Student: Ty Davis

Course: ECE 3210

Subject: Lab 1, Lab Basics

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1 Introduction

This is the first lab of the semester in which we cover the lab basics. We start by doing a brief analysis of a simple RLC circuit (shown in Fig. 1), and then measuring and comparing the results of our computation. Afterward, we practice some python by writing an integral approximation function and comparing it to an analytical solution of that integral.

2 Theory

2.1 Circuit Analysis

The RLC circuit that we analyzed in this lab is shown in Fig. 1. Using simple phasor analysis we found that the magnitude of $y(t)$ is 72.056 mV, and the phase angle is 1.499 rad or 85.87°. Thus, $y(t)$ can be represented as the following.

$$y(t) = 0.072 \cdot \sin(2\pi \cdot 10000t + 1.499) \tag{1}$$

2.2 Computation

Equation 2.1 given in the Lab Manual is shown below.

$$y(t) = \int_{-\infty}^{t} 5e^{-\tau} u(\tau) d\tau \tag{2}$$

The integral can be simplified to the following:

$$y(t) = 5 \cdot \int_{0}^{t} e^{-\tau} d\tau$$

And this equates to

$$y(t) = \begin{cases} -5e^{-t} + 5 & t \geq 0 \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

As will be shown later in the report, this analytical solution will be compared against the py_cumtrapz function we've written in python which approximates integrals by summing trapezoids.

3 Results

3.1 Circuit Analysis

The purpose of the lab was mostly to remind ourselves with how to use the lab equipment and familiarize ourselves with the techniques we will employ in later labs. After a brief analysis of the circuit in Fig. 1, we plotted the expected input and output, and compared to the measured values we grabbed from the oscilloscope when we built and measured the circuit. Refer to Fig. 2.

Then we practiced gathering the data from a frequency sweep of the oscilloscope. The results can be found in Fig. 3.

3.2 Computation

In the computation section of the lab we plot the results of our analytical solution shown in Eq. 3 against the approximation we achieved from our py_cumtrapz function. The results can be found in Fig. 4.

4 Discussion and Conclusions

As can be seen in Fig. 2, the observed values follow very close to the analysis that was calculated. The observed output values especially lined up right with the analytical solution given in Eq. 1. The result of the phasor circuit is another sine wave that has a decreased magnitude (down to just 72 mV from the 1 V input wave), and it is $\sim 85°$ ahead of the input signal. These numbers line up great with the values shown in the Bode plots from Fig. 3, where the magnitude of the signal is somewhere around -22 dB and the phase is just shy of $90°$.

In the computation portion of the lab, we compared our py_cumtrapz function (which approximates the integral of any function) against the analytical solution we found in Eq. 3. We made the comparison over the range $t \in [-1, 5]$. The results from Fig. 4 show that our implementation of the py_cumtrapz function and the analytical solution are nearly identical, certainly within the tolerance of an approximation that uses only 70 points within the range for a calculation. Separating the range into more subdivisions would certainly yield a more accurate result.

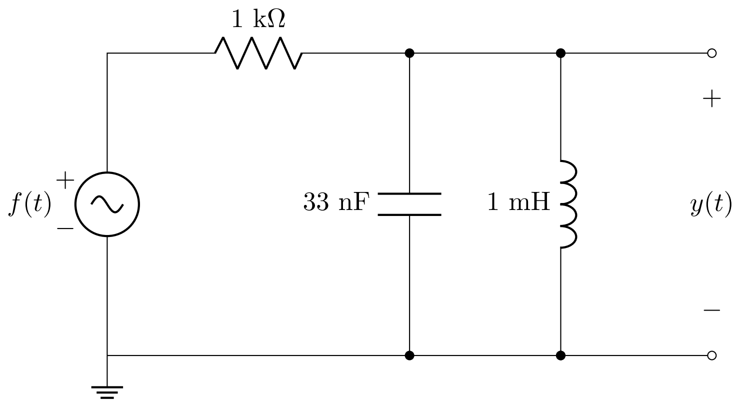

Figure 1: Circuit for analysis in the lab.

