

## **ASEN 3300, Fall 2023: Lab 4 Report Submission**

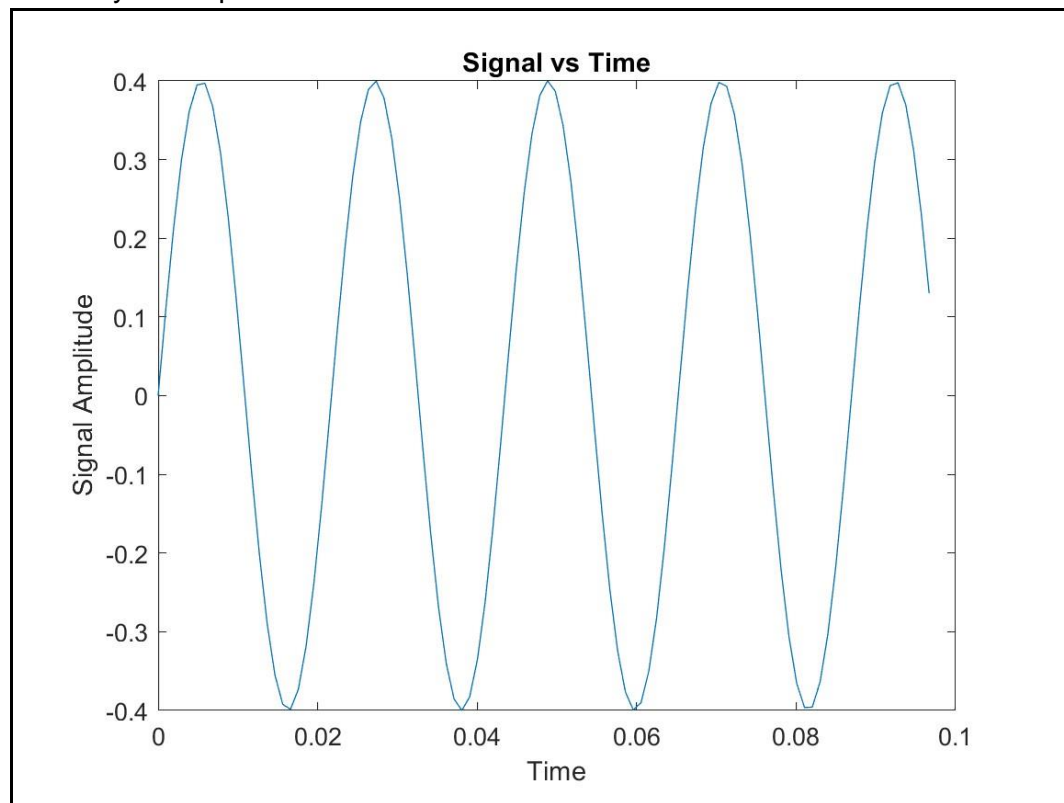
<b>Names:</b>	Brady Sivey
	Jared Steffen
	Joshua Geeting
<b>Section:</b>	012

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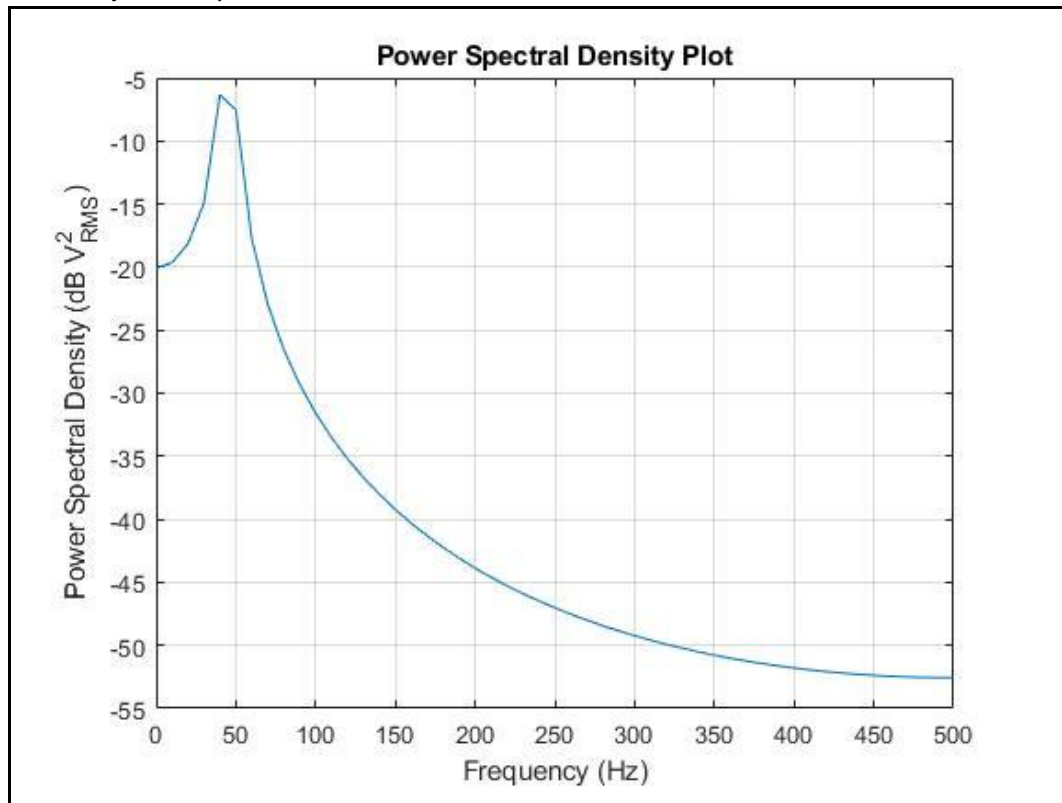
### **4. Experiment (25 pts)**

