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

Spring 2022

Lab #__5__

Topic:___RLC Circuit__

Final Report (Pre-lab + Post-lab)

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TA Signature:	

1. Introduction

1.1. In this lab we dealt with an RLC circuit in series with each other. Our goal of the lab was to create and observe the resonance and damping features of two different RLC circuits with varying resistor values. We also worked on using a step input to find the damped natural frequency and damping time constant. Once we found all of these values and compared them to the RL or RC circuits we used in the past labs and noted the differences between the response of the circuit.

2. Pre Lab Assignment

2.1. Prelab Question 1

To determine if the circuit is underdamped, over damped or critically damped we have to compare the values of α (alpha) to ω_0 (omega)

$$\omega_0 = \sqrt{1/(LC)} = \sqrt{1/(10mH\ *\ 0.01\mu F)} = 100,000Hz$$

$$\alpha\ \ =\ R/(2L)\ =\ 510\Omega/(2\ *\ 10mH)\ =\ 25500Hz$$

From this we can tell that $\alpha^2 > \omega_0^{\ 2}$

Because of this we can tell that the circuit will be under-damped.

Decaying time constant **τ** = 1/α = $1/25500\ =\ 3.921\ *\ 10^{-5}s$

Damped Natural Frequency $\omega_d\ =\ \sqrt{\omega_0^{\ 2} - \alpha^2}\ =\ \sqrt{100000^2 - 25500^2}$

$$\omega_d\ =\ 9.66\ *\ 10^4 Hz$$

2.2. Prelab Question 2

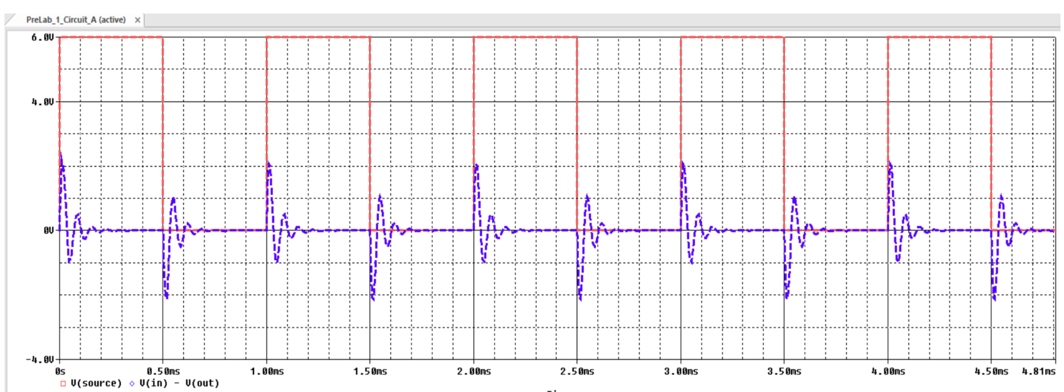

Figure 1 - Circuit A - Vsource: Red Small Dash, Vout: Purple Big Dash
X axis: Time (ns)   Y axis: Voltage(V)

