ME 391 Fundamentals of Control Systems
Assignment 3
Due at the beginning of class Friday Jan 28

1. You have a unity feedback system with two blocks in the forward path, K(s) (the controller) and G(s) (the plant). Choose K(s) = K, a scalar gain, and G(s) = 1/(s+1)(s+12).

a. What kind of control is this?

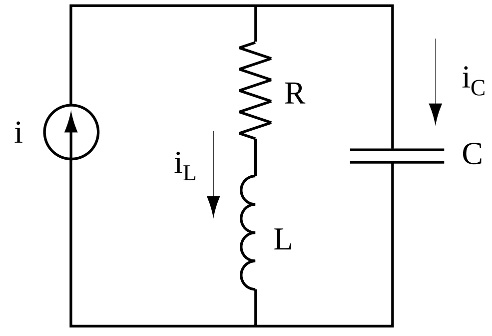
b. Choose K to give a damping ratio of 1.5. This system is called **overdamped**. Give the pole-zero plot of the system.

c. Choose K to give a maximum overshoot of 30%. Such a system is called **underdamped**. Give the pole-zero plot of the system.

d. Choose K to give a damping ratio of 1.0. Such a system is called **critically damped**. Give the pole-zero plot of the system.

e. Use MATLAB to plot the step response of the closed-loop system for the three controllers you found in parts a, b, and c on the same plot. In terms of performance specifications on the step response, explain why control systems are often designed for critical damping.

2. Consider the circuit below.



a. Find the transfer function $I_L(s)/I(s)$.
b. Put the transfer function in standard second-order form as on page 122 of the text. (You may have to multiply the form by a constant factor to do so.) Solve for ω_n, ζ, σ, and ω_d in terms of R, L, and C.
c. If the input is $i(t) = u_1(t)$, what is the steady state value of $i_L(t)$? The ratio $i_L(t)/i(t)$ in steady state is sometimes called the DC gain.
d. Set C = 1 and choose values of R and L so that the step response has a rise time of 0.1s and a 2% settling time of 0.2s.

3. For a second-order system, draw the region of allowable poles in the s-plane if we want a response with a rise time of less than 0.5 seconds, a 2% settling time of less than 2 seconds, and a maximum overshoot of 10%.

4. Problem 3.30.