Course Name: Principles of Electrical Engineering II

Course Number and Section:
14:332:222

Lab Report #2

TA (Instructor): Siwei Mai

Due Date: 2/19/25

Date Submitted: 2/20/25

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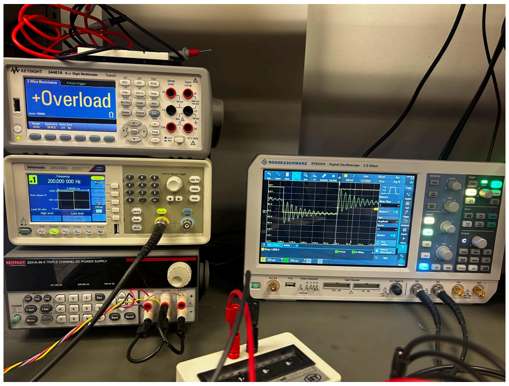
4.1.a: R = 6300 ohms
4.2: R = 182.5 ohms



4.3 Photo of the 1V steady state level of the capacitor
4.5: 54us

5.1 Derive Equation 1 in Section 2 for the underdamped case of an series RLC circuit.
Characteristic Equation For Step Response: s^2 + (R/L)s + 1/(LC) = 0
Homogenous Sol for underdamped: Vc(t) = 1 + (e^-at)(Acos(Wd*t) + Bsin(Wd*t))
Acos(Wd*t) + Bsin(Wd*t) = Kcos(Wd*t + phi)
Vc(t) = 1+K(e^-at) cos(Wd*t + phi)

5.2 Derive and prove Equation 4 in Section 2.
Taking the derivative of equation (1) and using the product rule , we get
dx/dt = (e^(-at))* -Aw*sin(wt + phase) + (-a*e^-at)A*cos(wt + phase)

Then factoring out the Ae^(-at) and setting it equal to zero due to us looking for a maxima or minima results in the equation:

-w*sin(wt + phase) - a*cos(wt + phase)=0

Moving each to seperate sides of the equation:

a*cos(wt + phase) = -w*sin(wt + phase)

And then dividing out the two trig functions:
sin(wt + phase)/cos(wt + phase) = -a/w

and then combining them:

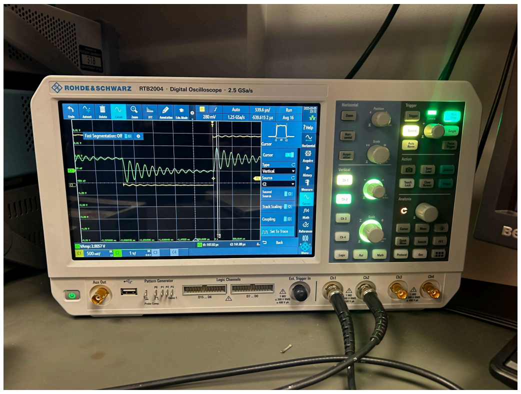
tan(wt + phase) = -a/w

We know that for tan(theta) = a constant the solution is wd = k*pi.

So therefore our final equation is
tan(wt + phase) = -a/w
with wd = k*pi

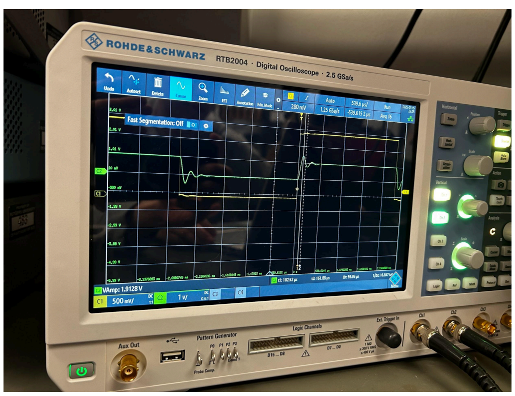
5.3 In pre-lab exercise 3.2 you have already filled in the theoretical values of the maxima and minima into Table 1. Compare them now with the experimental values. Print out the stored or photographed waveforms and label them appropriately.

T	Measured 1st max V	Theoretical 1st Max V	M 1st min V	Th 1st min V	M 2nd max	Th 2nd max
0.1	1.64	1.73	0.564	0.468	1.25	1.39
0.2	1.42	1.53	0.779	0.723	1.1	1.15
0.4	1.2	1.25	0.945	0.936	1.00	1.02
0.6	1.06	1.09	0.980	0.991	1.00	1.00
0.8	1.00	1.02	1.00	1.00	1.00	1.00
1	1.00	1.00	1.00	1.00	1.00	1.00

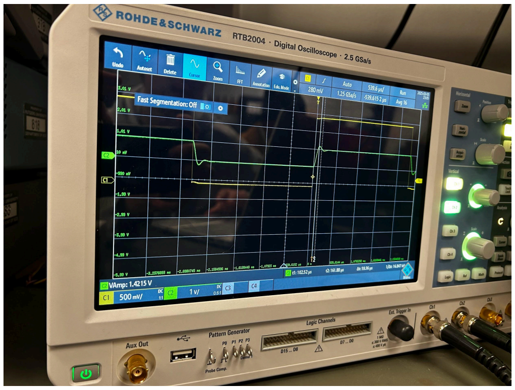


Zeta = 0.1

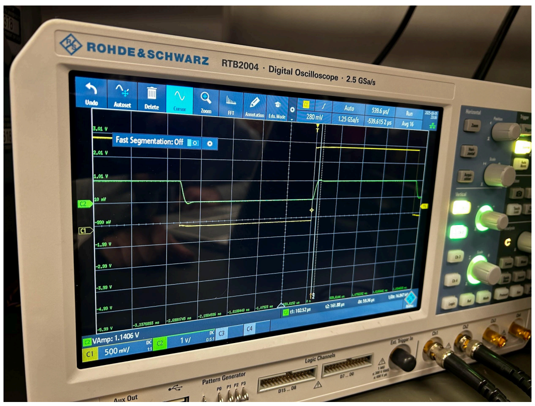
Zeta = 0.2



Zeta = 0.4



Zeta = 0.6



Zeta = 0.8

5.4 Prepare a summary.

The goal of this experiment was to analyze the step response of an underdamped RLC series circuit using an oscilloscope. We observed how the circuit behaves for different zeta damping coefficients by adjusting R value, and compared the theoretical values with measured values.

In the prelab, we first found the theoretical values by finding the C values for L = 100mH needed for a natural frequency of (10^4)pi. We then adjusted the zeta value by predicting the R values for each coefficient (0.1, 0.2, 0.4, 0.6, 0.8, 1.0).

In the lab, we built the RLC series circuit using an RLC box for R, L = 100 mH, and the calculated C. We set the frequency to 200 Hz, sweep rate to 400 μs/div, and observed the oscillating wave response. We measured peak values (1st max, 1st min, 2nd max) using built-in oscilloscope cursors.

The experiment successfully demonstrated the relationship between the damping coefficient and the RLC circuit's step response. The theoretical values found in the prelab followed the measured data closely. Deviations were present, but minimal and could be attributed to internal resistances of the components and the function generator.