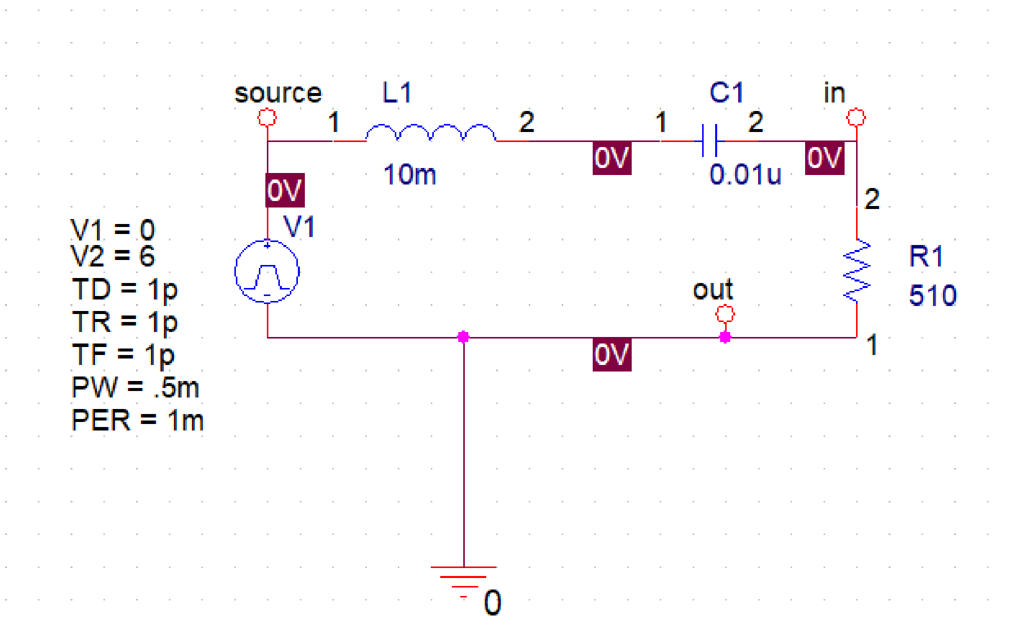

Figure 2 - Circuit A - Schematic

2.3. Prelab Question 3

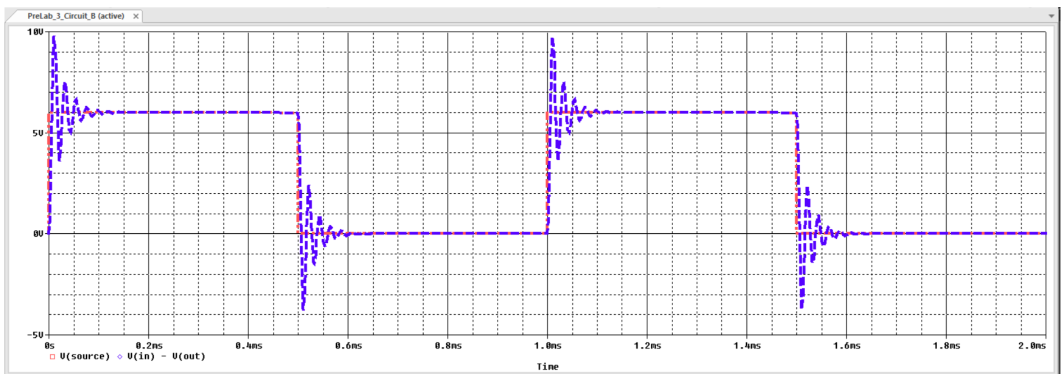

Figure 3 - Circuit B Under Damped -
Vsource: Red Small Dash, Vout: Purple Big Dash
X axis: Time (ms) Y axis: Voltage(V)

