase angle formulas are:

$$\left|\frac{V_r}{E}\right| = \frac{2\pi f RC}{\sqrt{(1+(2\pi f RC)^2)}}$$

HPF Gain formula.

$$\tan(\phi) = \frac{1}{2\pi f RC}$$

HPF phase angle formula.

Applying the above, the theoretical values are completed below (Also submitted in prelab assignment):

LOW-PASS FILTER AND HIGH-PASS FILTER THEORETICAL VALUES RESPECTIVELY.

F (Hz)	Gain (dB)	Phase Angle (Degree)
25	-0.106	-8.93
50	-0.409	-17.44
75	-0.871	-25.23
100	-1.445	-32.14
150	-2.761	-43.3
200	-4.115	-51.49
300	-6.583	-62.05
500	-10.362	-72.34
600	-11.822	-75.14
700	-13.084	-77.19
800	-14.194	-78.75
900	-15.182	-79.97
1000	-16.072	-80.96

F (Hz)	Gain (dB)	Phase Angle (Degree)
25	-16.183	81.07
50	-10.466	72.56
75	-7.406	64.77
100	-5.481	57.86
150	-3.275	46.7
200	-2.131	38.51
300	-1.077	27.95
500	-0.419	17.66
600	-0.295	14.86
700	-0.219	12.81
800	-0.169	11.25
900	-0.134	10.03
1000	-0.109	9.04

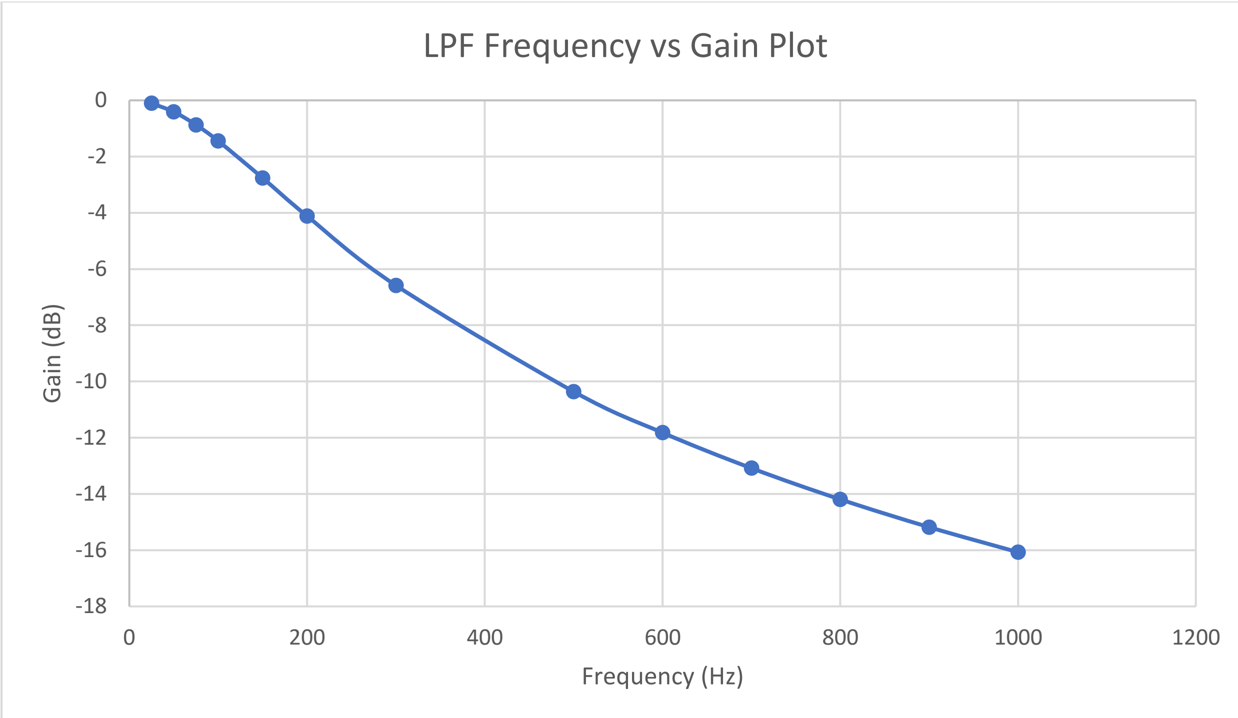
The cutoff frequency formula is provided as:

$$f_c = \frac{1}{2\pi RC}$$

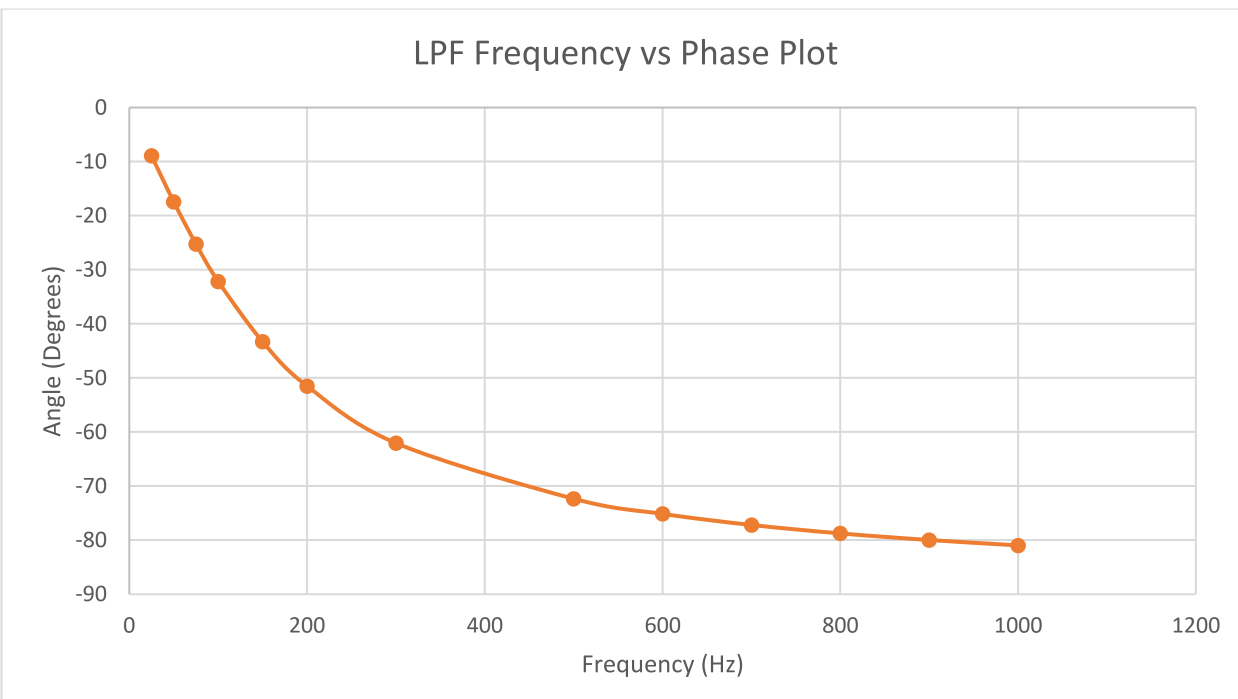
Applying the formula, which is true for both high and low pass filters, we get:

Cutoff Frequency (F_c = 1 / (2 * π * (1*10^3) * (1*10^-6)) = 159.15Hz

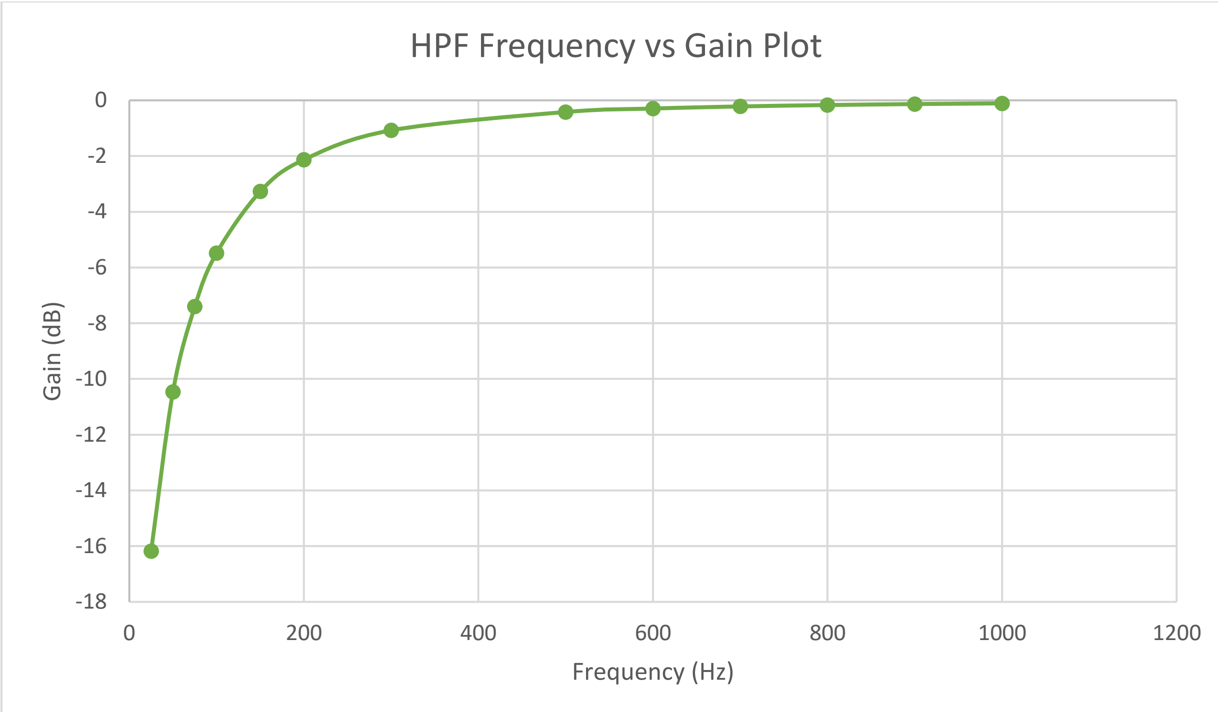
LPF GAIN VS. FREQUENCY PLOT:



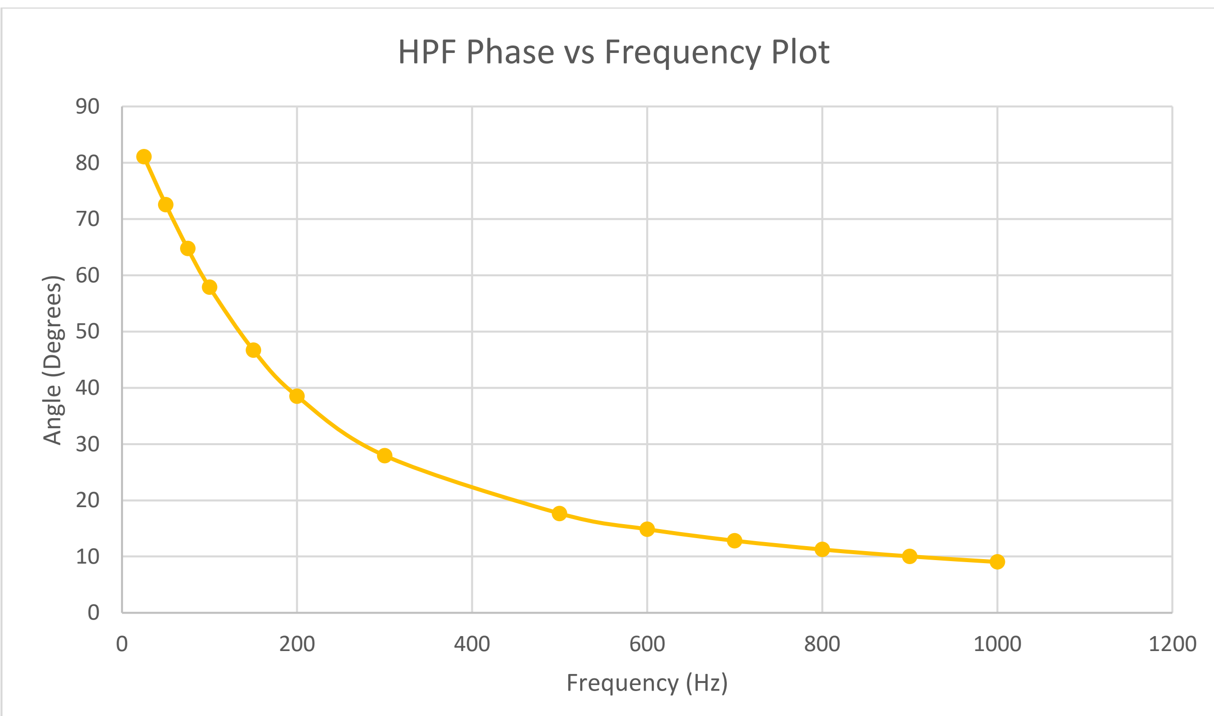
LPF PHASE VS FREQUENCY PLOT:



HPF GAIN VS FREQUENCY PLOT:



HPF PHASE VS FREQUENCY PLOT:



From the plots above, we can see that the phase angle pattern is almost the same for both configurations.