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

Spring 2022

Lab #__6__

Topic: Steady State Sinusoidal Response

Final Report (Pre-lab + Post-lab)

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1. Introduction

1.1. In this lab we dealt with an RC and RL Circuit and studied the Steady-State Sinusoidal Response of the two first order circuits and then compared them to each other as well as comparing their Transfer Functions. With each Circuit we compared the Steady-State output and the Sinusoidal Input. We calculated the gain, and time shift between the input and output signals in order to calculate the Phase Shift

2. Pre-Lab Assignment:

2.1. Find the Transfer Function $H(s) = V_{out}(s)/V_{in}(s)$

$$H(s) = \frac{s}{s+1*10^{-5}}$$

When we substitute different Frequencies in we get the following values:

Frequency	Magnitude of H(jω) (in V/V)	Phase of H(jω) (in radian)
1KHz	$1.5915 * 10^{-17}$	-1.5708
10KHz	$1.5915 * 10^{-18}$	-1.5708
100KHz	$1.5915 * 10^{-19}$	-1.5708

2.2. Use PSPICE to find the $v_{out}(t)$

- $\frac{759.927\mu - 999.5\mu}{1/1000} * 2\pi = -1.505$
- $\frac{84.159\mu - 100.03\mu}{1/10,000} * 2\pi = -9.97 * 10^{-1}$
- $\frac{9.864\mu - 10.005\mu}{1/100,000} * 2\pi = -8.86 * 10^{-2}$

Frequency	Magnitude of H(jω) (in V/V)	Phase of H(jω) (in radian)
1KHz	15.13279	-1.505
10KHz	1.87	$-9.97 * 10^{-1}$
100KHz	1.04974	$-8.86 * 10^{-2}$

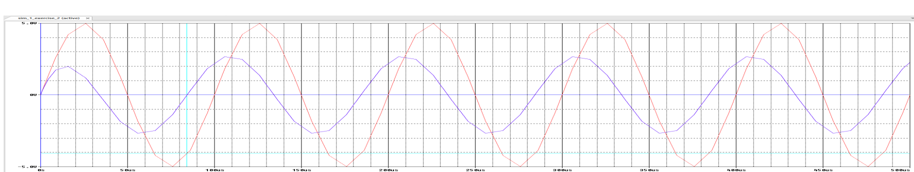

Figure 1 - 100KHz graph

3. Assignments:

3.1. Assignment 1

Frequency(f)	v_{in} (peak to peak)	v_{out}(peak to peak)	$\frac{v_{out}}{v_{in}}$(peak to peak)	$t_2 - t_1$ μs	Period (T) = 1/f	Phase Shift calculated	Phase Shift from oscillo scope
1 KHz	5.12 V	5.04 V	0.984	10.8μs	$\frac{1}{1,000}$	$6.78 * 10^{-2}$	-3.3°
10KHz	5.2 V	4.16 V	0.8	9.80μs	$\frac{1}{10,000}$	$6.15 * 10^{-1}$	-36.19°
100KHz	5.12 V	0.780 V	$1.52 * 10^{-1}$	2.28μs	$\frac{1}{100,000}$	1.41	-80.44°

