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Course: ECE 3210

Subject: Lab 01, Chapter 1: Lab Basics

Date: August 28, 2025

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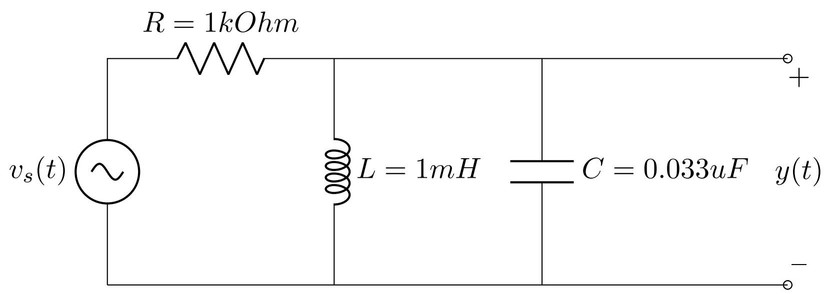
1 Introduction

In Lab 1 we looked over an RLC circuit. In the initial laboratory component, we passed a 2 V_{pp} sine wave through the RLC circuit at varying frequency values to determine the gain and phase of the output voltage. This method of continuous-signal processing is very helpful for designing passive filter to filter out or expose voltages at a set of frequencies we would like those voltages to appear.



$$v_s(t) = \cos(20000t\pi)V \tag{1.1}$$

2 Theory

Using theory we developed in ECE1270 we were able to find the impedance of the circuit components (Resistor, Inductor, and Capacitor) using the equations below:

$$Z_R = R \tag{2.1}$$

$$Z_C = \frac{1}{jwC} \tag{2.2}$$

$$Z_L = jwL \tag{2.3}$$

After applying these impedance equations to the circuit you then would be able to simplify using a voltage divider to find the output voltage or current of your circuit by multiplying your output phasor by your input equation.

3 Results

The curves are shown below as part of this lab. Figure 1 is the numerical and analytical estimation of the voltage in $y(t)$. Figure 2 is the analytical estimate of the 10kHz sine wave passed through the circuit, combined with the measured input voltage and output voltage for that circuit. We noted that the phase on the expected output voltage and the measured output voltage was similar but not quite the same. Figure 3 is a sweep of frequencies across the circuit (100Hz–100kHz). This graph includes the data for the gain across the frequency sweep as well as the phase across the frequency sweep.