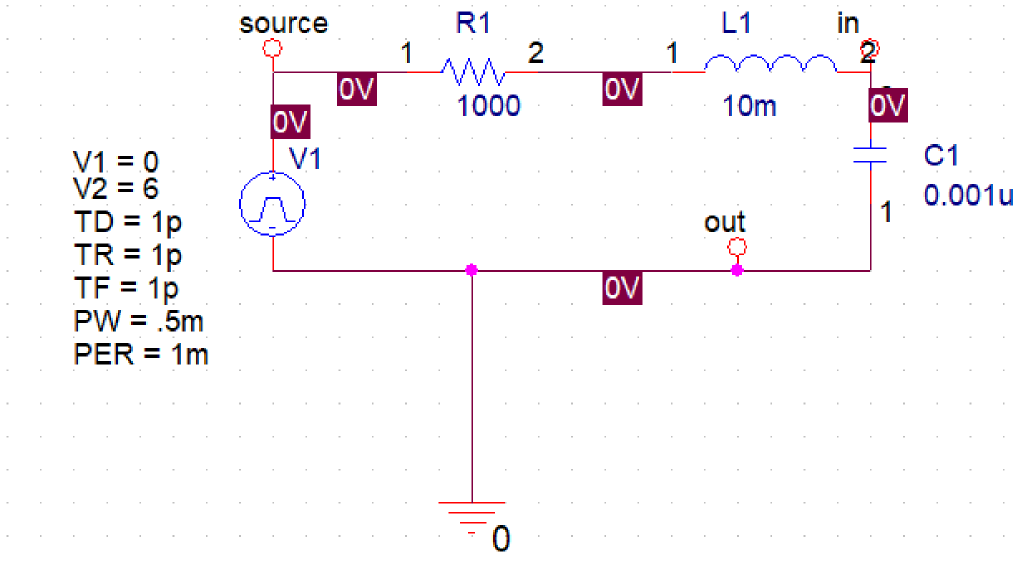

Figure 4 - Circuit B - Schematic - R = 1000Ω

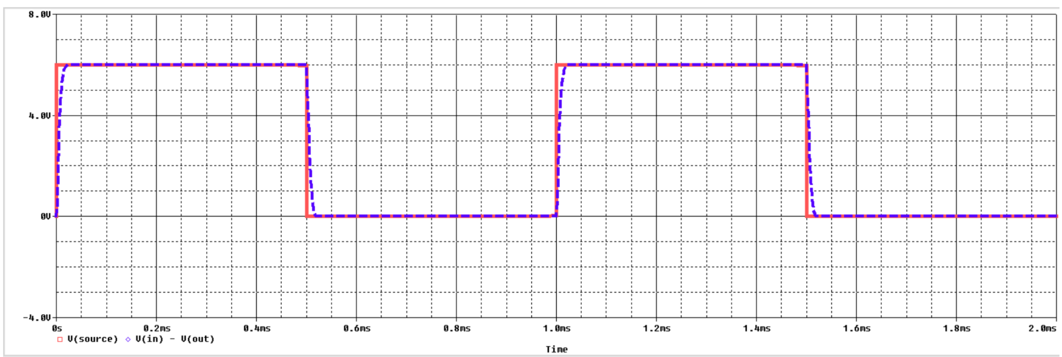

Figure 5 - Circuit B Critically Damped -
Vsource: Red Small Dash, Vout: Purple Big Dash
X axis: Time (ms)   Y axis: Voltage(V)

