Laboratory 1
Frequency Response Analysis, Simulation, and Measurements

Introduction: We will review the analysis (using phasors and impedance) and measurement of the frequency response of frequency-selective circuits (filters) operating in the sinusoidal steady-state. Please begin by reviewing the RC circuit in Figure 1 (which we used in Lab 7 in ELEC 225) and continue with the more complex circuits in Figure 2.
Chapter 14 and 15 (Section 1) in the textbook are relevant.

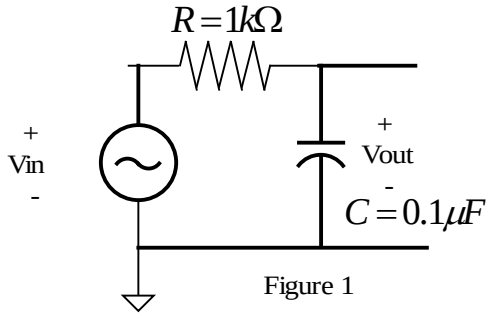

Figure 1

Review:

1. Analytically determine the *frequency response* of the circuit for both the amplitude gain and the phase difference between the input and output signals at sinusoidal steady-state. Express the amplitude gain formula in decibels (dB) = 20 * $\log_{10}$ (amplitude gain). Keep R and C as variables in your analysis, then substitute the particular values of R and C at the end.

2. Provide a rough plot of the amplitude gain (in dB) and the phase shift versus frequency using a logarithmic scale on the frequency axis (this is a Bode plot). Label the "-3 dB cutoff frequency" on your Bode plot of amplitude gain.

3. Experimentally measure the the magnitude of v_{out}/v_{in} and the phase difference between v_{in} and v_{out} at four frequencies: 159 Hz, 1,590 Hz, 15,900 Hz, and 159,000 Hz. .
Be sure to display both v_{in} and v_{out} on the oscilloscope.

4. Compare the measured values with your analysis and Bode plots.

The circuit in Figure 2 is proposed as an alternative to the low-pass filter in Figure 1. It is claimed that it might have better properties than the single-capacitor filter. Your problem is to investigate the circuit and to determine if there is any advantage to using it instead of the original single-capacitor circuit.

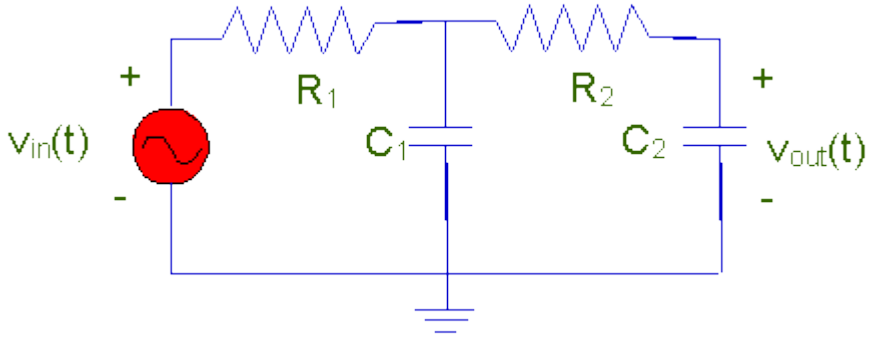

Figure 2

Begin with an analysis of the circuit. Then continue with wiring the circuits and measurement, as on page 1 for the single capacitor circuit. You can set $R_1=R_2=R$ and $C_1=C_2=C$ when you build the circuit.

Before you leave the lab, discuss your results with the instructor or the lab assistant.