ECEN 3714--------Network Analysis
Cover Sheet for Lab 3 to 11

Spring 2022

Lab #__7__

Topic: Active Low Pass Filter

Final Report (Pre-lab + Post-lab)

Name of Group Members:	
Name (Print): Roger Bennett	Name (Print): Thomas Kidd
Signature: *Roger M. Bennett*	Signature: *Thomas Kidd*
TA Signature:	

1. Introduction

1.1. In this lab we are dealing with a First-Order active low pass circuit and examining the circuit's frequency-response and assessing the load dependence of the First-Order low pass circuit. We will be using a capacitor and resistors alongside an Op-Amp

2. Pre-Lab Assignment:

2.1. Calculate the Cutoff Frequency of the Low-Pass Filter

$$f_C = \frac{1}{2\pi RC} = \frac{1}{2\pi(1k\Omega)(100nF)} = 1591.5Hz$$

2.2. PreLab Question 2

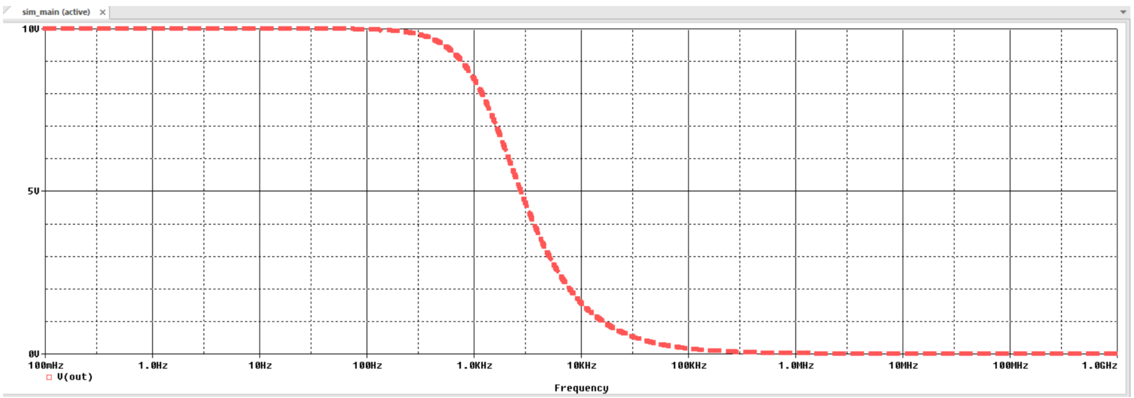

Figure 1 - Magnitude Response of Circuit

	Evaluate	Measurement	Value
	☑	Cutoff_Lowpass_3dB(V(out))	1.58777k
▶	☑	YatX(P(V(out)), 1587)	-44.91797

Figure 2 - Cutoff Frequency and Phase Shift

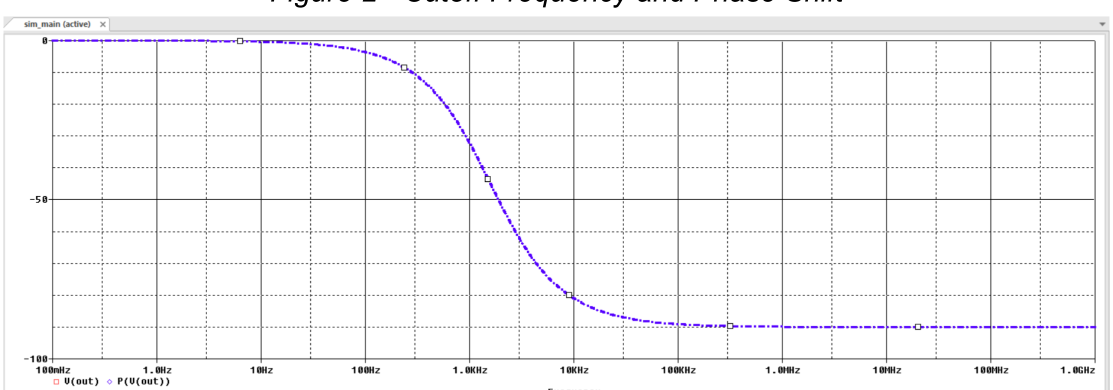

Figure 3 - Phase Response of Circuit

As seen in Figure 2, our cutoff frequency is equivalent to what we calculated in section 2.1. The phase shift is negative as expected for a low pass filter.