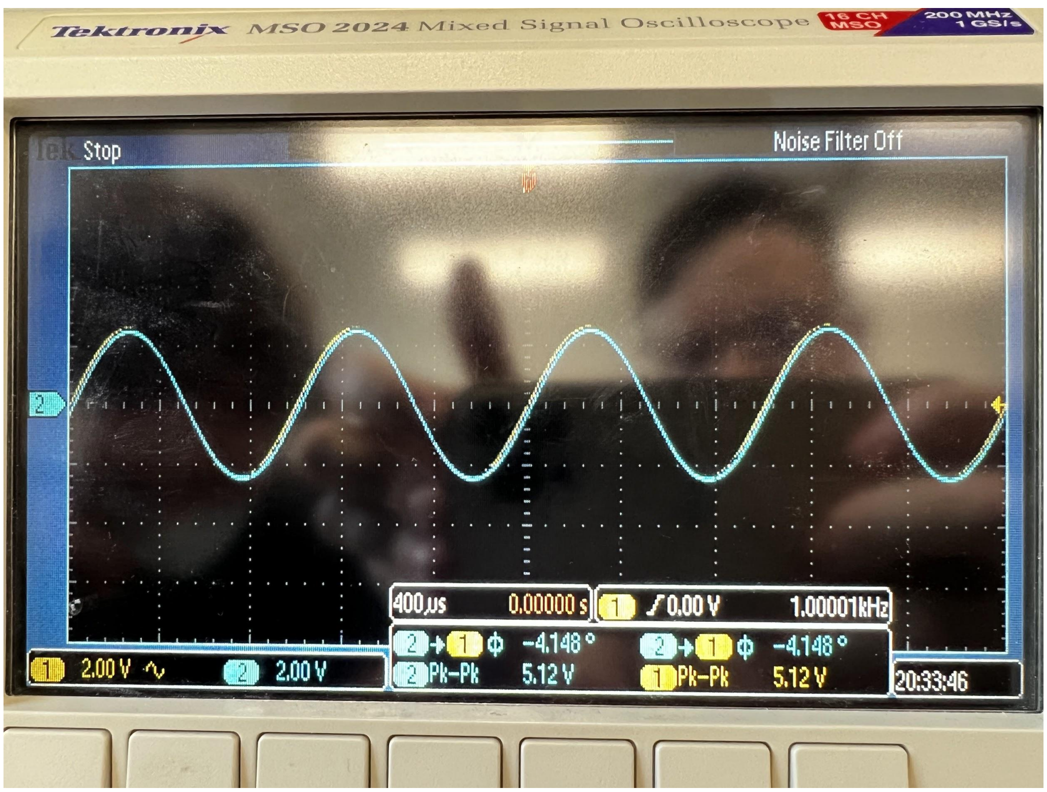

Figure 2: Circuit 1 - 1kHz

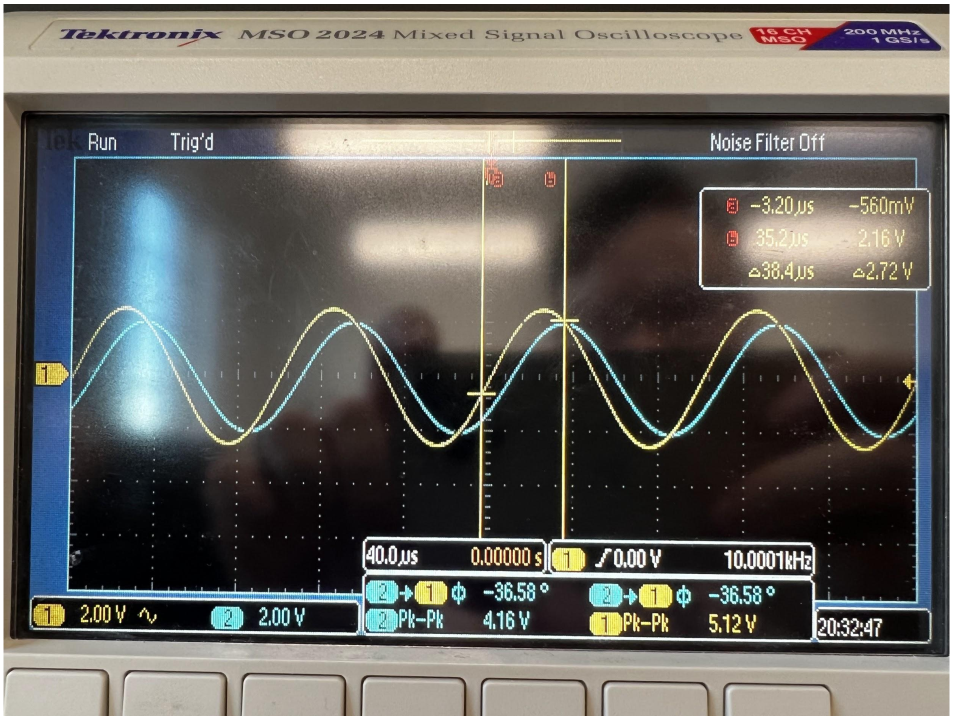

Figure 3: Circuit 1 - 10kHz

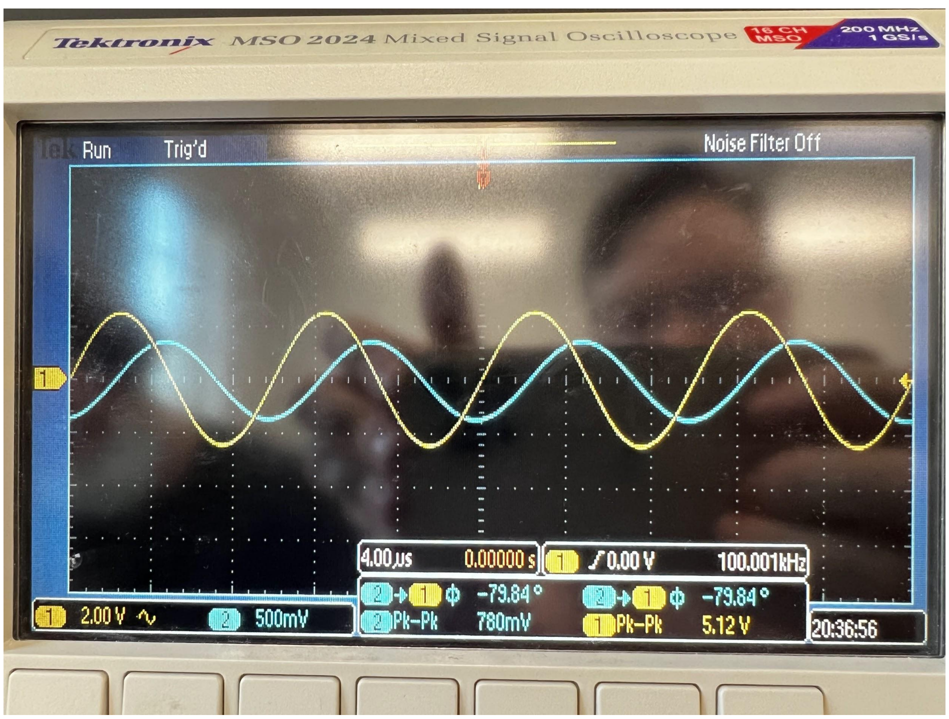

Figure 4: Circuit 1 - 100kHz

3.2. Assignment 2

Frequency (f)	v_{in} (peak to peak)	v_{out}(peak to peak)	$\frac{v_{out}}{v_{in}}$(peak to peak)	$t_2 - t_1$ µs	Period (T) = 1/f	Phase Shift Calculated	Phase Shift (Direct from oscilloscope Display)
1kHz	4.88 V	316mV	64.75	190µs	$\frac{1}{1,000}$	1.194	63.69°
10kHz	5.04 V	2.52 V	0.5	17.4µs	$\frac{1}{10,000}$	1.0932	58.41°
100kHz	5.12 V	5.04V	$9.84 * 10^{-1}$	136ns	$\frac{1}{100,000}$	$8.545 * 10^{-2}$	4.436°