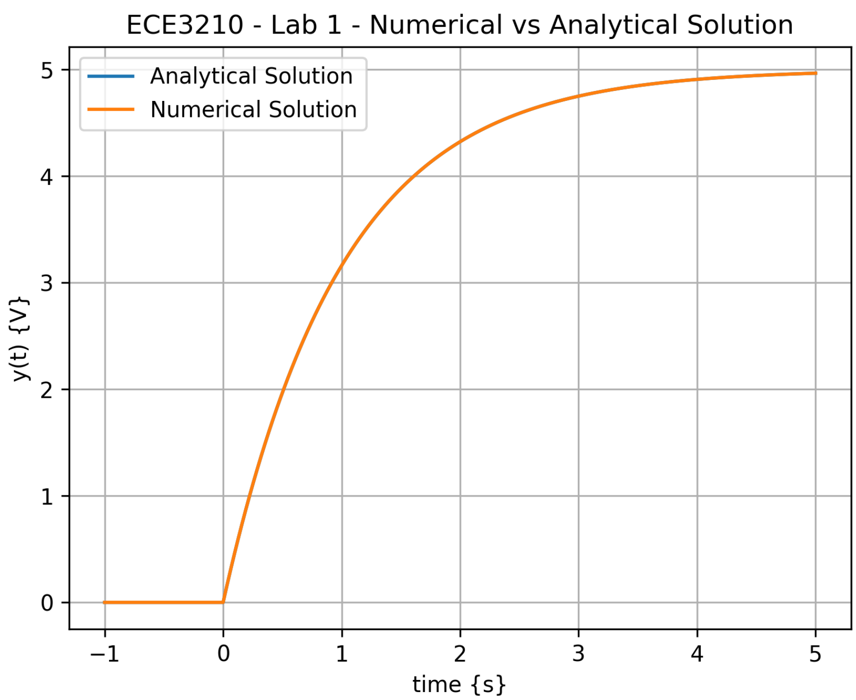


Figure 1: Numerical vs Analytical Solution

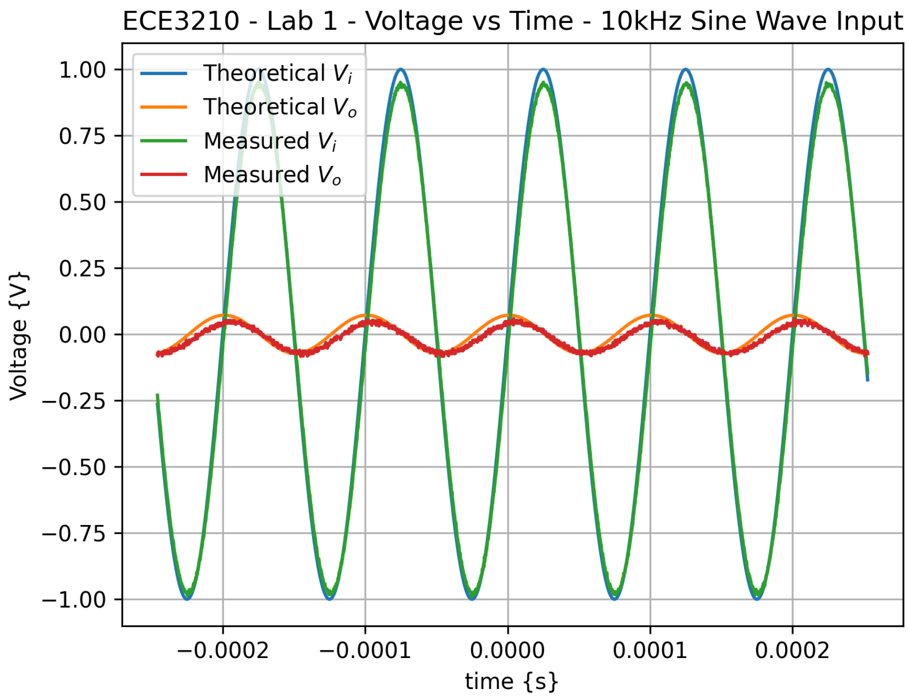


Figure 2: Voltage vs Time, 10kHz Sine Wave Input

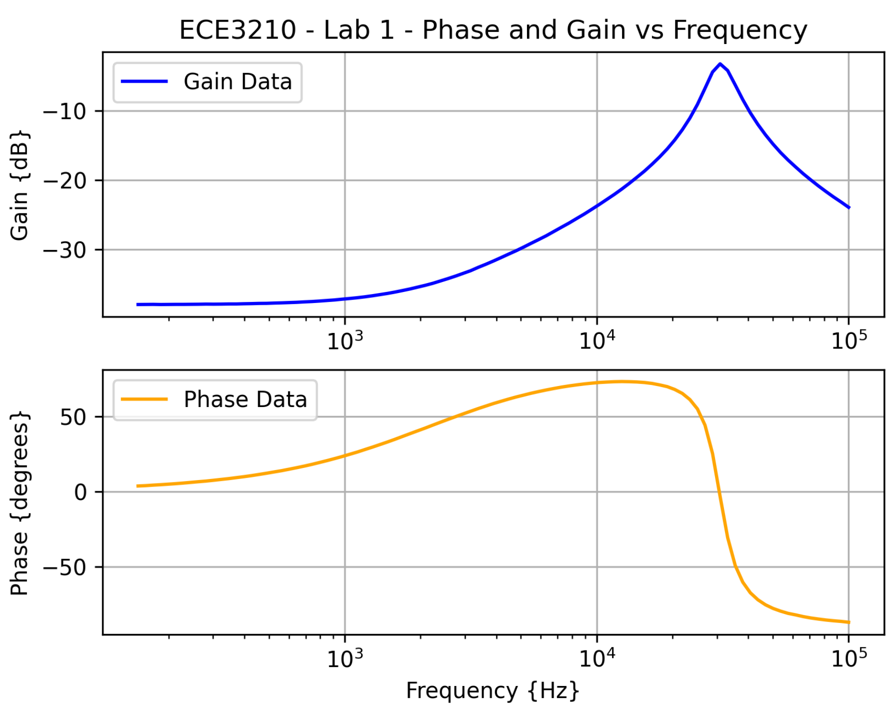


Figure 3: Phase and Gain vs Frequency

4 Discussion and Conclusions

I found $Fig.3$ to be particularly interesting in this lab. We see that it is a bandpass filter that is letting frequencies around 27kHz $\rightarrow$ 35kHz through and everything else is being attenuated. We learned in ECE2260 that the circuit components here can be adjusted change where this f_o or w_o is located and to what degree the frequencies are attenuated or amplified.

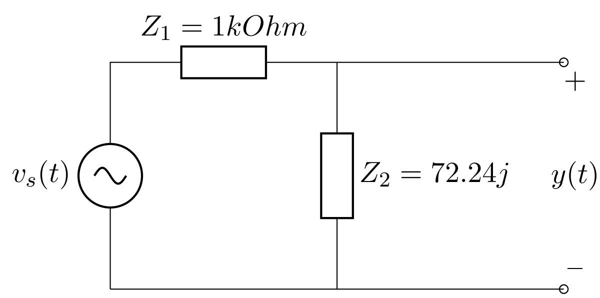
$$w_o = \sqrt{\frac{1}{LC}}, w_o = 27.705kHz \tag{3.1}$$

$$w_{c_1} = -\frac{1}{2RC} + \sqrt{(\frac{1}{2RC})^2 + \frac{1}{LC}}, w_{c_1} = 25.4kHz \tag{3.2}$$

$$w_{c_2} = \frac{1}{2RC} + \sqrt{(\frac{1}{2RC})^2 + \frac{1}{LC}}, w_{c_2} = 30.2kHz \tag{3.3}$$

Using equations 5, 6, and 7 we are able to calculate some things about the parallel RLC circuit. Unfortunately, our data does not match up correctly. There seemed to be a + 3-5kHz shift in the measured data compared with the calculated values. This could be due to faulty components that we did not test before we constructed the circuit.

$Fig.2$ was also an interesting representation of the data that we were able to gather in the lab. In order to graph the expected voltage I found the impedance of all circuit components and simplified.



$$y(t) = v_s(t)\frac{Z_2}{Z_1 + Z_2} \tag{4.1}$$

$$y(t) = 72.05\cos(20000t\pi + 1.5)mV \tag{4.2}$$

It is my belief that imperfect component values adjusted the phase and the gain by a small amount in our expected voltage curve relative to the measured output voltage of our circuit. However, they are still quite similar. I can also see that our 1 V_{pp} curve does not quite reach 1 V at its peaks or its troughs. This is due to operator error. We should have checked the curve and adjusted it as necessary to make sure that it was truly the waveform that the function generator was supposed to be creating for us.

$Fig.1$ was quite boring. Although it was quite interesting to see the numerical approximation of the voltage across the capacitor as time increases. I could see this being incredibly useful if you were working on a machine or a program needed programs to run quickly and efficiently with minimal overhead from imported modules. The below equations allowed us to graph the expected voltage as time increased.

$$y(t) = \int_{-\infty}^{t} 5e^{-x}\,dx \tag{5.1}$$

$$y(t) = 5 - 5e^{-t}\,V, \quad t \geq 0 \tag{5.2}$$