2.3. Filter Under Load:

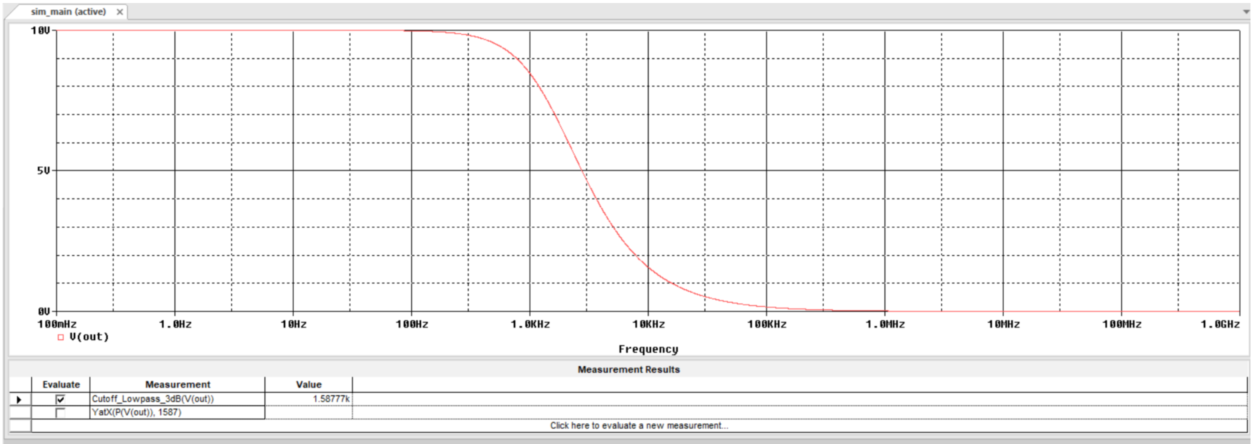

Figure 4 - Magnitude Response for a 4kΩ load and cutoff frequency

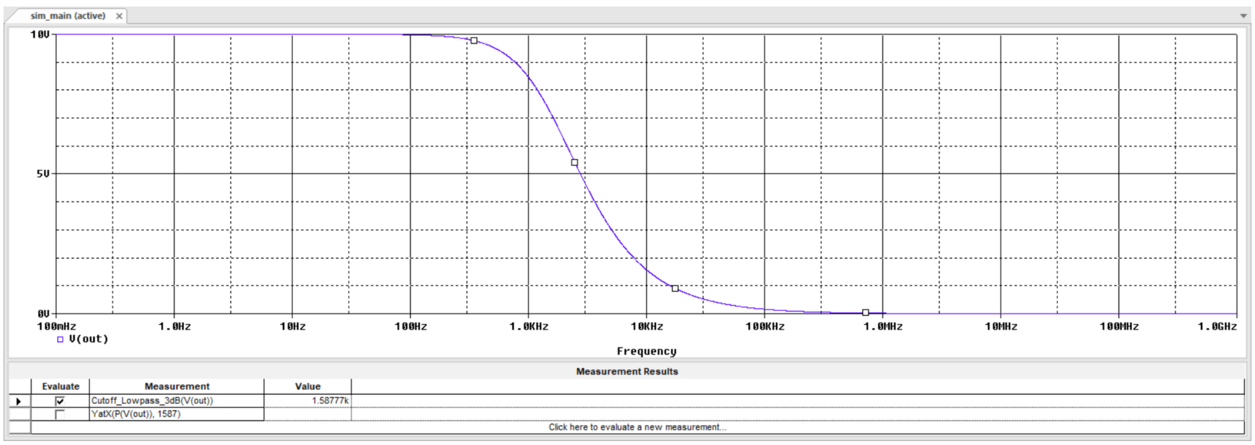

Figure 5 - Magnited Response for a 40kΩ load and cutoff frequency

As seen both in *Figure 4* and *Figure 5*, regardless of the load, using an active filter does not change the magnitude response of the circuit. This can also be seen in each image with the cutoff frequency not changing.

