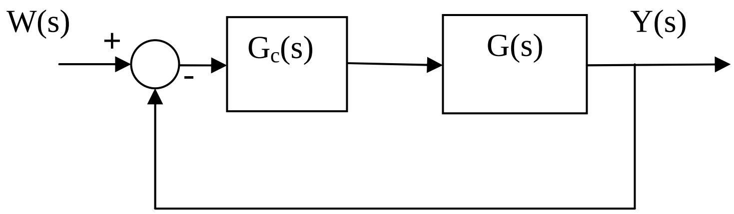
Due Wednesday, February 6th **EE/MFS 599** HW #5

You may use Matlab/Simulink wherever applicable

1. Consider the standard, unity-feedback closed loop control system shown below where $G(s) = 10/[s^q(s+1)(s+9)]$




a) Let q=0 (type zero system) and plot the OPEN-LOOP step response for K=1, 10 and 100.
b) Measure the settling time and overshoot. Does changing the value of the gain alter the dynamics of the system (i.e., is the settling time faster, does the overshoot change)?
c) Now, consider the closed-loop system and let our controller Gc(s) be a simple proportional gain K. Use the matlab rlocus() command to plot the closed-loop poles of this system as we vary K from 0.1 to 1000. Do these poles ever go unstable (cross into the RHP)?
d) Look at the root locus. Let s1 be the pole that corresponds to a settling time of 0.8 seconds and a damping ratio of 0.707 (i.e., about 5% overshoot). Is the pole s1 on your root locus? If so, find the value of the gain K which produced these poles by solving the equation, 1+KG(s1)=0
e) Find the static error and velocity coefficients (Kp and Kv) and calculate what the theorectical steady-state error should be for a step and ramp input
f) Plot the closed-loop step and ramp response for Gc(s) = K in part d). Does the settling time and overshoot for the step response agree with what you expected?
g) Use your plots to find the steady-state error for each input and compare to the theoretical answers. Can your system follow a ramp?
h) We can decrease the steady-state error due to a step by increasing the value of the gain K. Try using a K ten times greater and again find the step response and measure the steady-state error and compare to the new value of 1/(1+Kp). What happened to the overshoot when you increased the gain by a factor of 10?

2. Next, consider the closed-loop system when q=1 (type 1 system)

a) Now, consider the closed-loop system and let our controller Gc(s) be a simple proportional gain K. Use the matlab rlocus() command to plot the closed-loop poles of this system as we vary K from 0.1 to 1000. Do these poles ever go unstable (cross into the RHP)?
b) Look at the root locus. Let s1 be the pole that corresponds to a settling time of 1 seconds and a damping ratio of 0.707. Is the pole s1 on your root locus?
c) If no, we have to design a PD compensator to force the root locus to pass thru s1. Let Gpd(s) = Kp + Kds = K(s+z) where K=Kd and z=Kp/Kd. Find values of K and z to make s1 a closed-loop pole of the system
d) Find the static error and velocity coefficients (Kp and Kv) and calculate what the theorectical steady-state error should be for a step and ramp input
e) Plot the closed-loop step and ramp response for Gpd(s) = K(s+z) in part c). Does the settling time and overshoot for the step response agree with what you expected? If not, what have you inserted in the system that could be influencing these values?
f) Use your plots to find the steady-state error for each input and compare to the theoretical answers. Can your system follow a ramp?