1 Introduction

The goal of this lab is to use Laplace transforms to find the time-domain response of an RLC bandpass filter to impulse and step inputs.

2 Equations

We used the transfer function from pre-lab to find the Impulse response and the step response.

$$H(s) = \frac{v_{out}(s)}{v_{in}(s)} = \frac{\frac{s}{cR}}{s^2 + \frac{s}{cR} + \frac{1}{cL}} \tag{1}$$

$$y(t) = \frac{|g|}{w} e^{at} sin(wt + < g)u(t) \tag{2}$$

$$H(t) = (5000 + j1344.08)e^{(-5000t + j18.6*10^3 t)} + (5000 - j1344.08)e^{(-5000t - j18.6*10^{3t})} \tag{3}$$

$$Final - value - of - step - response = \lim_{s \to 0} sH(s)u(s) = \lim_{s \to 0} H(s) = \lim_{s \to 0} \frac{\frac{s}{cR}}{s^2 + \frac{s}{cR} + \frac{1}{cL}} = 0 \tag{4}$$

3 Methodology and Results

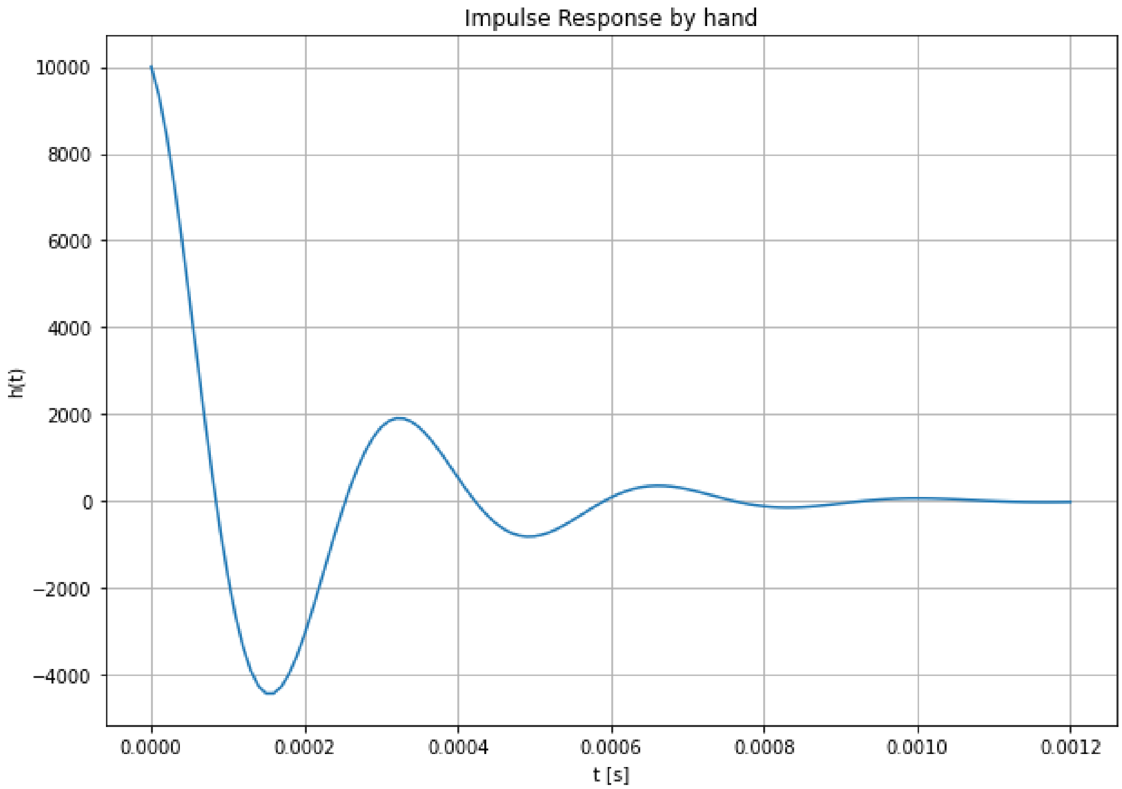
This lab consists of two parts:

- Part 1:

  In this part, we started with finding the impulse response h(t) that we found by hand in the prelab assignment:

```
        #%% part 1 task 1

        steps = 1e-5
        t = np.arange(0, 1.2e-3 + steps, steps)

        def h(t):
        h = (5000+1345j)*np.exp(-(5000+18584j)*t)+(5000-1345j)*np.exp
    ((-5000-18584j)*t)
        return h
        plt.figure(figsize=(10,7))
        plt.subplot(1, 1, 1)
        plt.plot(t,h(t))
        plt.grid()
        plt.ylabel ('h(t)')
        plt.xlabel('t [s]')
        plt.title ('Impulse Response by hand')


```

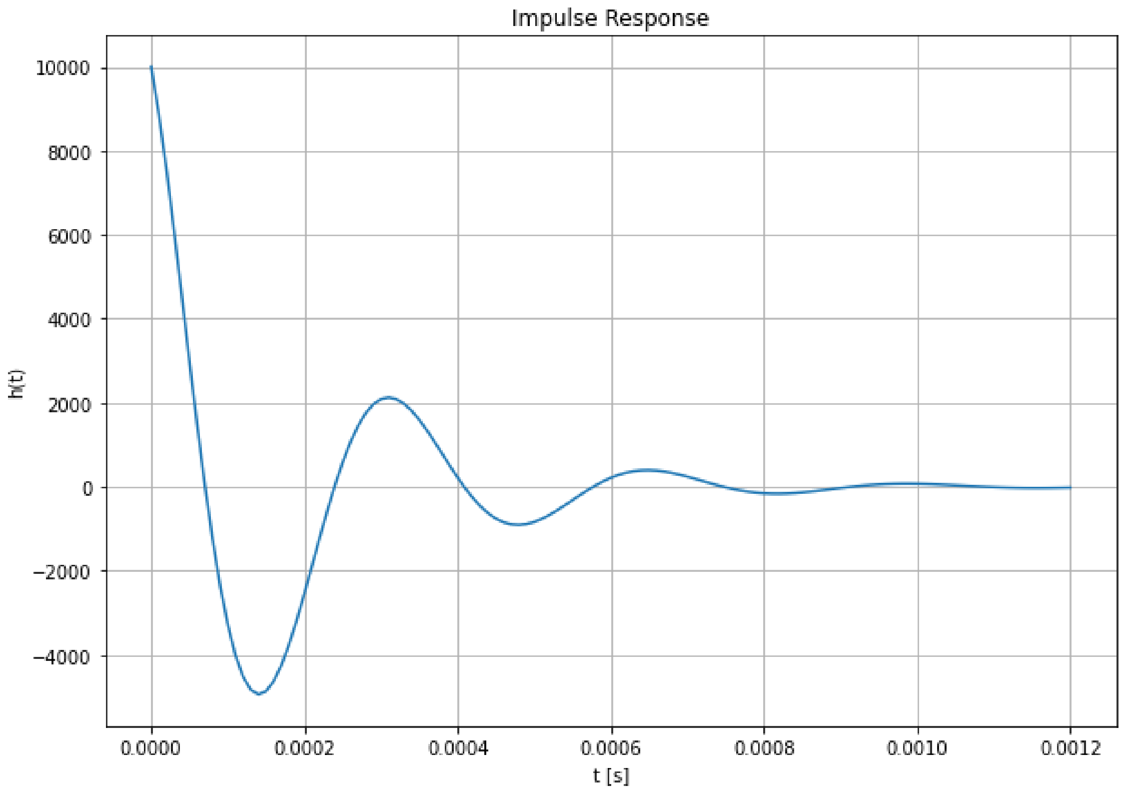
The output of this is:



Then We were asked to do the impulse response function using scipy.signal.impulse() as in the following:

```
#%% part 1 task 2

R = 1000
L = 27e-3
c = 100e-9

num = [0 , 1/(R*c) , 0]
den = [1 , 1/(c*R) , 1/(c*L)]

tout , yout = sig.impulse(( num , den ) , T = t )

plt.figure(figsize=(10,7))
plt.subplot(1, 1, 1)
plt.plot(tout, yout)
plt.grid()
plt.ylabel ('h(t)')
plt.xlabel('t [s]')
plt.title ('Impulse Response')