2.4. Passive Filter

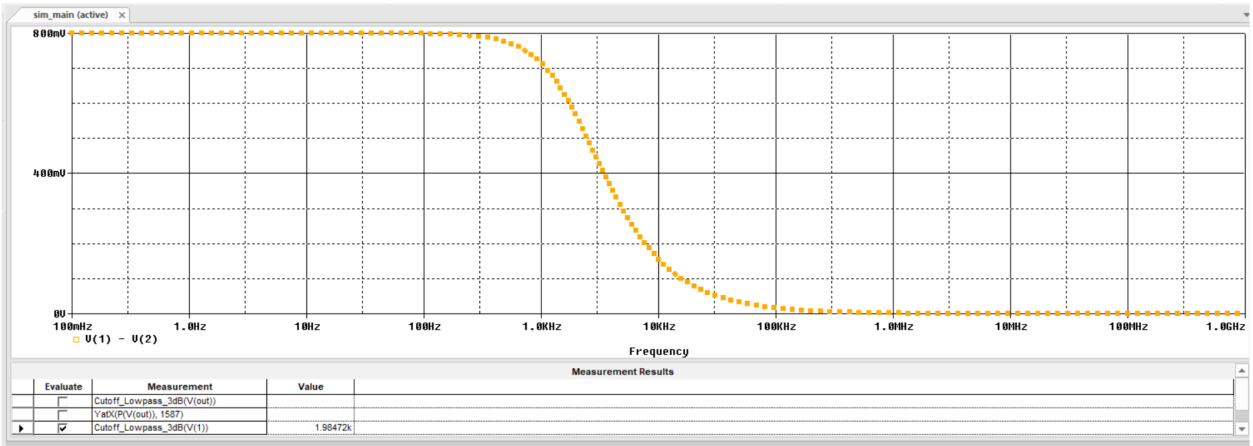

Figure 6 - 4kΩ load for passive circuit and cutoff frequency

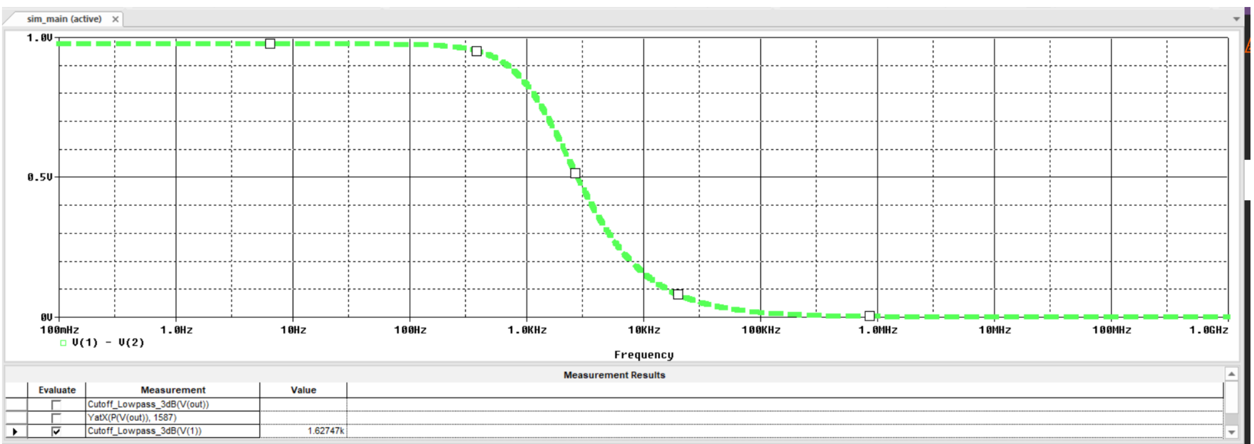

Figure 7 - 40kΩ load for passive circuit and cutoff frequency

As seen in both Figure 6 and Figure 7, with a passive filter when a load is applied the cutoff frequency changes based on the load.