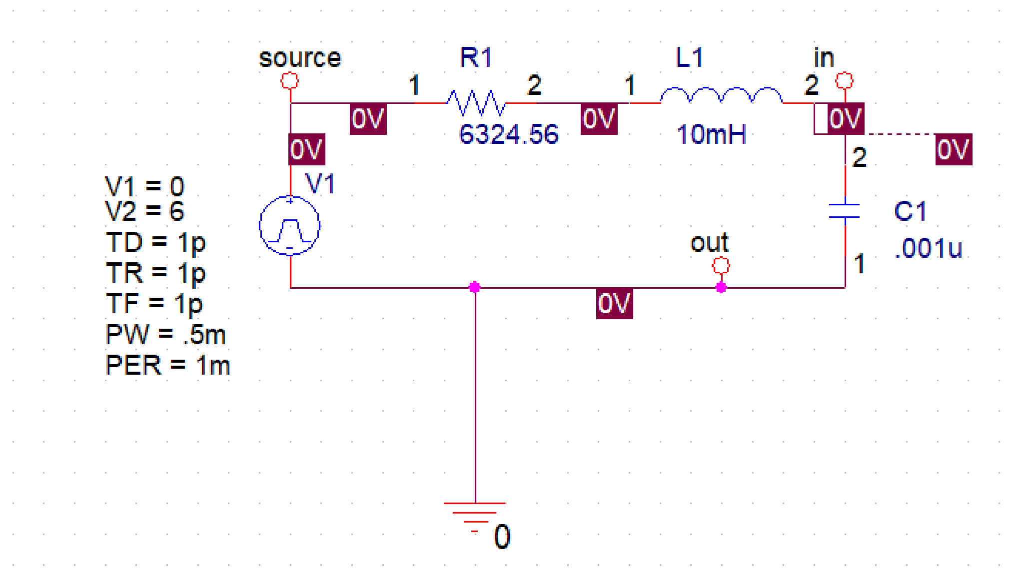

Figure 6 - Circuit B - Schematic - R = 6324.56Ω

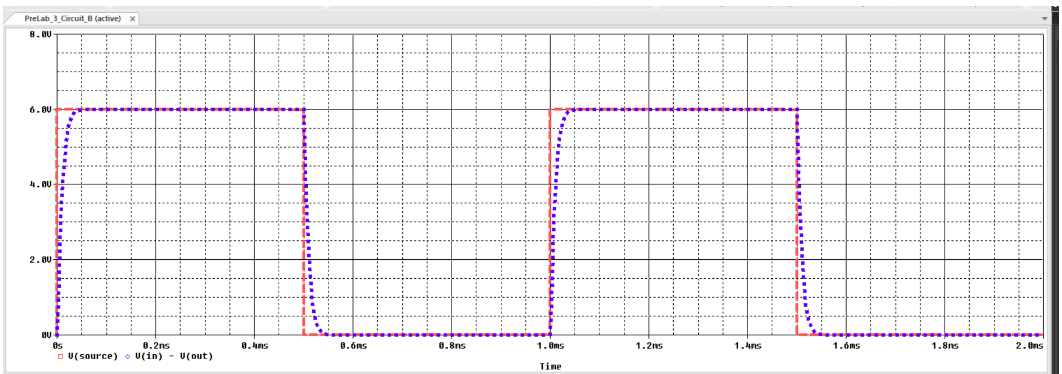

Figure 7 - Circuit B Over Damped -
Vsource: Red Small Dash, Vout: Purple Big Dash
X axis: Time (ms) Y axis: Voltage(V)

