Studying the Response of RLC Circuits to Sinusoidal Inputs Using Simulink

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• **Name:**	**Student No.:**	**Lab Group No.:**
• **Name:**	**Student No.:**	**Grade.:**

IMPORTANT

Provide here the hash value you calculated for your group denoted by Θ (see lab instructions).

Hash value Θ =

Include all other requested screenshots of the plots and answers as needed below.

1. Natural frequency of an RLC Circuit

1.1 Exercise 1.1

Calculate the natural frequency for the following systems **(1 pt)**

1. $C = 0.01 \times \Theta, L = 0.01 \times \Theta$
2. $C = 0.02 \times \Theta, L = 0.01 \times \Theta$
3. $C = 0.04 \times \Theta, L = 0.01 \times \Theta$
4. $C = 0.01 \times \Theta, L = 0.02 \times \Theta$
5. $C = 0.01 \times \Theta, L = 0.04 \times \Theta$

Compare them with the experimental results. Obtain a screenshot of the spectrum plot to show your results and include with your submission.

1.2 Exercise 1.2

a. *Vary the resistance values to show that damping factor increases as you increase the resistance (set $C = 0.01 \times \Theta$ and $L = 0.01 \times \Theta$).*
Save your screenshot of the capacitor voltage over time and attach to this document. **(1 pt)**

b. *At what resistance does the system transition from underdamped to overdamped? (Keep $L = 0.01 \times \Theta$ and $C = 0.01 \times \Theta$)* **(0.5 pt)**

c. *How would underdamped to overdamped transition change if you increase L to $0.02 \times \Theta$ and C to $0.02 \times \Theta$?* **(0.5 pt)**

2. RLC circuit response to an external voltage source

2.1 Exercise 2.1

a. *Set the amplitude of your voltage source to 1 and measure the amplitude of the output response of the circuit for the case when the sine-wave input has the following frequencies.***(1 pt)**

1. *Natural frequency / 5*
2. *Natural frequency / 2*
3. *Natural frequency*
4. *Natural frequency * 2*
5. *Natural frequency * 5*

Save your screenshots of the output signal and attach to this document, as well as your explanations.

2.2 Exercise 2.2

Include a screenshot demonstrating the square-wave Simulink model (the time-domain plot and its frequency-domain spectrum) and provide an explanation of the peaks in the spectrum analyzer. **(1 pt)**

3. Applying Fourier Series in circuit analysis

3.1 Exercise 3.1

a. *Use a square wave with 1/32 sec period. Read the frequency of the first 4 peaks on the frequency-domain spectrum, and record the results below. Include a screenshot of your plots.* **(0.5 pt)**

b. *Calculate the first 4 terms of the Fourier series for the square wave using the equation provided, and write down the frequency and amplitude of each term from the Fourier approximation below.* **(0.5 pt)**

c. *Include a screenshot demonstrating how closely the 4-term Fourier series approximation matches the square wave.* **(0.5 pt)**

3.2 Exercise 3.2

Compare the output response of the RLC circuit to the 4-term Fourier series approximation input and the response to the square-wave input, respectively. Include a screenshot of the output response in the two cases, respectively. **(1 pt)**

3.3 Exercise 3.3

a. *Include a screenshot demonstrating how closely the 8-term Fourier series approximates the square wave.* **(0.5 pt)**

b. *Compare the output response of the RLC circuit to the 8-term Fourier series approximation input and the response to the square-wave input, respectively. Include a screenshot of the output response in the two cases, respectively.* **(1pt)**

c. *Does the 8-term Fourier series approximate the square wave better than the 4-term Fourier series? Does the output response of the RLC circuit to the 8-term Fourier series input approximate the output response to the square-wave input better than when the 4-term Fourier series was used as input? Include an answer and justify your answer.* **(1pt)**