Project Report for ECE 351

Lab 05 - Step and Impulse Response of an RLC Bandpass Filter

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ECE351 Code Repository:
$https://github.com/ElfinPeach/ECE351_Code.git$

ECE351 Report Repository:
$https://github.com/ElfinPeach/ECE351_Report.git$

Contents

1 Circuit Analysis **1**

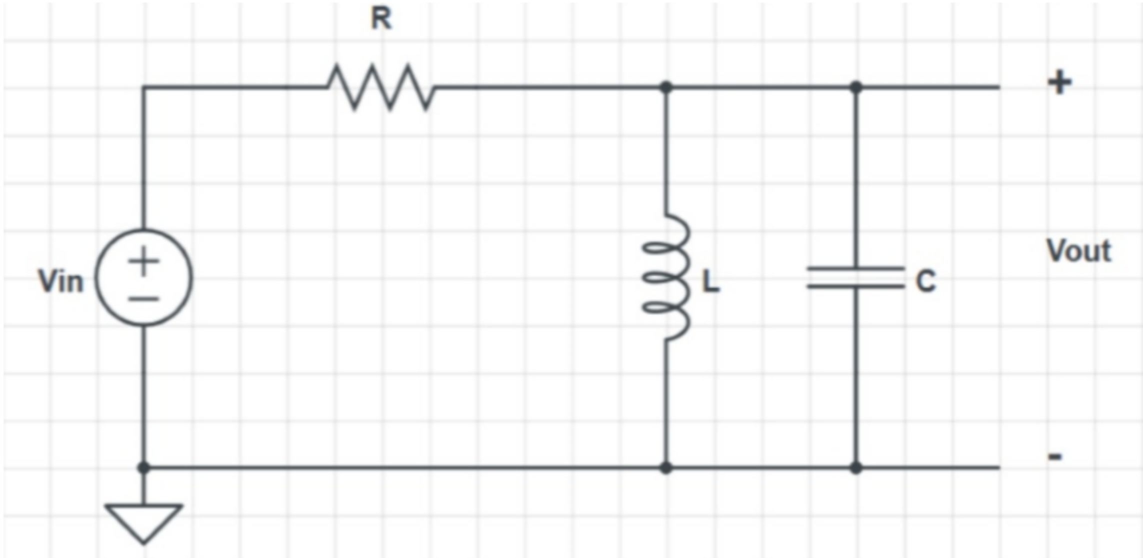
1.1 Finding Laplace Form 1

1.2 Finding Impulse Response 1

1 Circuit Analysis

This prelab has one circuit that has two parts: find the transfer function $H(s) = V_out/V_in$ and the impulse response $h(t)$. The following circuit is the one used for analysis.

Figure 1



R = 1kΩ, L = 10mH, C = 100nF

1.1 Finding Laplace Form

In order to solve this, I used a nodal equation at the node above the inductor/capacitor (they share a node). For the KCL, I used $I_R = I_L + I_C$ as my base to build the nodal equation.

Furthermore, I transformed each component into its Laplace equivalent, which is defined by the following: $R(s) = R$, $L(s) = L * s$, $C(s) = 1/(C * s)$. I used V_i and V_o for the input and output, respectively, because I'm lazy.

$$\frac{V_i - V_o}{R} = \frac{V_o}{L*s} + \frac{V_o}{1/(C*s)}$$

Putting this into my calculator for it to solve for V_o then dividing the result by V_i, I got:

$$\frac{V_o}{V_i} = H(s) = \frac{L*s}{R*(C*L*s^2+1)+L*s}$$

1.2 Finding Impulse Response

Plugging the values in for R, L, and C, the equation turned into:

$$H(s) = \frac{10^4*s}{s^2+10^4*s+3.7*10^8}$$

Since the denominator has complex roots, I decided to use the sine method to solve this.

$$p = \frac{-10^4 + \sqrt{(10^4)^2 - 4*1*3.7*10^8}}{2}$$
$$p = -5000 + 18574j$$
$$\therefore \omega = 18574 \text{ rad/s and } \alpha = -5000$$
$$g(s) = 10^4 * s$$
$$g(-5000 + 18574j) = 10^4 * (-5000 * 18574j)$$
$$= 1.9 * 10^8 \angle 1.5$$

Using the sine method, the equation for the impulse response is as follows:

$$h(t) = \frac{\|g\|}{\omega} * e^{\alpha * t} * \sin(\omega * t + \angle g)$$

Plugging in all the values for α, ω, and g, I get the impulse response:

$$h(t) = \frac{1.9*10^8}{1.9*10^4} * e^{-5000*t} * \sin(1.9 * 10^4 * t + 105)$$
$$h(t) = 10^4 * e^{-5000*t} * \sin(1.9 * 10^4 * t + 105)$$