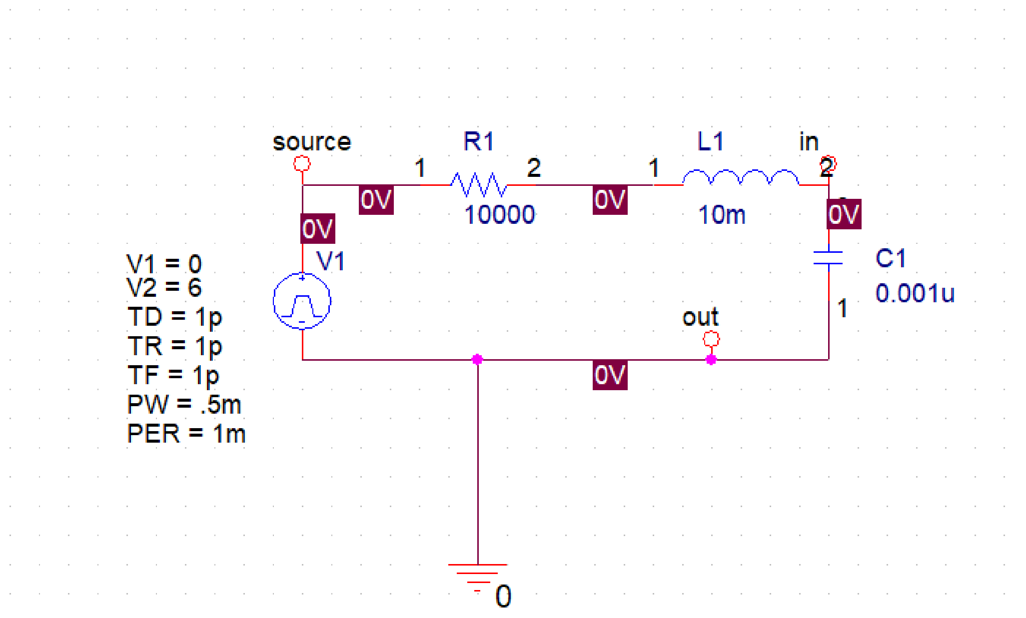

Figure 8 - Circuit B - Schematic - R =10,000Ω

2.4. Prelab Question 4

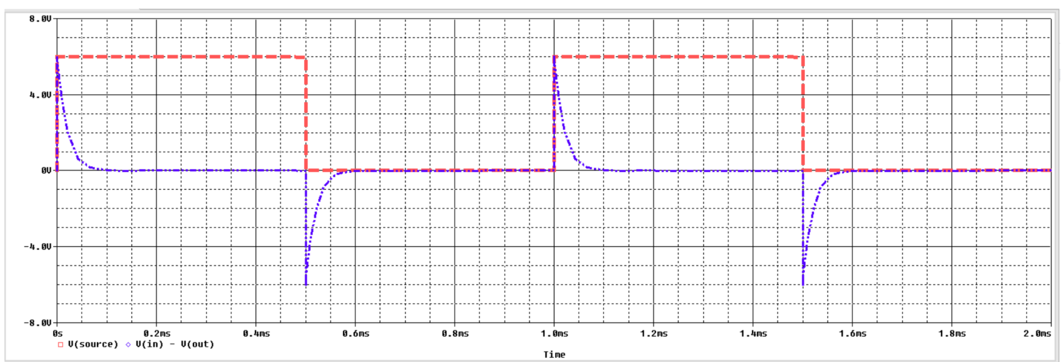

Figure 9 - Circuit Created τ = 20us -
Vsource: Red Small Dash, Vout: Purple Big Dash
X axis: Time (ms)   Y axis: Voltage(V)

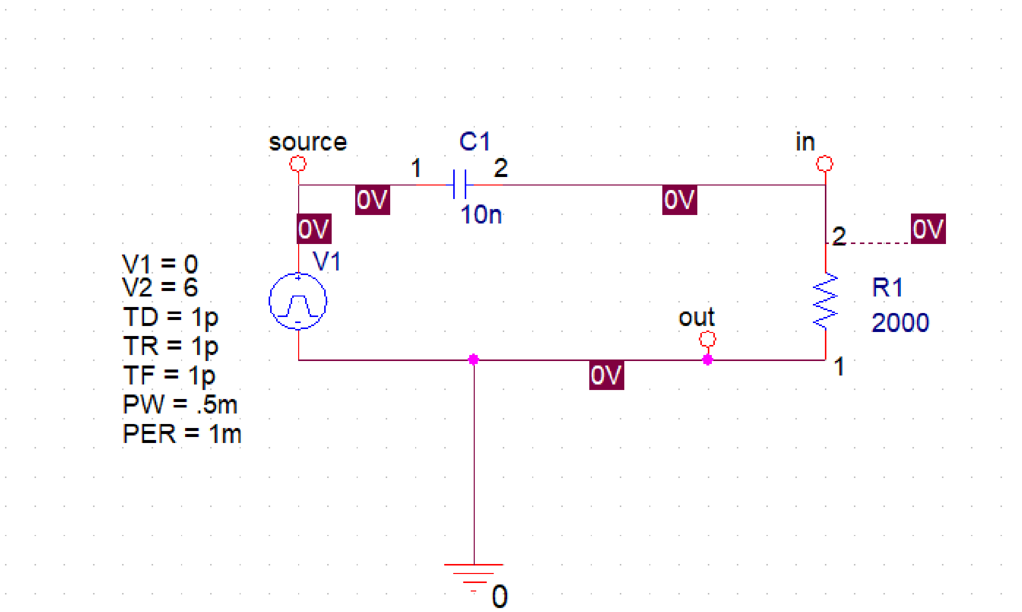

Figure 10 - Circuit Created - Schematic - R =2000Ω C = 10nF

3. Lab Assignments

3.1. Assignment 1

Circuit A given in the Lab Manual is an underdamped RLC series circuit. We can calculate this by comparing the α^2(alpha = R/2L) and ω_0^2(omega = $\sqrt{1/(LC)}$

There are 3 different scenarios when we compare these two values.