```

The output of this is:

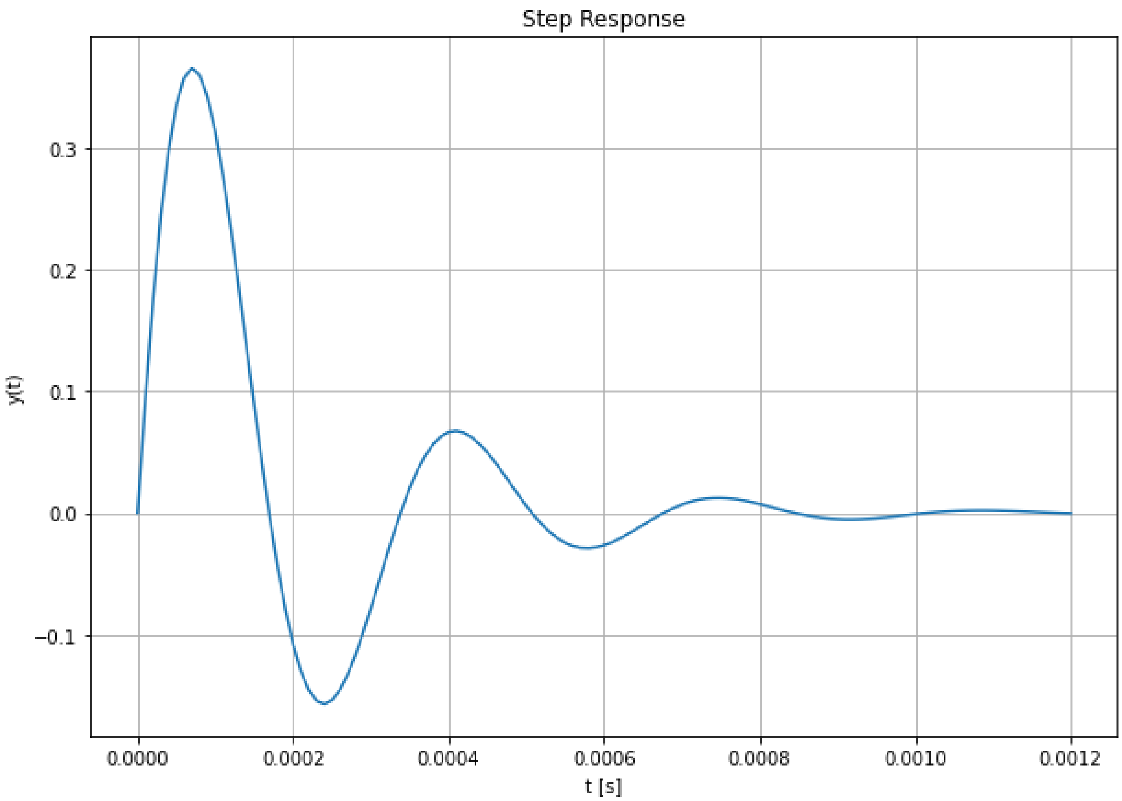


- Part 3:

  In this part, we find the step response of H(s) using the scipy.signal.step() function:

```
#%% part 2 task 1

num = [0 , 1/(R*c) , 0]
den = [1 , 1/(c*R) , 1/(c*L)]

tout , yout = sig.step(( num , den ) , T = t )

plt.figure(figsize=(10,7))
plt.subplot(1, 1, 1)
plt.plot(tout, yout)
plt.grid()
plt.ylabel ('y(t)')
plt.xlabel('t [s]')
plt.title ('Step Response')
plt.show()
```

The output is:



The result of this part is different than part one. This part starts at 0 when t=0 wher part 1 starts at 10000. Also, the maximum value of each part is different.

4 Questions

1. Explain the result of the Final Value Theorem from Part 2 Task 2 in terms of the physical circuit components.

   After a long enough time the capacitor will be open circuit and the inductor will be a short circuit that is why the voltage will be zero at the output.

2. Leave any feedback on the clarity of the expectations, instructions, and deliverables.

5 Conclusion

At the end of this lab, we become familiar on how use Laplace transforms to find the time-domain response of an RLC bandpass filter to impulse and step inputs.