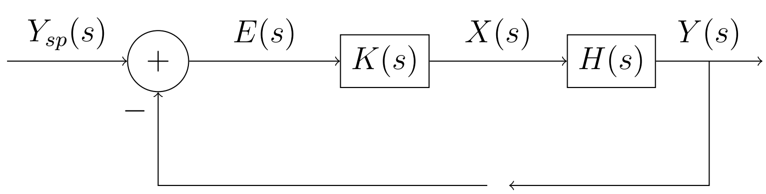
Olin College of Engineering
ENGR2410 – Signals and Systems
Problem set 10

Problem 1: Use the Laplace transform to verify that the step response of the system $\dot{y} + y = x$ is $y(t) = (1 - e^{-t})u(t)$. Be sure to indicate the regions of convergence of any functions in the s-plane. You will have to refresh your partial fraction expansions.

Problem 2:

A. Find the DC gain of the system $Y(s)/Y_{sp}(s)$ below if you use an integral controller $K(s) = K_I/s$ for any $H(s)$. Does it depend on the value of K_I? *The reference has an equation to find the DC gain that might be useful.*



B. Assume $H(s) = \frac{1/\tau}{s+1/\tau}$. Find $Y(s)/Y_{sp}(s)$. Find the pole(s) of the system assuming $K \gg 1/\tau$. Draw a pole-zero diagram in this case.

Problem 3:

Analyze the behavior of the systems listed using a Bode plot, a pole-zero map, and the step response. For each system, note the relationship between all three plots: order of the system, number of poles and zeros, real or complex poles, oscillations and so forth. Hand in a couple of sentences for each system describing its behavior and any notable characteristics concisely.

$A.\ \dfrac{s}{s+1}$ $\qquad$ $B.\ \dfrac{s}{s^2+100s+1}$

$C.\ \dfrac{s}{s^2+s+1}$ $\qquad$ $D.\ \dfrac{s}{s^2+0.1s+1}$

$E.\ \dfrac{s^2-0.01s+1}{s^2+0.01s+1}$ $\qquad$ $F.\ \dfrac{s^2+0.1s+1}{s^2+0.11s+1}$

Problem 4: You are asked to stabilize the system

$$H(s) = \frac{1}{s^2 - 0.01s + 1}$$

Do the algebra by hand in this problem. Computational methods may introduce numerical errors and give you the wrong answer.

A. Plot the step response and pole-zero map of this system.

B. Use the pole-zero map to show the effect of using proportional control on this system. Show the step response of at least two feedback gains to illustrate. Can you stabilize the system?

C. Repeat part B using integral control.

D. Repeat part B using differential (or derivative) control.