- $\alpha^2 < \omega_0^2$ - underdamped situation as seen in *Figure 11*
- $\alpha^2 = \omega_0^2$ - critically damped situation as seen in *Figure 13*
- $\alpha^2 < \omega_0^2$ - overdamped situation as seen in *Figure 14*

When we calculate α^2 we get

$$\alpha^2 = (R)/(2L) = (510\Omega\,/\,(2 * 10mH)^2 = 650250000$$

When we calculate ω_0^2 we get

$$\omega_0^2 = 1/(LC) = 1/(10mH * .01uF) = 10000000000$$

Comparing the two values we can see that $\alpha^2 < \omega_0^2$ which means our circuit is underdamped. This can be clearly seen in *Figure 11* exactly how it's supposed to be.

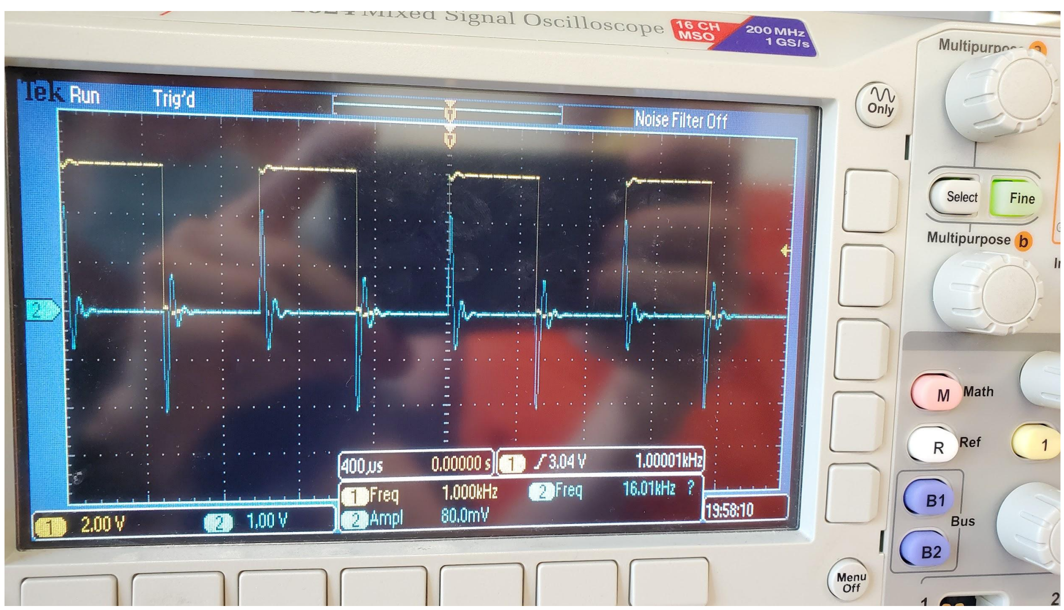

Figure 11: Underdamped

3.2. Assignment 2

	Resistance Value used in Hardware	Resistance Value used in Simulation (Pre-Lab)	Input Frequency Used
Underdamped	1.516kΩ	1kΩ	1kHz
Critically Damped	6.210kΩ	6.3248kΩ	1kHz
Overdamped	7.7838kΩ	10kΩ	1kHz