3. Assignments:

3.1. Assignment 1:

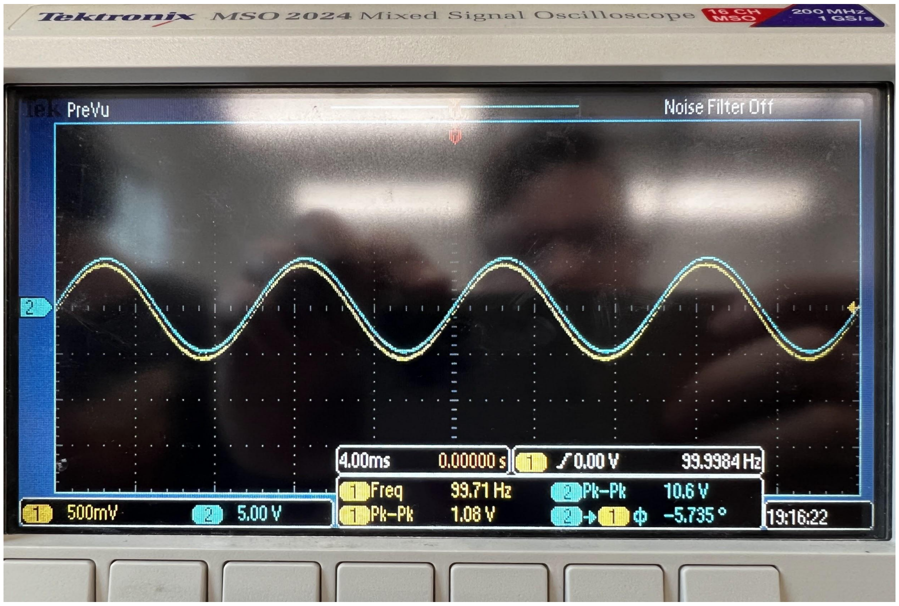

Figure 8 - 100Hz Frequency

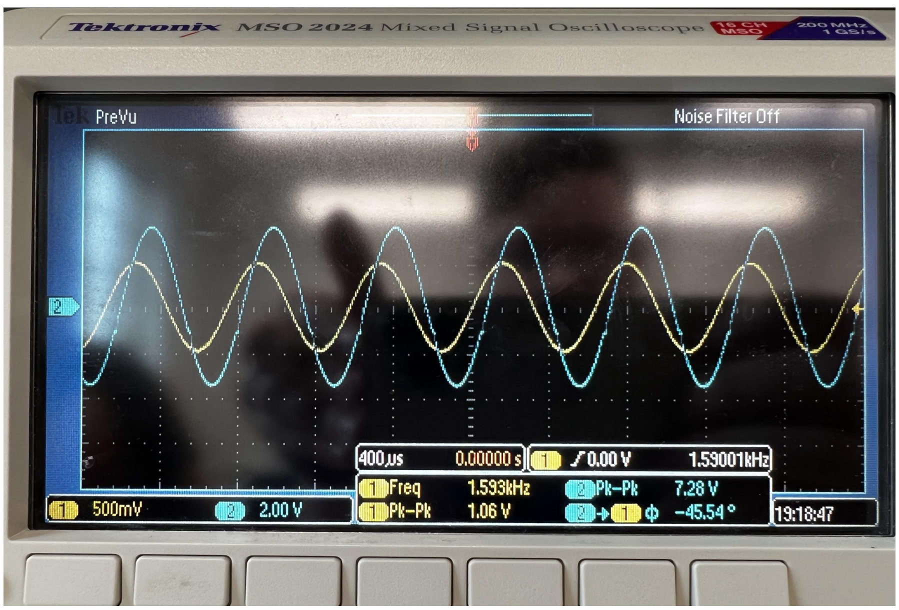

Figure 9 - 1.59kHz Frequency

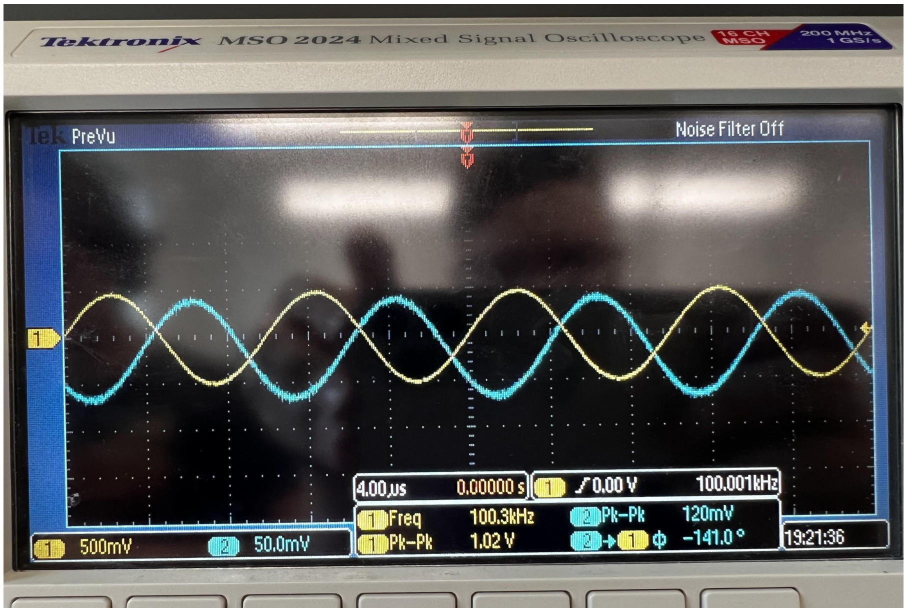

Figure 10 - 100kHz Frequency

Frequency	Magnitude Response	Phase Response (°)
100Hz	10.6v	-5.735°
200Hz	10.6v	-10.10°
500Hz	10.2v	-17.59°
1kHz	9.0v	-31.72°
1.59kHz (Cut-off Freq)	7.28v	-45.54°
2kHz	6.4v	-53.30°
5kHz	3.08v	-72.24°
10kHz	1.68v	-88.04°
20kHz	.880v	-96.01°
50kHz	.296v	-118.8°
100kHz	.120v	-141.0°

