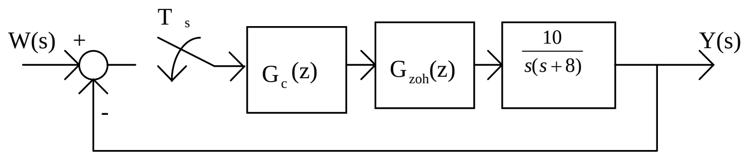
Due Monday, March 29 EE572 HW #17

1. Keep working on your project!

2. Consider the system from HW#16:



Recall that we have already designed a lead compensator, $G_c(z)$, to meet the following specifications:

$t_s \leq 0.4$ sec and $M_p \leq 2\%$

(see solution to HW#17 on the Web for one possible $G_c(z)$).

a) Now design a $G_{lag}(z)$ to be put in series with $G_c(z)$ so that the compensated system meets the above specs plus the added spec that e_{ss} due to a unit ramp $\leq 1/50$.

b) Sketch the compensated root locus.

c) Simulate (See Below or use Simulink)* a step and ramp response for your original closed-loop system, your lead compensated design from HW#16 (see web solution), and your new lead/lag system using MATLAB and lsim(). Measure t_s, M_p, and e_{ss} (both step and ramp) for all three cases. Does your design meet specs? (Hint: for the lead lag system, you may have to increase your time axis to measure e_{ss}).

Turn this in on Wednesday since we didn't get to the example

2. a) Now design a compensator for the system in part a) that meets all of the following specifications (Hint: Think PID):

$t_s \leq .65$ sec

$M_p \leq 10\%$

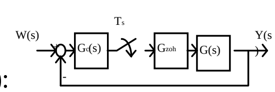
e_{ss} due to a ramp = 0

e_{ss} due to a unit parabola $\leq 1/50$

b) Sketch the compensated root locus.

c) Simulate a step, ramp, and unit parabola responses for your lead/lag system using MATLAB. Measure t_s, M_p, and e_{ss} (for step, ramp and parabola (a unit parabola is defined as $0.5t^2u(t)$).

Here's how to use Matlab to simulate the **step response** following closed-loop system (or, use Simulink):



Let's assume in Matlab we already have $G_{zoh}(s)G(s)$=num/den and $G_c(s)$=numc/denc

(Note: the conv() command in Matlab multiplies two polynomials together!!! Also note that the commands cloop() and feedback() can also be used to find the closed - loop transfer function once you have found num_open_loop and den_open_loop)

```
» num_open_loop=conv(num,numc)                          %Find the total open-loop numerator of GcGzohG(s)
» den_open_loop=conv(den,denc)                          %Find the total open-loop denominator of GcGzohG(s)
» n_minus_m=length(den_open_loop)-length(num_open_loop) %Find difference in order between numerator and denominator
» num_closed_loop=num_open_loop                         %The closed-loop and open-loop numerators are the same
» num_same_order=[zeros(1,n_minus_m) num_closed_loop]   %Pad the closed-loop numerator with zeroes so we can add it
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» den_closed_loop=num_same_order+den_open_loop    %to the open-loop denominator to form the closed-loop denom-
» Ts=0.01                                         %inator then select the sampling time to be 10 msec
» t=[0:100]*Ts;                                   %time scale is 1 second
» u=ones(1,length(t));                            %u (the input) is a unit step
» y=lsim(num_closed_loop,den_closed_loop,u,t);    %Use lsim to simulate the step response of the closed-loop
» plot(t,y)                                       % system, Y(s)/W(s) and plot the results
```