Due: Friday, March 1.

1. Text, Problem 13.17.
2. Text, Problem 13.18.
4. Text, Problem 13.51. Also, sketch the frequency response magnitude for a), b), and e).
5. Consider the 2nd-order RLC circuit shown below.
   a. Determine the transfer function, \( H(s) = \frac{V_0(s)}{V_i(s)} \).
   b. Set \( C = 0.4 \text{ } \mu F \) and design the circuit (that is, select values for \( R \) and \( L \)) so that the natural frequency is \( \omega_n = 10,000 \text{ rad/sec} \), and the damping constant is \( \xi = 1/2 \). Determine the resulting rise time, settling time, and percent overshoot of the unit step response. Sketch the pole positions in the s-plane and express the angle of the poles with respect to the negative real axis in terms of \( \xi \).
   c. Use Matlab to plot the unit step response for your design in part b). Verify that the response has the correct rise time, settling time, and percent overshoot.
   d. Use Matlab to accurately plot the frequency response magnitude. What is the filter gain at frequency \( \omega = \omega_n \)?
   e. Using the same capacitor value as in part b), modify the design to be a 2nd-order Butterworth lowpass filter with cutoff frequency \( \omega_c = 5,000 \text{ rad/sec} \). This requires that the angle of the poles be \( \pm 45^\circ \) with respect to the negative real axis. Determine the rise time, percent overshoot, and 2\% settling time. Use Matlab to plot the unit-step response and the filter frequency response. Verify that the numerical values match your intended design.
   f. In the circuit below, instead let the output be the inductor voltage. Determine the transfer function. Using the same value of capacitor as in part e, design the filter to be a Butterworth highpass filter with cutoff frequency 1 kHz.