Table 1: Assignment 2

Figure 12: Underdamped

Figure 13: Critically Damped

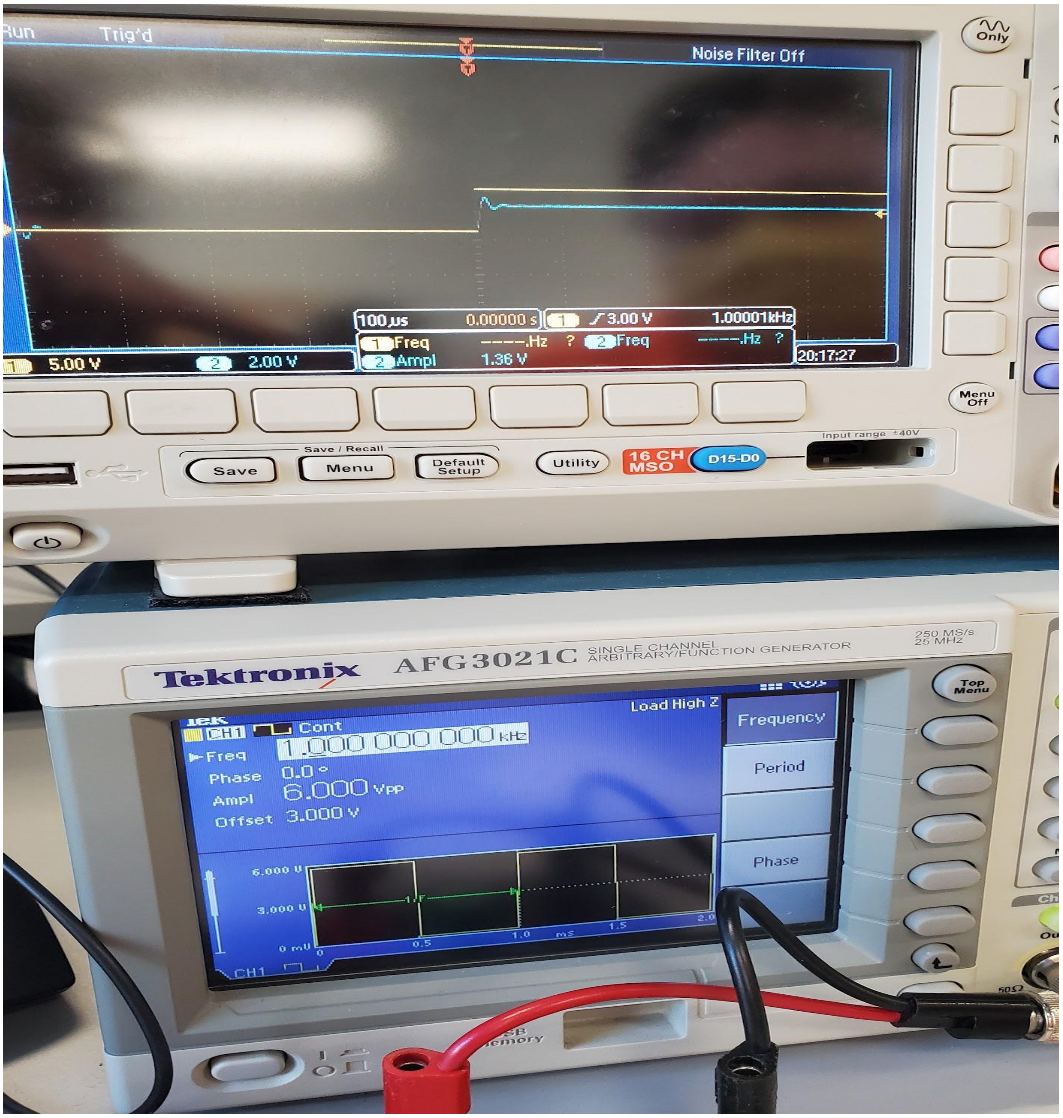

Figure 14: Overdamped

3.3. Assignment 3

Parameter	**Estimated** (Calculated using the resistance value used in Circuit)	**Measured**	**% Error**
τ, Time Constant	$1.314x10^{-5}$ s	$1.345x10^{-5}s$	1.97%
ωd, Damped Natural Frequency	$3.07x10^{5}Hz$	$3.021x10^{5}Hz$	1.63%
R, Resistance used in Circuit	1.5168Ω		

4. Discussion

4.1. When working with different resistances, it was interesting to note that the RLC circuit was much more calculation heavy than was RL or RC. That was because of the necessity to calculate the natural frequency and the damped natural frequency.

4.2. The response types were also variable, under, critically and overdamped instead of just changing the time constant of the responses; one unique to inductors and the other to capacitors.

4.3. When RLC is critically damped, it shows a similar pattern to a step response of a RL or RC circuit, however. And, by extension, we could look at the overdamped response as being similar to changes to the time constant of an RL or RC circuit.