#### **4.1. Signal Frequency Content**

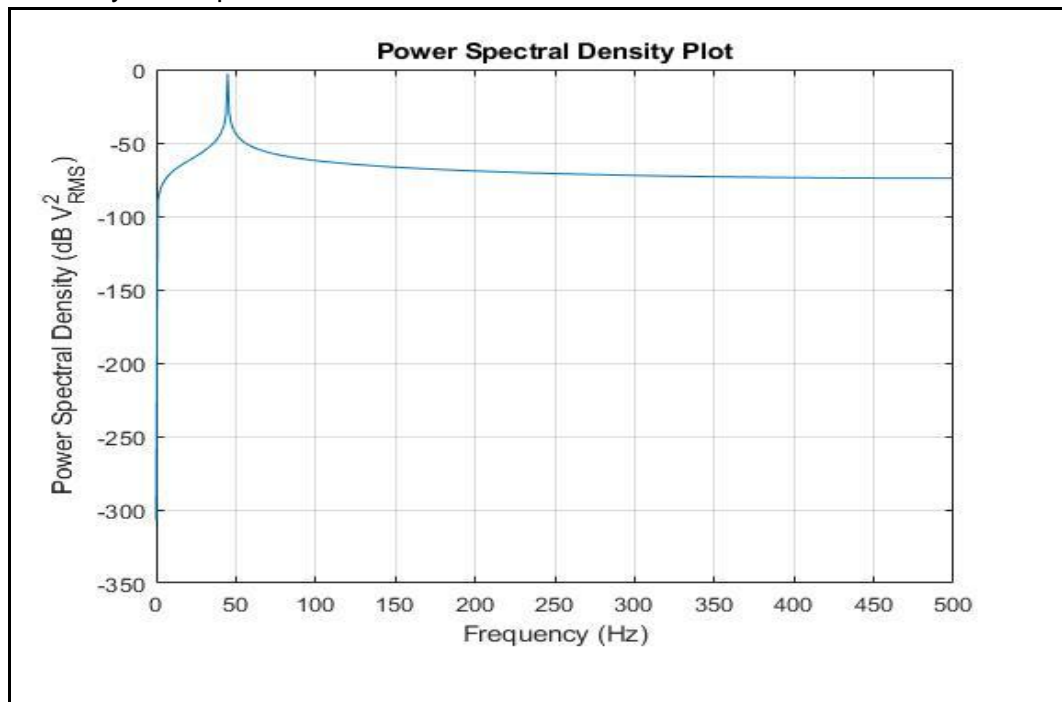
a. Record your response to 4.1.a below:



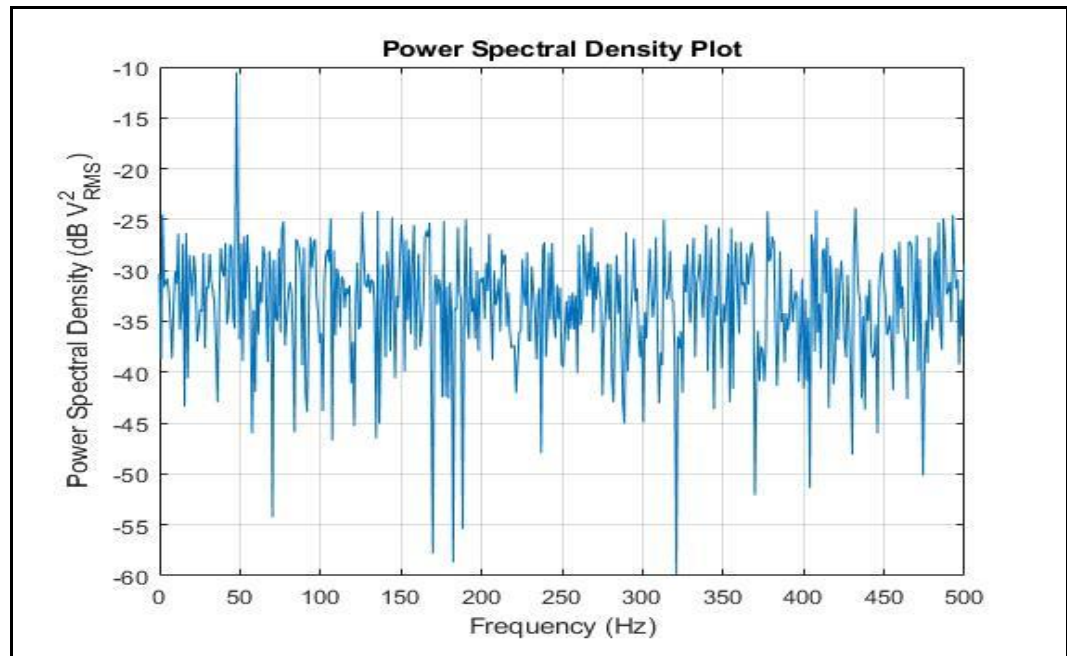
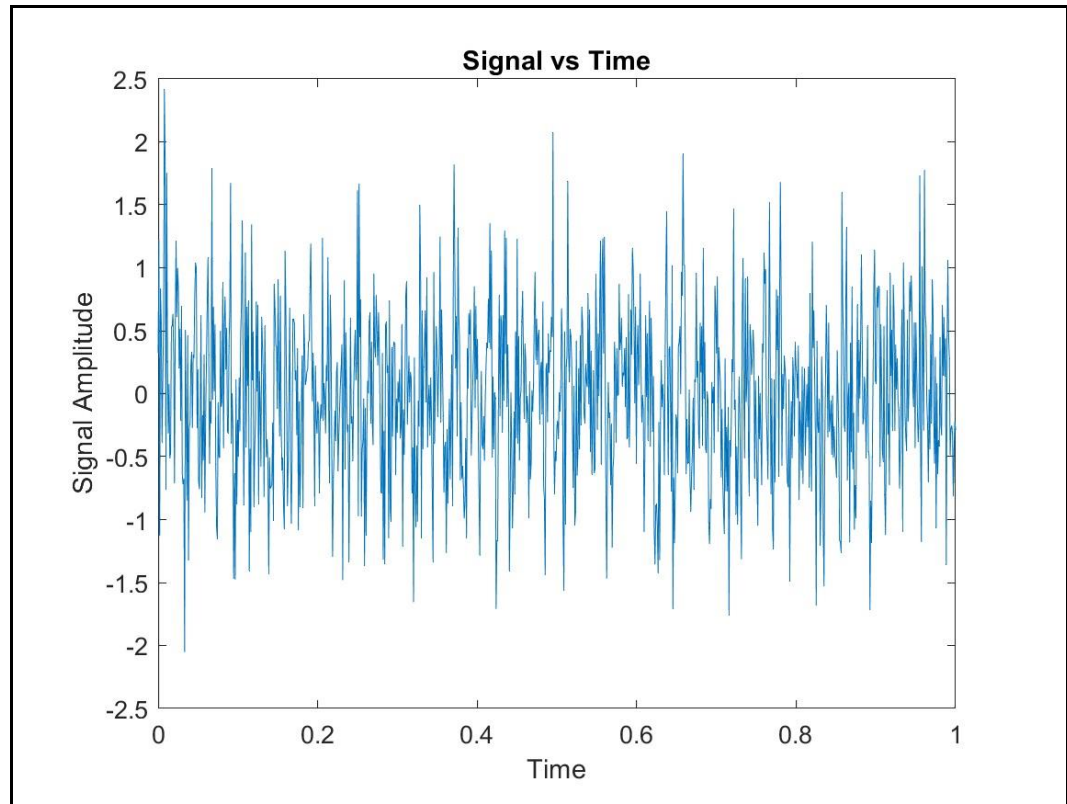
b. Record your response to 4.1.b below:



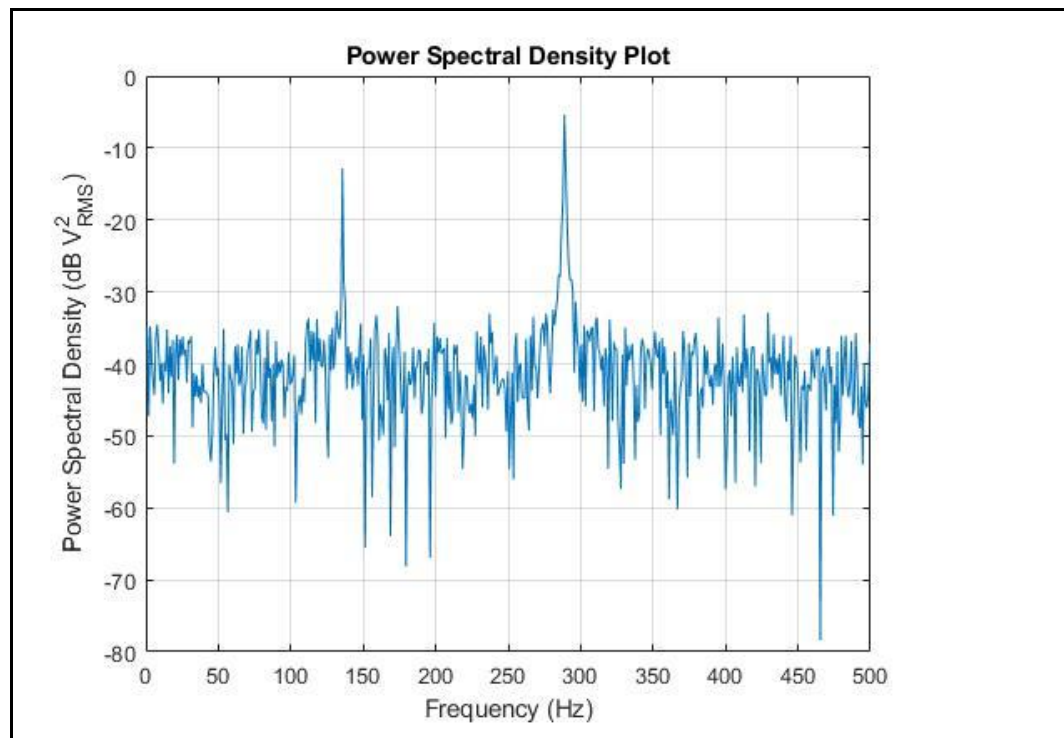
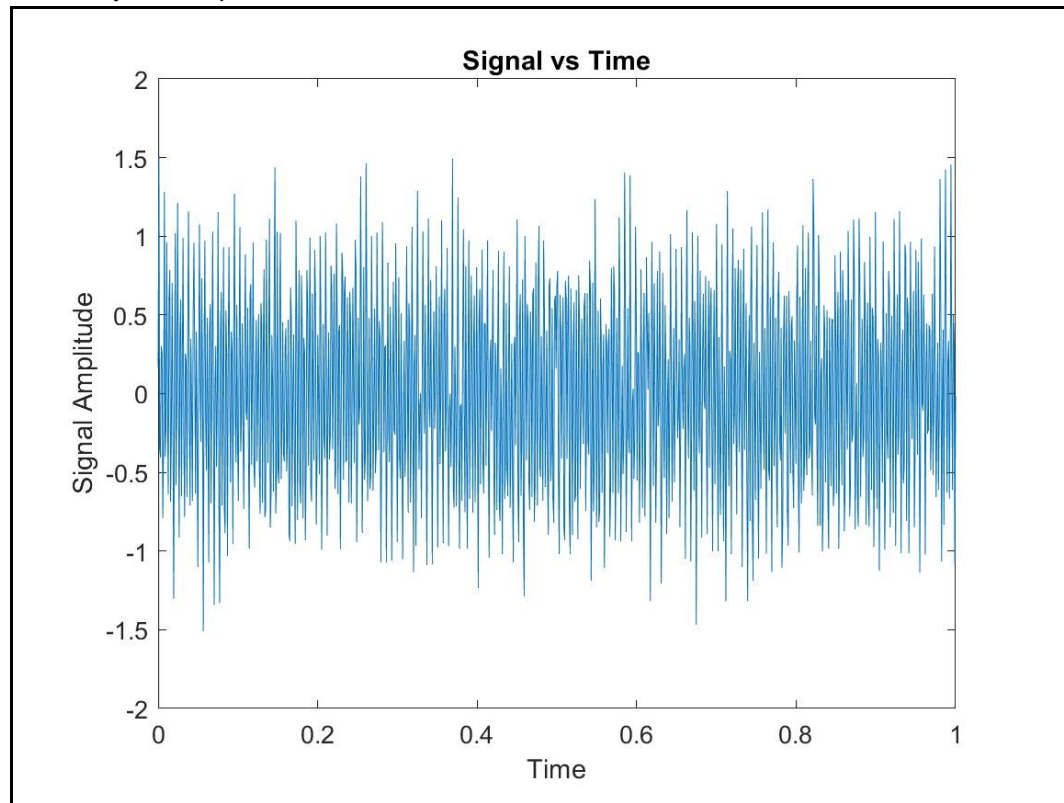
c. Record your response to 4.1.c below:



d. Record your responses to 4.1.d below:

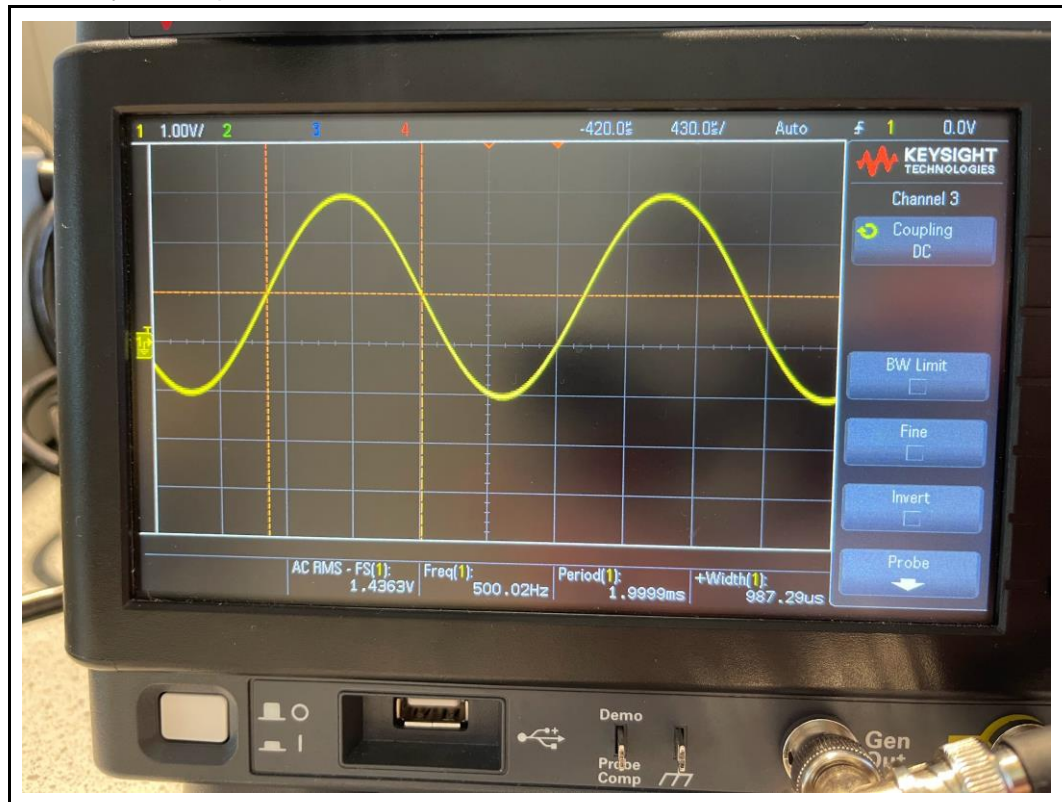


e. Record your responses to 4.1.e below:



## 4.2. Time and Frequency Domain

b. Record your response to 4.2.b below:



c. Record your response to 4.2.c below:

$V_{PP}$ :

4.1 V

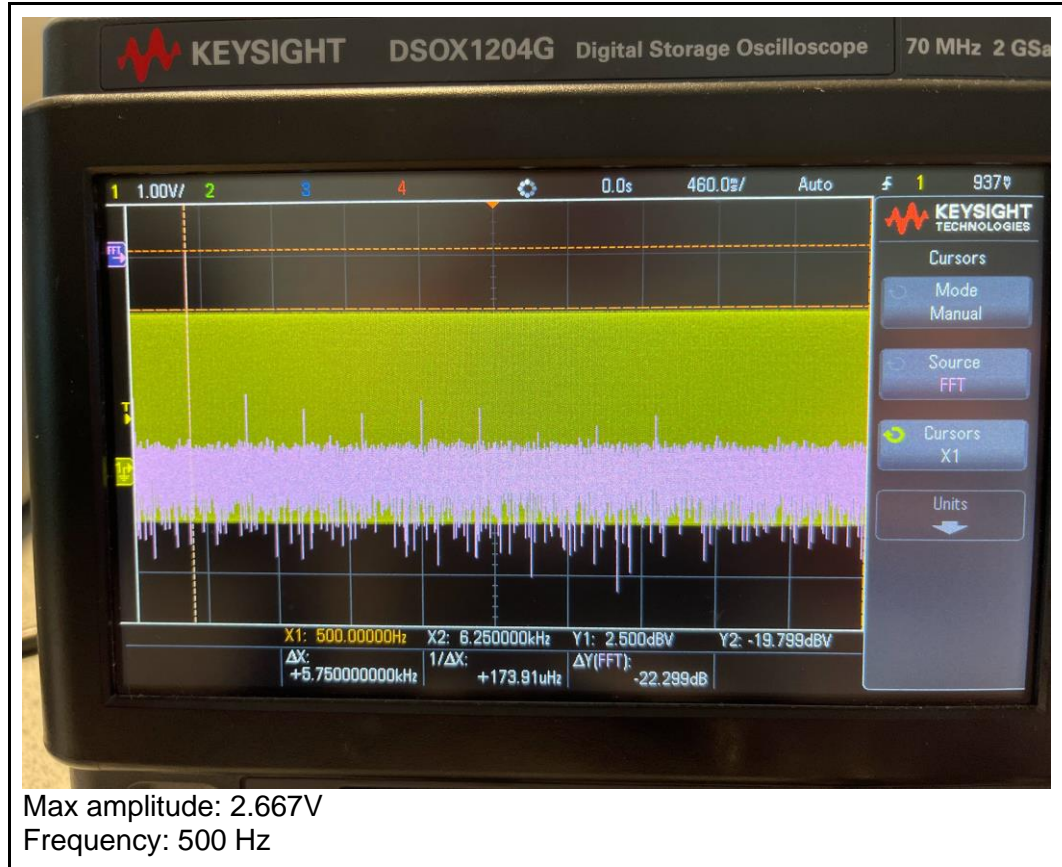
$V_{RMS}$ :

1.4 V

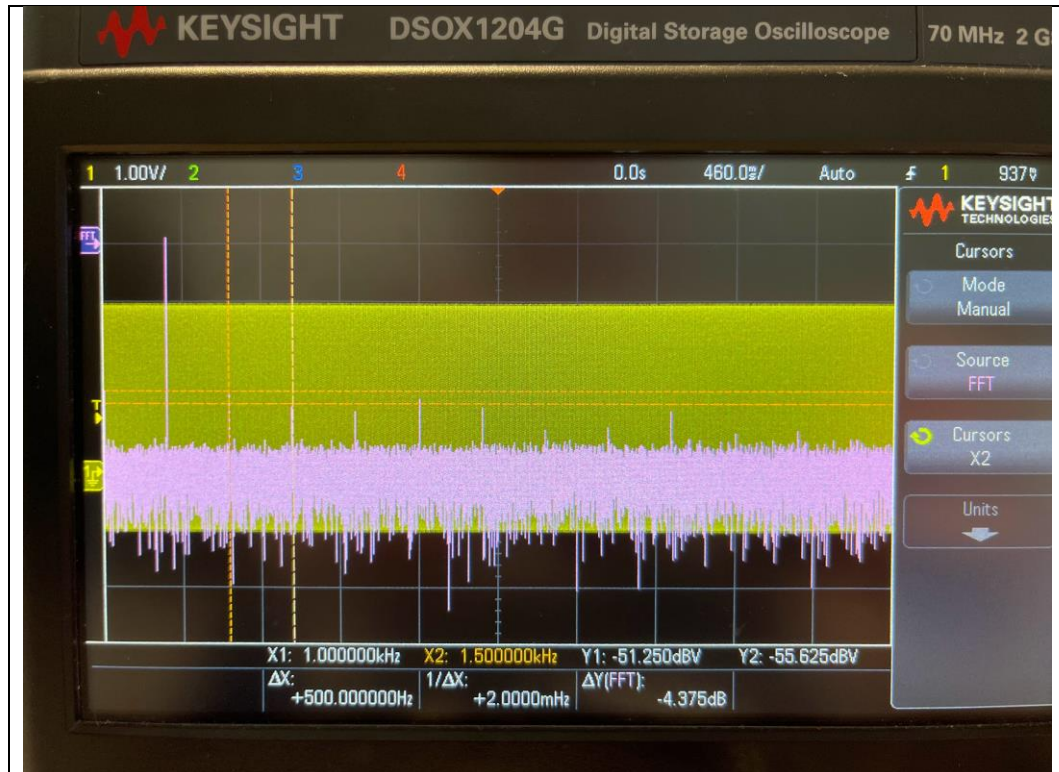
Frequency (Hz):