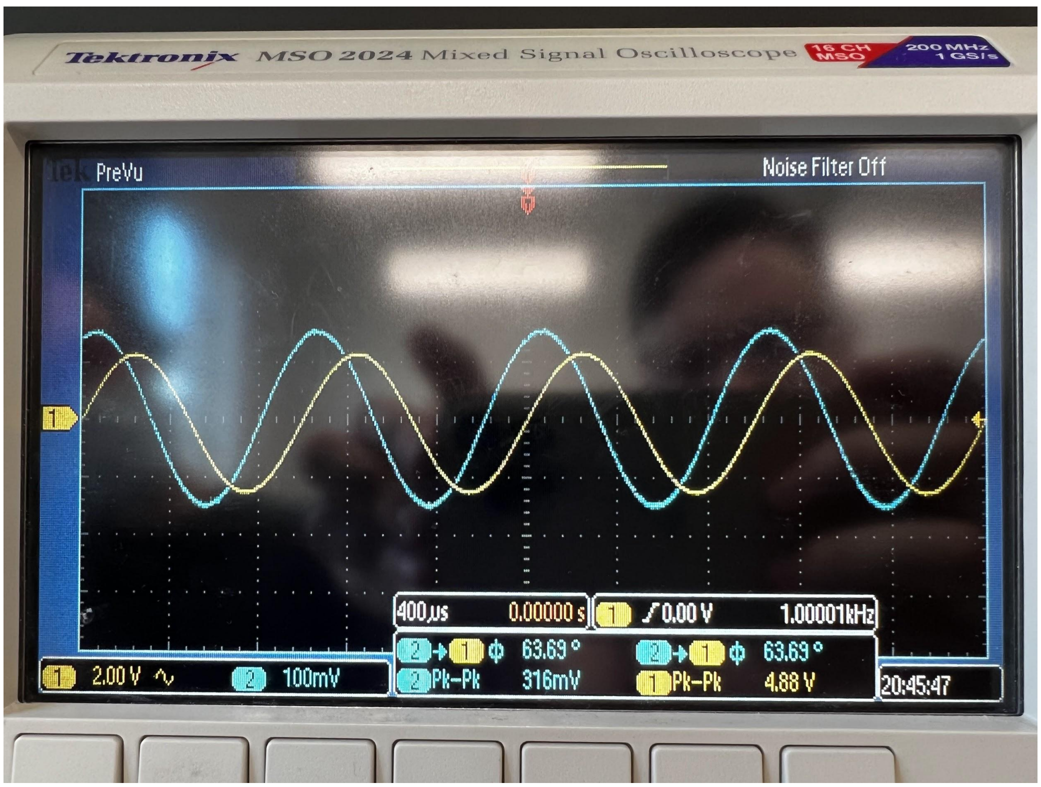

Figure 5: Circuit 2 - 1kHz

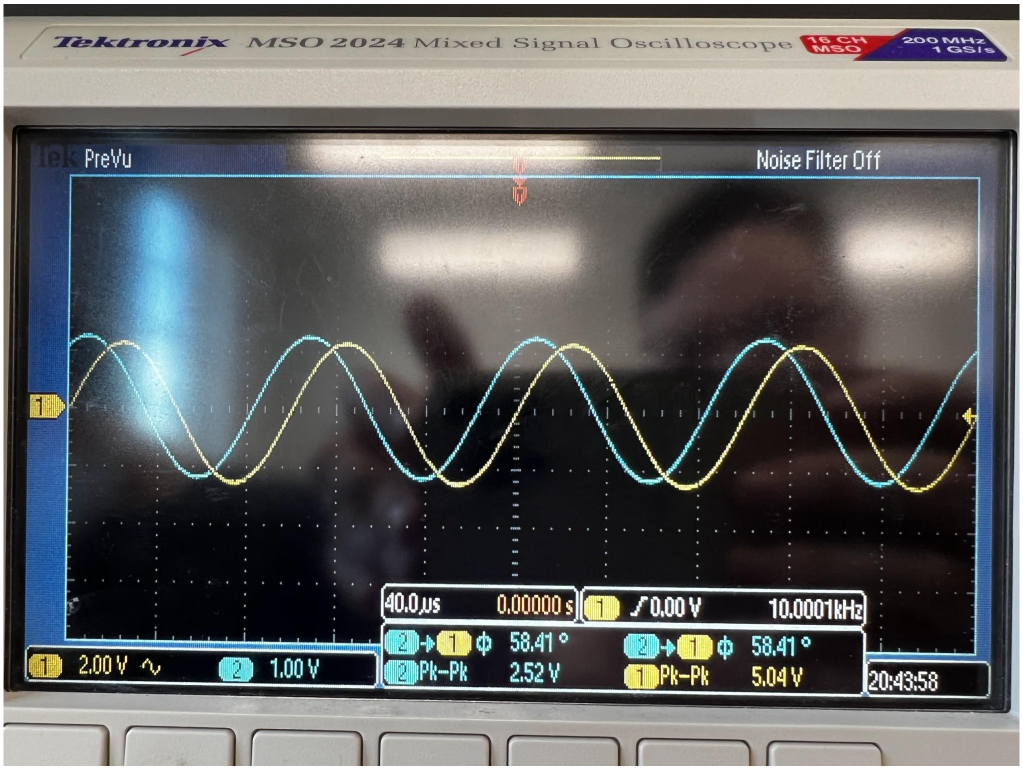

Figure 6: Circuit 2 - 10kHz

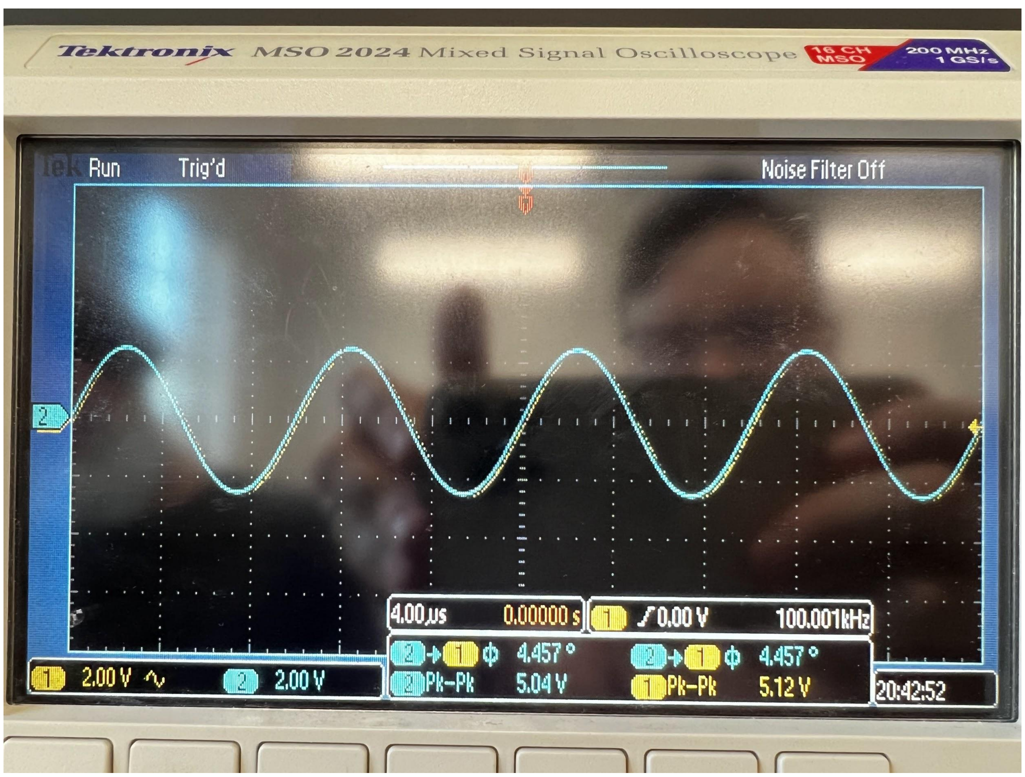

Figure 7: Circuit 2 - 100kHz

4. Discussion

4.1. As seen in our table, in Circuit 1 our v_{in} is equivalent to v_{out} at low frequencies. We can describe this behavior as a low pass filter. In Circuit 2 our v_{in} is equivalent to v_{out} at high frequencies. We can describe this behavior as a high pass filter. To understand why this happens we need to dive deeper into the workings of the capacitor and inductor.

When we take the Laplace transform for both Circuit 1 and Circuit 2 and find the transfer functions for each of them we end up with the following:

$$Circuit\ 1:\ H(s) = \frac{s}{s+1*10^{-5}}$$
$$Circuit\ 2:\ H(s) = \frac{s}{s+1*10^{5}}$$

As seen the transfer functions differ by the sign of the exponent 5. This creates different responses for Circuit 1 and Circuit 2. When applying the equation to Circuit 2 we can see that at a low frequency the term $1 * 10^{5}$ has a large impact on the outcome of the transfer function. At high frequencies the impact is minimal and the transfer function acts like the number 1. Impedance plays an active role in this process.

For Circuit 1 when the frequency is low the impedance of the Capacitor is high which allows for v_{out} to mimik v_{in}. When the frequency is high the impedance is low and this does not happen anymore.

4.2. As seen in the tables. The pattern in the two Circuits is opposite. Circuit 1 allows for the “passage” of low frequencies while Circuit 2 allows for the “passage” of high frequencies.