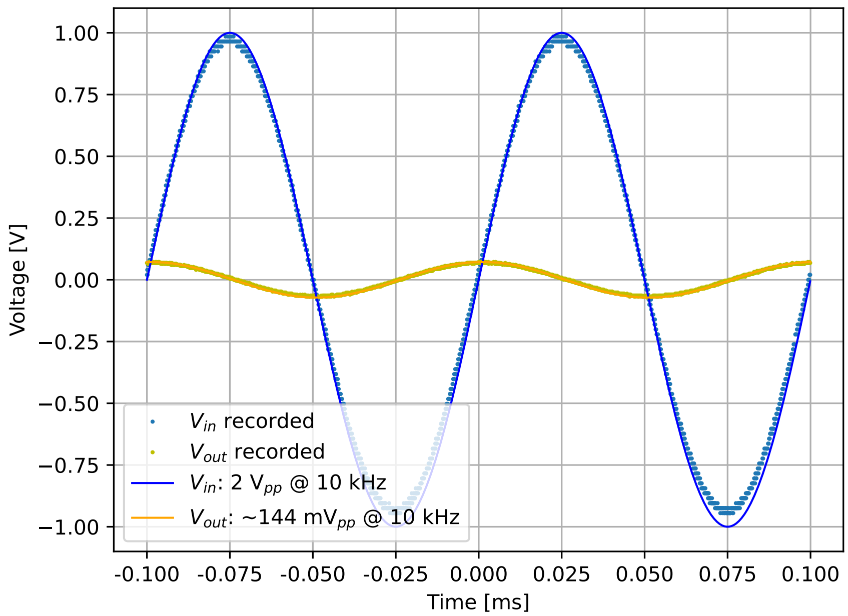

Figure 2: Plot for the circuit analyzed in Fig. 1.

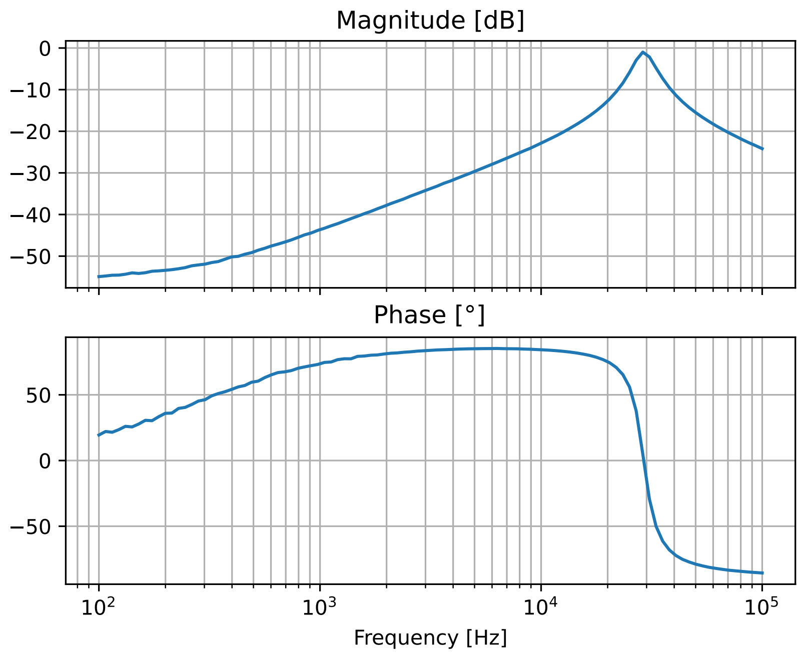

Figure 3: Bode plot of the frequency analysis for the circuit in Fig. 1.

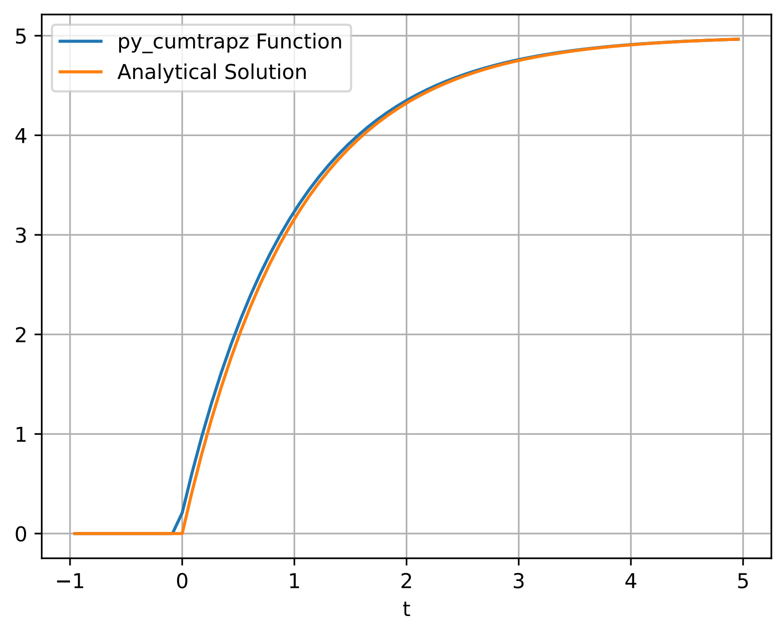

Figure 4: Comparison of the py_cumtrapz function and the analytical solution.