NORTHWESTERN UNIVERSITY
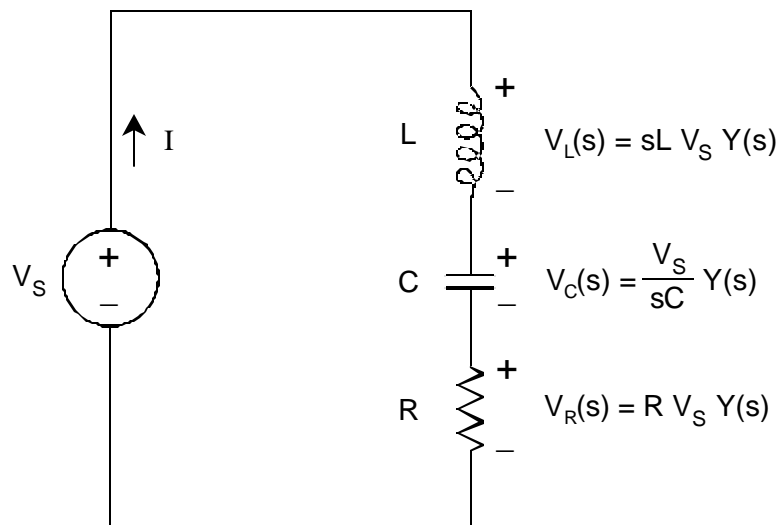## Department of Electrical and Computer Engineering

ECE-221 Fundamentals of Circuits

LAB 6: FREQUENCY RESPONSE OF RLC CIRCUITS

1. **Theory**

Consider the following series RC circuit.

The admittance of this circuit can be expressed as follows:

$$Y(s) = \frac{s/L}{s^2 + \frac{R}{L}s + \frac{1}{LC}}.$$

1.1: Find the transfer function $H_R(jw)$, $H_C(jw)$ and $H_L(jw)$ by using voltage division in the frequency domain. Given that $L = 1\,\text{mH}$, $R = 500\,\Omega$ and $C = 1\,\text{nF}$, calculate the resonant frequency of RLC series circuit and the total impedance at the resonance frequency.

1.2: Plot the amplitude and phase of V_L, V_C, and V_R phasor in the excel spreadsheet by using the amplitude of voltage source is 5V. When you hand in your lab report, these should appear as six separate plots. You will add your experimental results to these graphs.

2. Experiment

2.1 Connect the circuit. Use the scope to measure the amplitude and phase of $V_L, V_C,$ and V_R. Take measurements at frequencies from 40kHz to 400kHz in steps of 20kHz. Reduce the step size to 5kHz in the 140–180kHz range (why?).

3. Questions

3.1: Add the data you obtained in section 2.1 to the plots of section 1.2. Choose a frequency at which theory and practice are not in agreement, and produce separate phasor diagrams for the theoretical and measured results.

3.2: What is Q_0 for the theoretical circuit? What was Q_0 for the circuit you constructed in the lab?

3.3: Comment on the degree to which your theoretical and measured results are in agreement. Is the error in any way dependent on frequency? What do you think is the reason for the error?

3.4: At resonance, $V_L = -V_C$. Was this true for the circuit you constructed in lab? Why or why not?

4. PSpice Simulation

4.1: Use the PSpice to simulate the circuit by selecting the AC sweep and use VAC as the voltage source. Frequency starts at 10kHz and ends at 1MHz. Plot the amplitude of V_L, V_C, and V_R phasor.