500 Hz

d. Record your response to 4.2.d below:





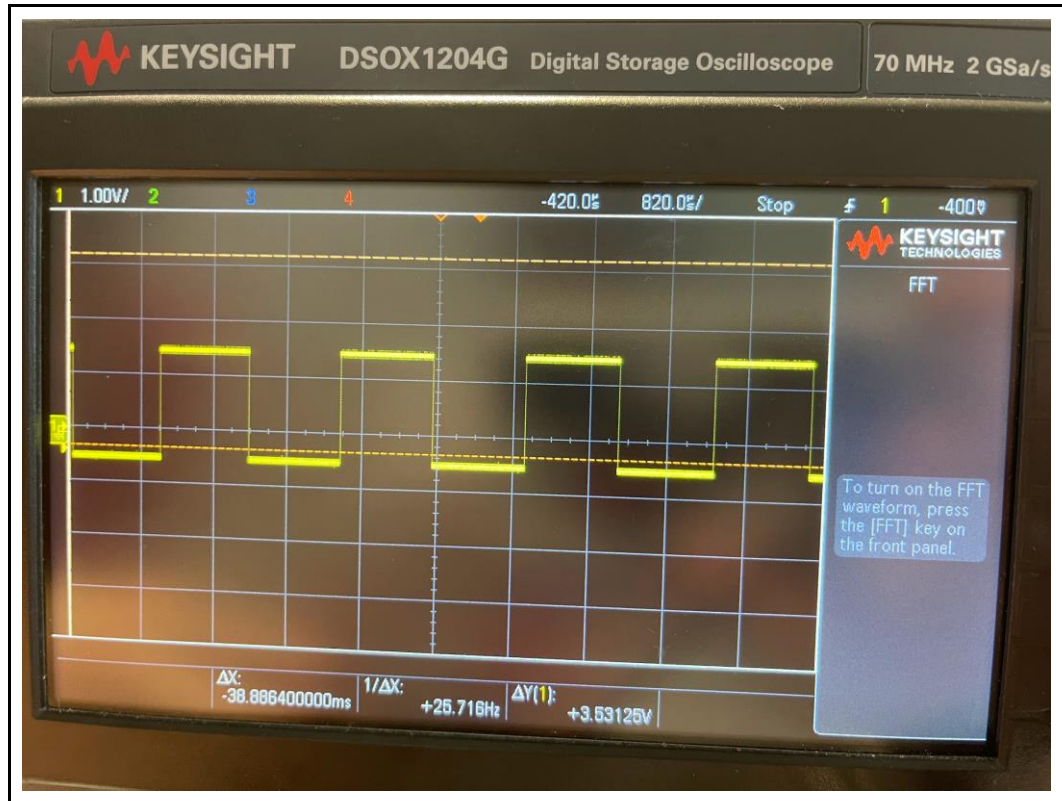


Max amplitude: 5.48 mV  
Frequency: 1 kHz

***Do not include of spectral peak corresponding to DC - it will be incorrect as appears on oscilloscope fft (see note in lab document for more information)***

Amplitude(s) [dBV <sub>RMS</sub> ]:	0.7397 dBV_RMS	-54.26 dBV_RMS	-58.63 dBV_RMS
Corresponding Frequency / Frequencies:	500 Hz	1000 Hz	1500 Hz

e. Record your response to 4.2.e below:

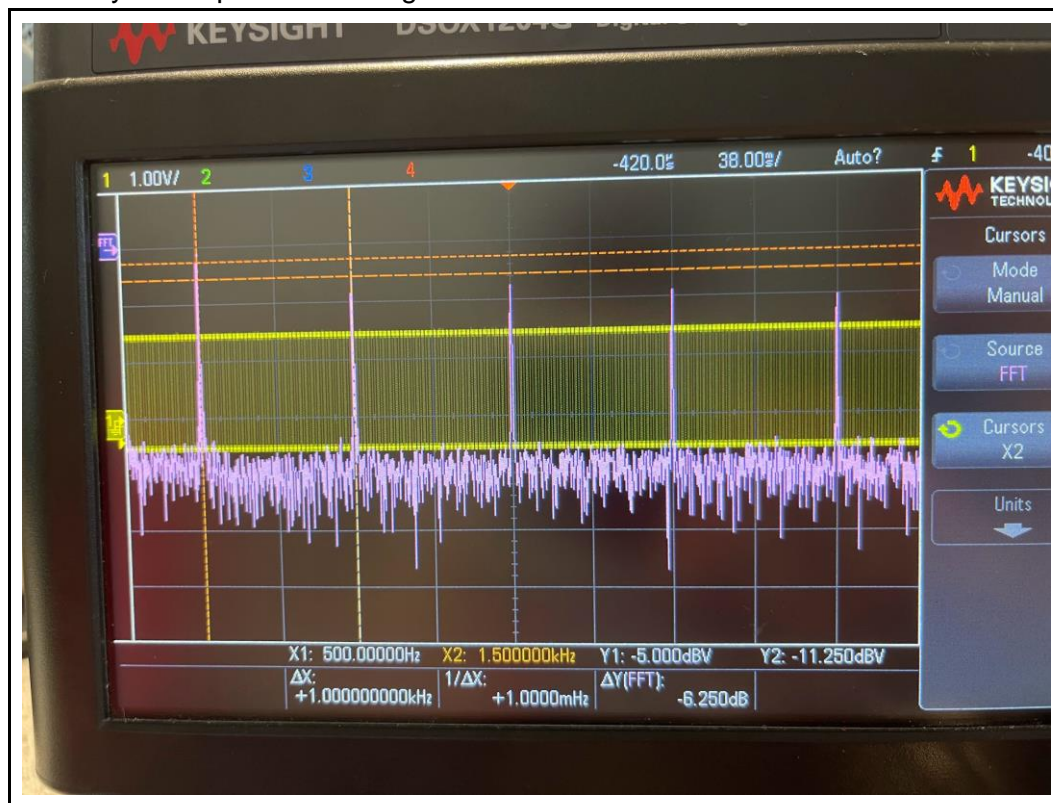


f. Record your responses to 4.2.f below:

$V_{PP}$ :	2.13 V
$V_{RMS}$ :	0.93 V
Frequency (Hz):	500 Hz



g. Record your responses to 4.2.g below:



**Do not include of spectral peak corresponding to DC - it will be incorrect as appears on oscilloscope fft (see note in lab document for more information)**

Amplitudes:	-8.01 dBV_RMS	-14.26 dBV_RMS	-27.38 dBV_RMS	-33.01 dBV_RMS
Corresponding Frequencies:	500 Hz	1500 Hz	2500 Hz	3500 Hz

#### 4.3. Low-Pass Filter Circuit

- a. Record your responses to 4.3.a below:

R value: 3.3 k $\Omega$

C value: 0.1  $\mu$ F

- d. Record your responses to 4.3.d below:



Amplitude Ch. 1 (50 Hz): 2.09 V

Frequency Ch. 1 (50 Hz): 50 Hz

Amplitude Ch. 2 (50 Hz): 1.35 V

Frequency Ch. 2 (50 Hz):

50 Hz

The low pass filter is impeding the 50 Hz frequency sine wave. This results in a lower amplitude wave for channel 2. However, 50 Hz is a relatively low frequency, so the impedance is not as high.

e. Record your responses to 4.3.e below:



Amplitude Ch. 1 (200 Hz):

2.1 V

Frequency Ch. 1 (200 Hz):

200 Hz

Amplitude Ch. 2 (200 Hz):

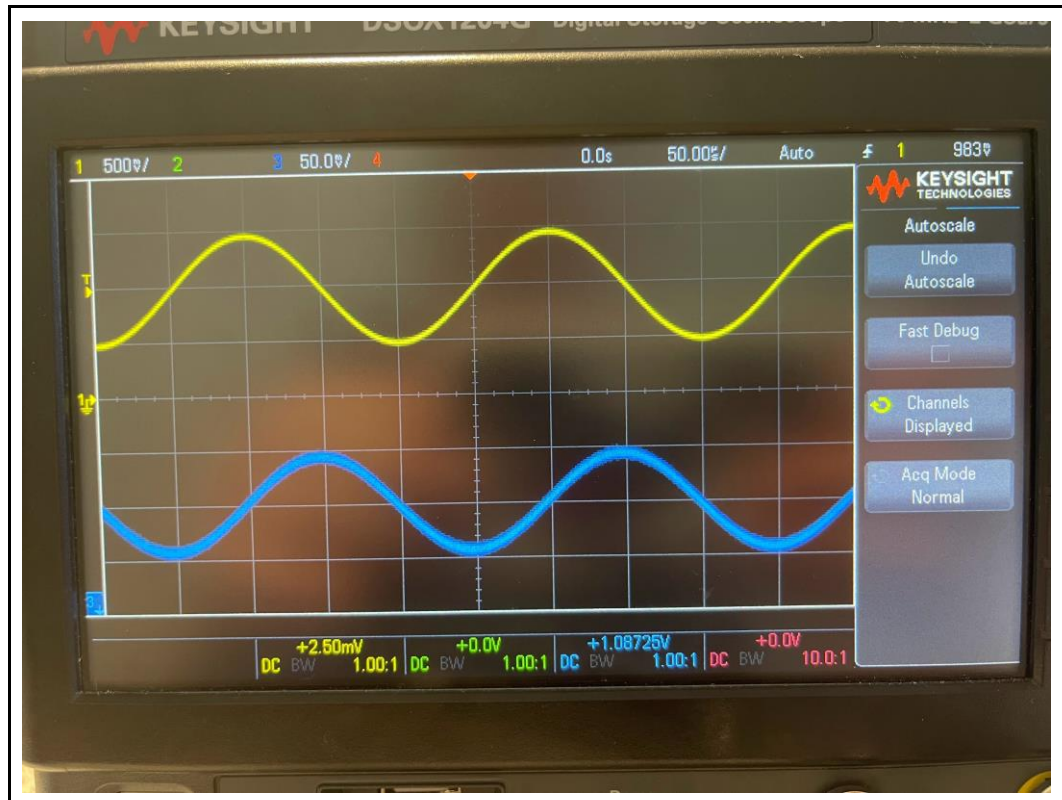
.470 V

Frequency Ch. 2 (200 Hz):

200Hz



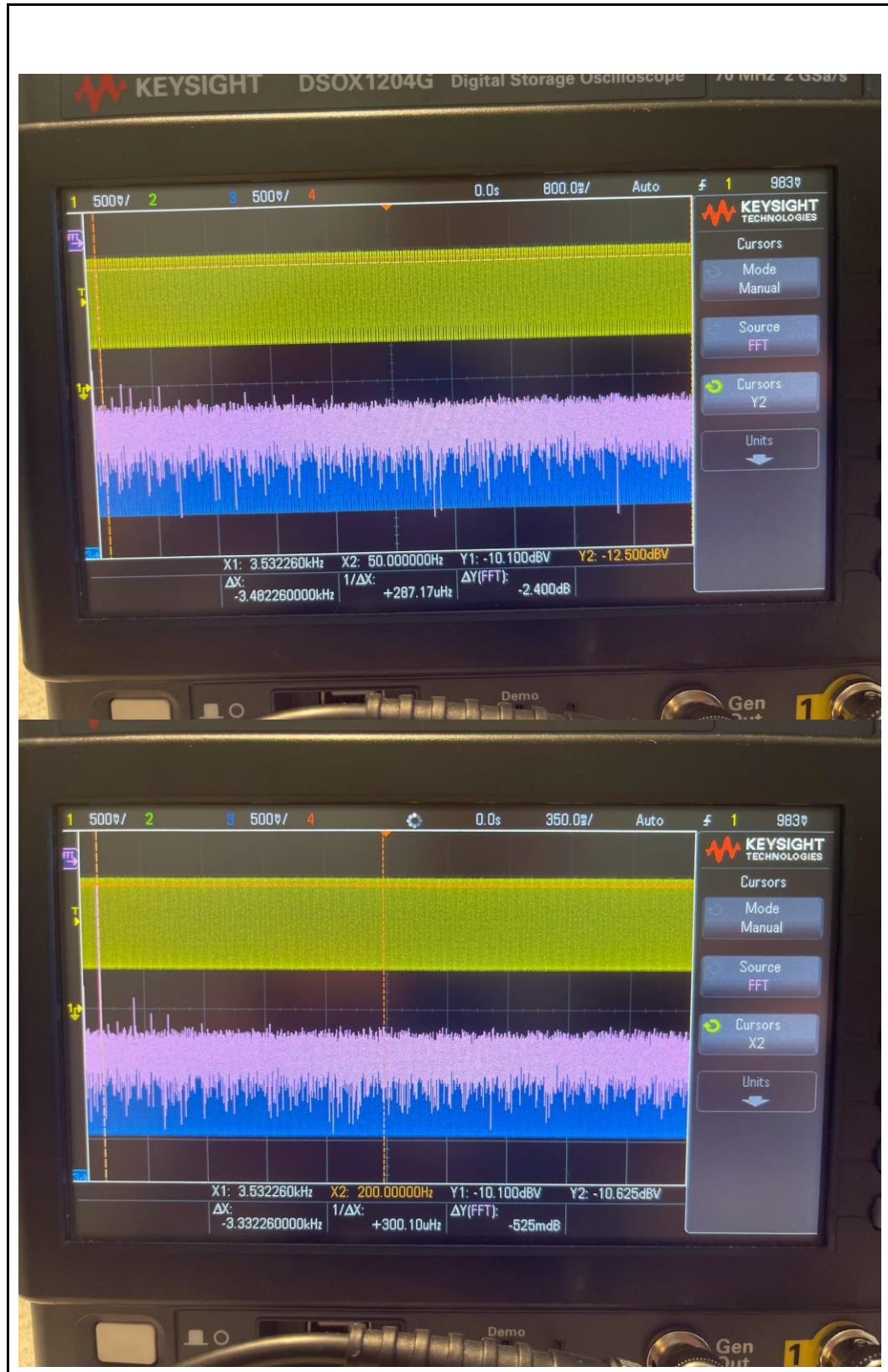
As the frequency gets higher, so does the complex impedance. This is consistent with the lower amplitude of channel 2 as compared to when we used the 50 Hz resistor.