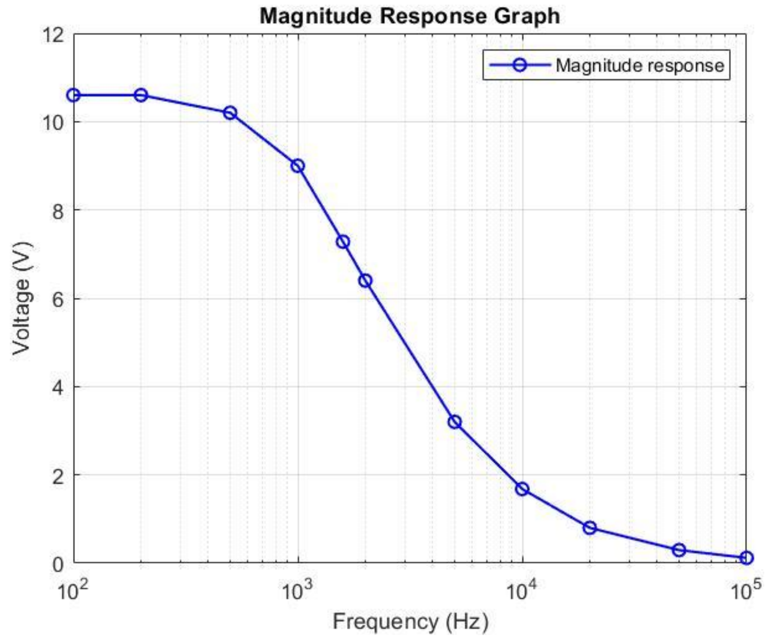

Figure 11 - Magnitude Response Plot from table above

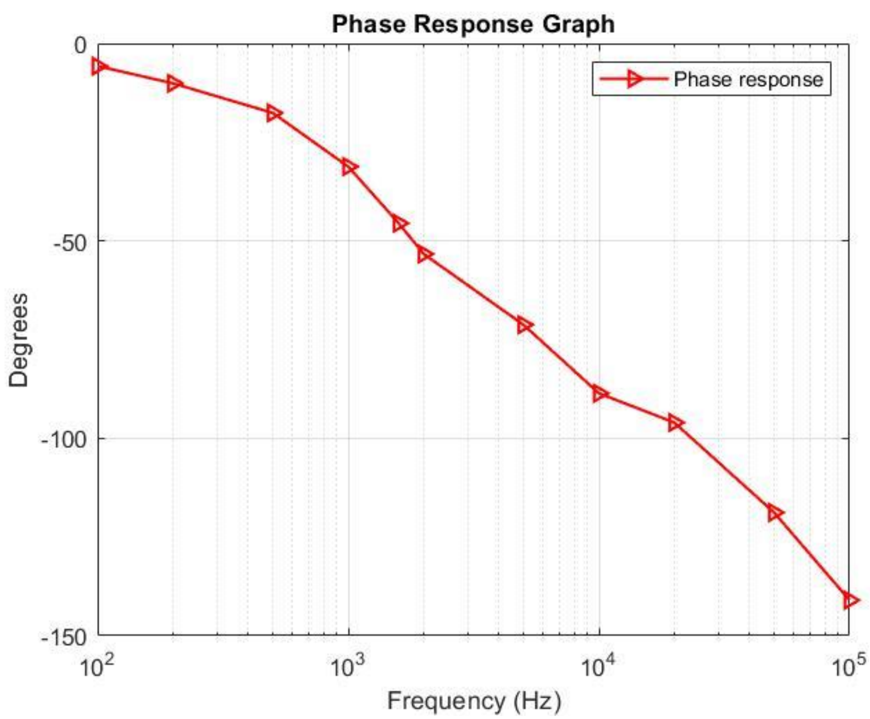

Figure 12 - Phase Response graph from table above

3.2. Assignment 2:

After adding a 5.6kΩ Load to the circuit we discovered that it had no effect on the output of the circuit.

3.3.

Frequency	Magnitude Response (No Load)	Magnitude Response (4kΩ Load)	Magnitude Response (40kΩ Load)
100Hz	1.10v	.900v	1.08v
200Hz	1.10v	.880v	1.06v
500Hz	1.06v	.880v	1.02v
1kHz	.940v	.820v	.940v
1.59kHz (Cut-off Freq)	.800v	.720v	.800v
2kHz	.640v	.660v	.720v
5kHz	.328v	.400v	.400v
10kHz	.184v	.260v	.260v
20kHz	.112v	.180v	.180v
50kHz	.064v	.140v	.140v
100kHz	.048v	.120v	.120v

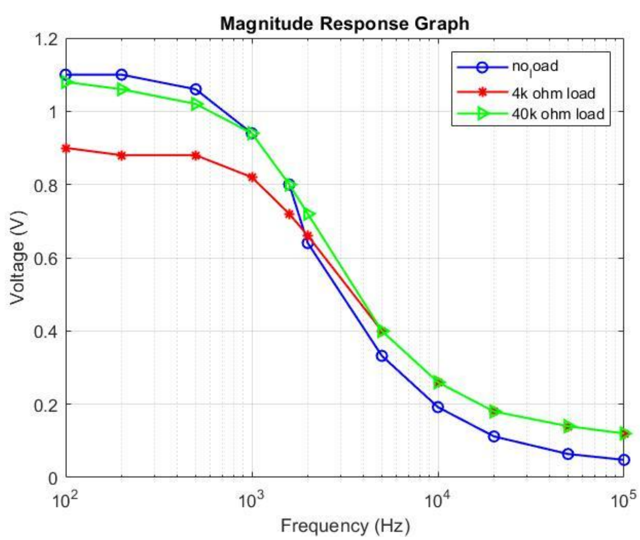

Figure 13: Assignment 3 - MATLAB Plot

4. Discussion

4.1. We learned what low pass filters are and how to construct them. We also learned about the cut off frequency and what effect it has on the circuit. Low pass filters can achieve a gain higher than 1. Active low pass filters are good at handling any kind of load and maintaining the desired cutoff frequency. Passive low pass filters will change their cutoff frequency as the load changes in resistance. This can lead to undesired cutoff frequencies which can hinder the application of the device.

4.2. With a Passive Low-Pass Filter, when the load resistance becomes lower the Cut-off Frequency with that load will become greater. As seen in section 2.4 of the lab report.

4.3. V_{in} leads V_{out} in the time domain for the filter in this lab, this is given by the negative degree change from out to in, showing that V_{in} leads V_{out}.