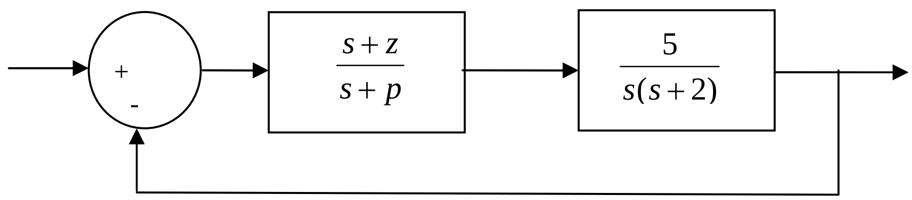
ECE-320: Linear Control Systems
Homework 7

Due: Tuesday October 20, 2009 at the beginning of class

1) For the system shown below, with the lag compensator ($z > p$):



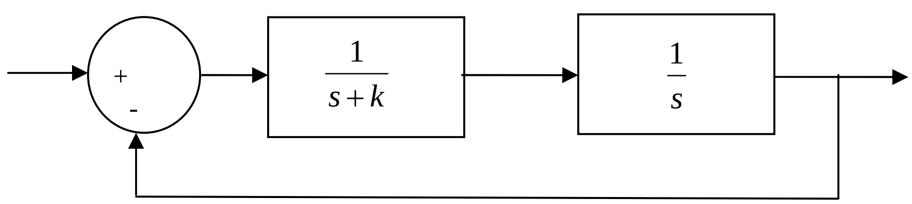
a) Show that without the lag compensator, $K_v = \frac{5}{2}$ and the steady state error for a unit ramp input is $e_{ss} = \frac{2}{5}$.

b) Include the lag compensator, with z = 0.1, so the steady state error will be 0.01. (Answer: p = 0.0025).

2) Standard root locus form for determining the poles of the closed loop transfer function is

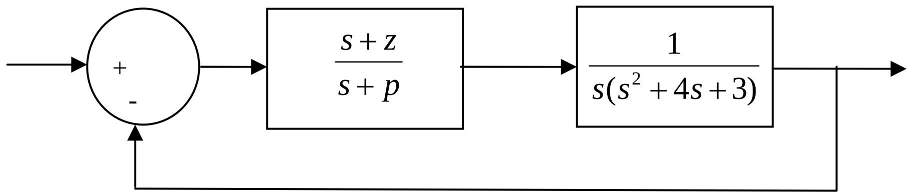
$$1 + kG(s) = 0$$

If we want to use the root locus to determine the possible pole locations for the following system,



what is $G(s)$?

3) For the system shown below:

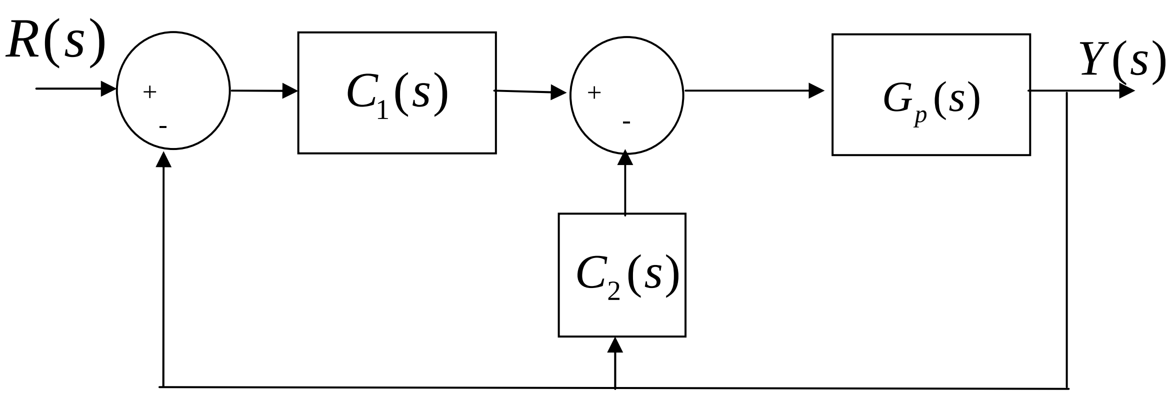


Assume we want to use the lag compensator so that the steady state error for a unit ramp is $e_{ss} = 0.1$ We will be varying the locations of the pole and zero of the lag compensator to accomplish this, and will look at the effects of these changes on both the unit step response and the unit ramp response. For each of the simulations below, run the simulation to 35 seconds. For z = 0.1, 0.01, and 0.001

- Find the correct value for p to produce the required steady state error.
- Using Matlab, simulate the unit step response for the original system (without the lag compensator) and with the lag compensator. Plot both results on one graph, as well as the input signal, using different line styles and a legend. Use the subplot command to put this on the top of the page.
- Using Matlab, simulate the unit ramp response for both the original system and the system with the lag compensator. Plot both results on one graph, as well as the input signal, using different line styles and a legend. Use the subplot command to put this on the bottom of the page.

You should notice that the large the value of z, the quicker the steady state velocity error is reduced. However, this is at the expense of large changes in the step response.

4) For the following block diagram,



show that the transfer function from input to output is given by

$$\frac{Y(s)}{R(s)} = \frac{C_1(s)G_p(s)}{1 + C_2(s)G_p(s) + C_1(s)G_p(s)}$$

This is the structure we will use in Lab for the PI-D and I-PD controllers.