Amplitude Ch. 1 (5 kHz):	2.05 V
Frequency Ch. 1 (5 kHz):	5 kHz
Amplitude Ch. 2 (5 kHz):	0.0257 V
Frequency Ch. 2 (5 kHz):	5 kHz

Now, with extremely high frequency, we see the most impedance. This results in the smallest amplitude from channel two after the high frequency sign wave has run through the low pass filter.

f. Record your responses to 4.3.f in the boxes below:





g. Record your response to 4.3.g below:

Input  $V_{PP}$  :

2.09 V

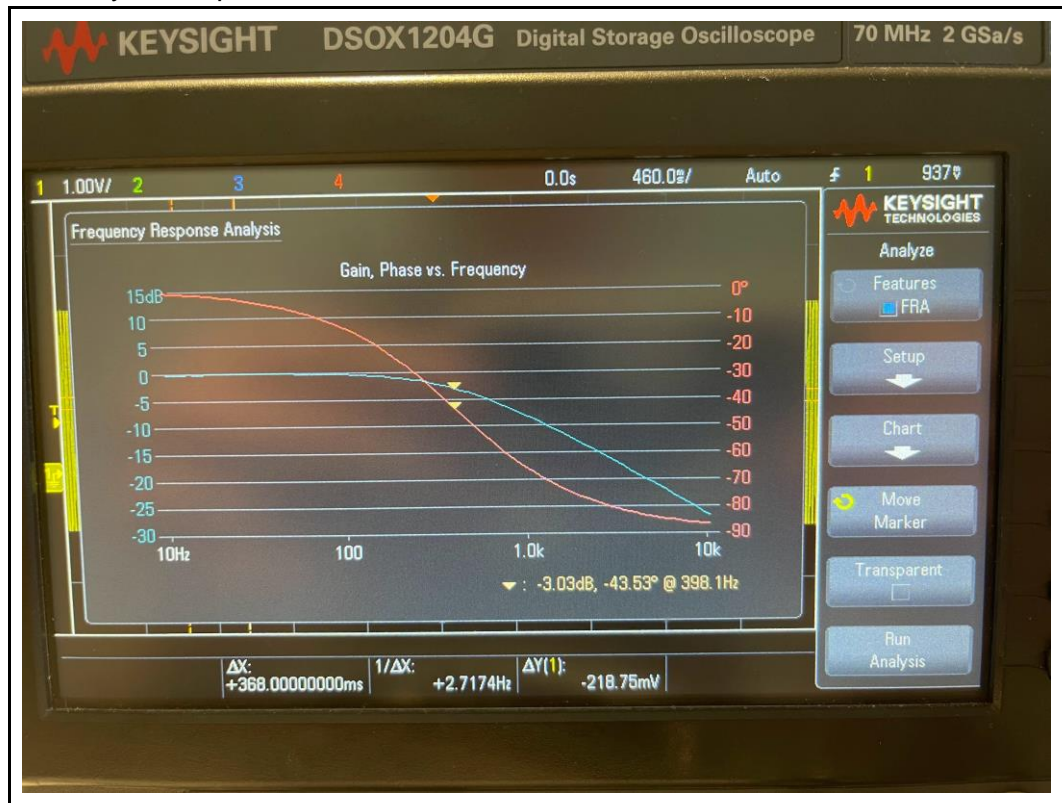
Frequency:

Output  $V_{PP}$  :

50 Hz	1.05 V
100 Hz	1.01 V
200 Hz	920 mV
500 Hz	680 mV
1 kHz	440 mV
2 kHz	260 mV
5 kHz	140 mV
10 kHz	100 mV



h. Record your response to 4.3.h below:



## 5. Analysis (25 pts)

### 5.1. Decibels

a. Record your response to 5.1.a below:

$$\text{dBV}_{\text{out}} = \text{dBV}_{\text{in}} + \text{dB}_{\text{gain}}$$

## 5.2. Signal Frequency Content

- a. Record your response to 5.2.a below:

Amplitude of 0.4 V at 50 Hz. Due to the fact this signal is periodic and sinusoidal, the frequency and amplitude are easy to read off.

- b. Record your response to 5.2.b below:

Amplitude is -2.73 dB at 50 Hz. We are confident in these answers because the frequency and amplitude of the periodic waveform in the magnitude spectrum plot are represented as peaks and therefore are easier to estimate within MATLAB.

- c. Record your response to 5.2.c below:

Amplitude of 2.5 V at 128 Hz. We are not confident in these answers because the frequency and amplitude of a non-periodic signal are very hard to read off in the time domain plot.

47.8 Hz with an amplitude of -11.81 dB. We are confident in these answers because the frequency and amplitude of the periodic waveform in the magnitude spectrum plot are represented as peaks and therefore are easier to estimate within MATLAB.

- d. Record your response to 5.2.d below:

Amplitude of 1.28 V at 128 Hz. We are not confident in these answers because the frequency and amplitude of a non-periodic signal are very hard to read off in the time domain plot.

145 Hz and amplitude of -13.654 dB  
288.7 Hz and amplitude of -6.16 dB

We are confident in these answers because the frequency and amplitude of the periodic waveform in the magnitude spectrum plot are represented as peaks and therefore are easier to estimate within MATLAB.

### 5.3. Time and Frequency Domain

- a. Record your response to 5.3.a below:

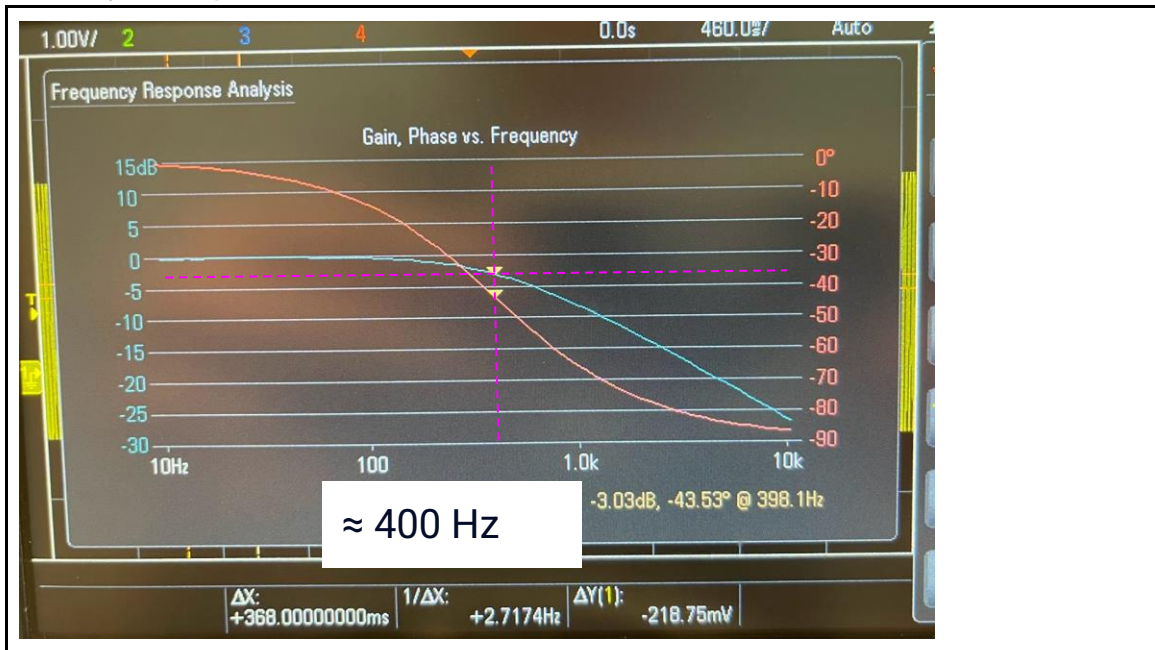
The amplitude and frequencies of the measured spectral lines were accurate as compared to what we determined in the prelab. We recorded a maximum amplitude in the prelab of 3 V. During the experiment, we measured a  $V_{out}$  of 2.667 V. This was determined by taking the 2.5 output dBV and using a 2 V input voltage to calculate the output voltage.

- b. Record your response to 5.3.b below:

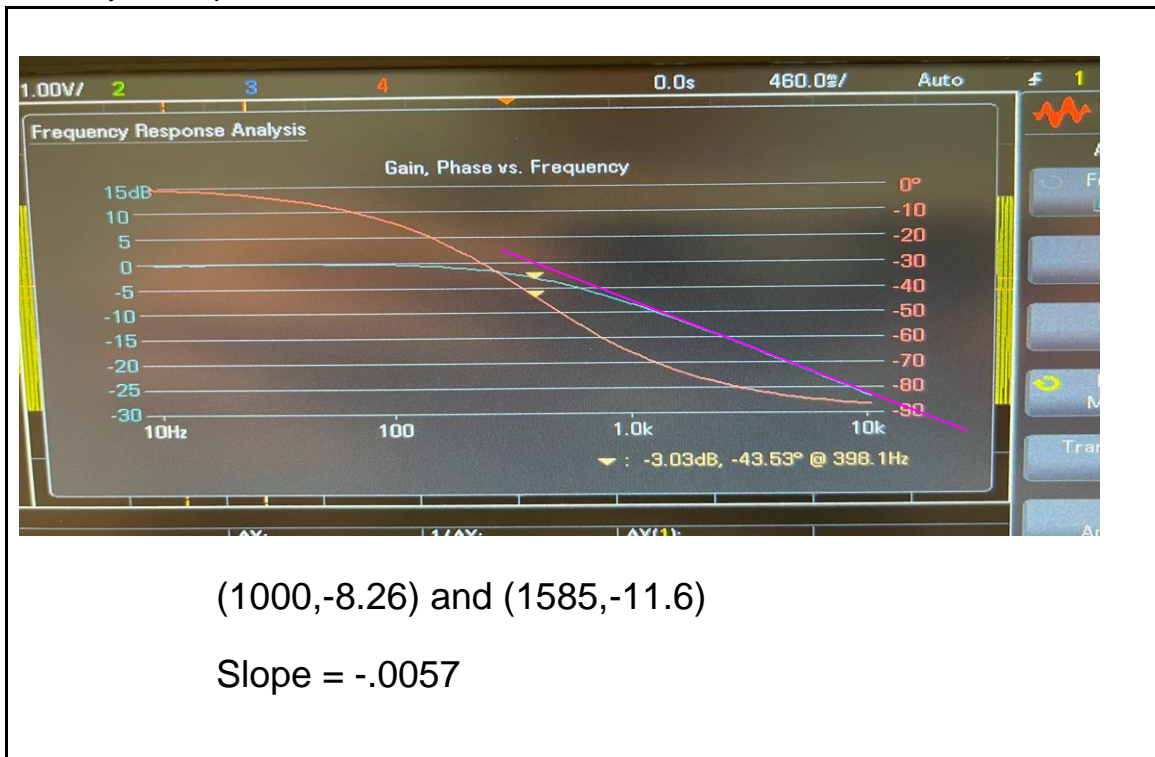
The amplitudes and frequencies of the spectral lines observed in the square wave closely approximated the expected values outlined in the pre-lab. Specifically, our measurements indicated an amplitude of -8.01 dBVrms at 500 Hz and -14.26 dBVrms at 1500 Hz. Comparing these findings to the prelab data, we noted amplitudes of -6.932 and -16.48 dBVrms for the 500 and 1500 Hz frequencies, respectively. While our measured values deviate from the expected ones by a value of 2, they can still be considered reasonably accurate. It's possible that the observed inaccuracy could be attributed to factors such as errors on our part during the experimentation.

#### 5.4. Low-Pass Filter

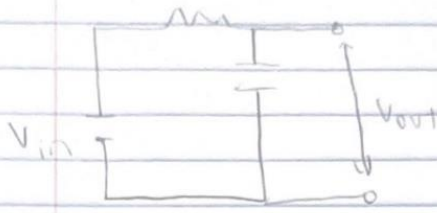
a. Record your response to 5.4.a below:



b. Record your response to 5.4.b below:



c. Record your response to 5.4.c below:



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

$$\omega = 2\pi f$$

$$-3 = -20 \times \log \sqrt{1 + (\omega RC)^2}$$

$$1.413 = \sqrt{1 + (\omega RC)^2}$$

$$0.998 = \omega RC \quad \omega_c = \frac{0.998}{RC}$$

$$-30 = -20 \times \log \sqrt{1 + (\omega RC)^2}$$

$$31.607 = \omega RC \quad \omega \text{ for } 8 \text{ kHz } f = 50265.48$$

$$RC = 6.288 \times 10^{-4} \text{ s} = \tau$$

$$0.629 \text{ ms}$$

If  $R = 3.3 \text{ k}\Omega$ ,  $C = 0.191 \text{ }\mu\text{F}$

With these R and C values a 100 Hz signal will attenuate -1.26 dB.

**Optional:** Do you have any useful comments to help us improve this lab?

As always, more help from lecture would be appreciated.