ME 5200/6200 Classical Controls **Fall 2020**

Homework 04 **Due Thursday, Oct. 1, turn in through CANVAS**

Do the following problems and show all your work for full credit. Note: not all problems will be graded, but you must complete all problems to get full credit.

Problem 1 [20 points]

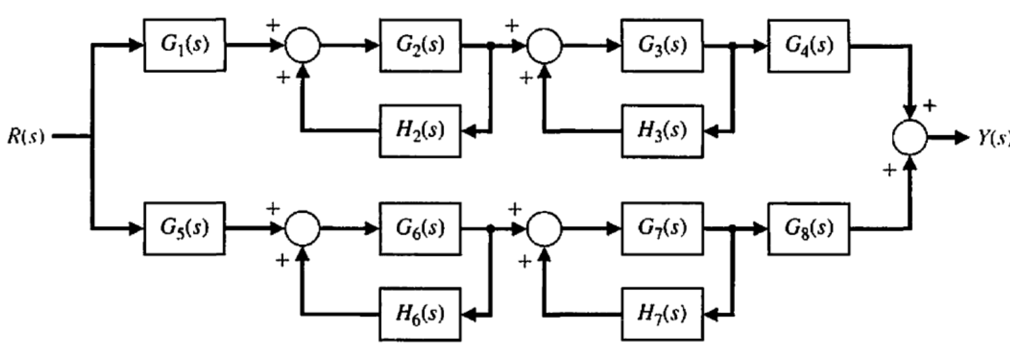
For each of the following transfer functions with zeros, use Matlab to plot the step response, then compare and contrast the step responses. Note that both systems have the same poles, but the zeros are different. How does this affect the response? (Hint – one of the systems is nonminimum phase – briefly describe what this behavior is. Refer to your text for additional details). You may want to do a partial fraction decomposition to help explain the differences in behavior.

a. $G(s) = \dfrac{s+2}{s^2+3s+36}$

b. $G(s) = \dfrac{s-2}{s^2+3s+36}$

Problem 2 [10 pts]

Consider the following block diagram below:

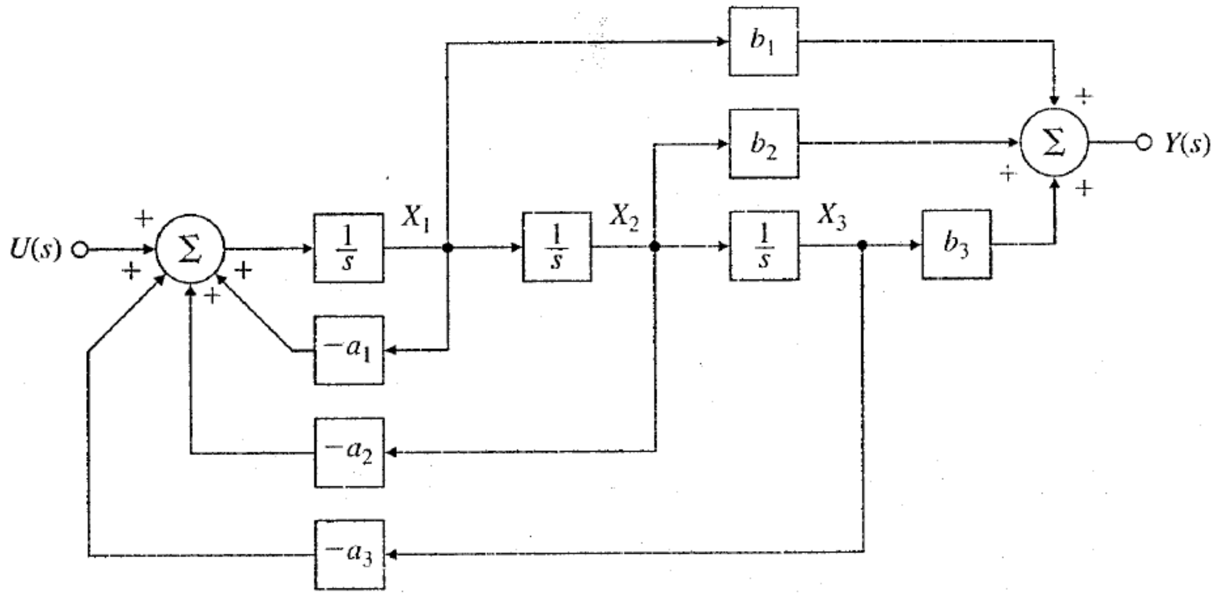


Using block diagram algebra (i.e., manipulating and moving blocks), determine the transfer function Y(s)/R(s).

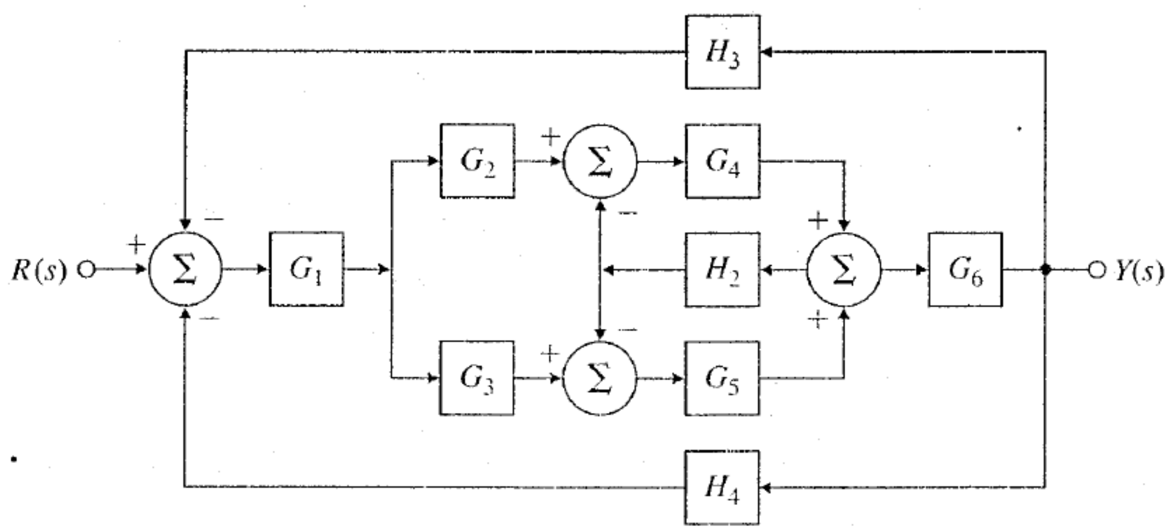
Problem 3 [40 pts]

Find the transfer function from U(s) to Y(s) for the following using block diagram algebra and Mason's Rule:

(a)

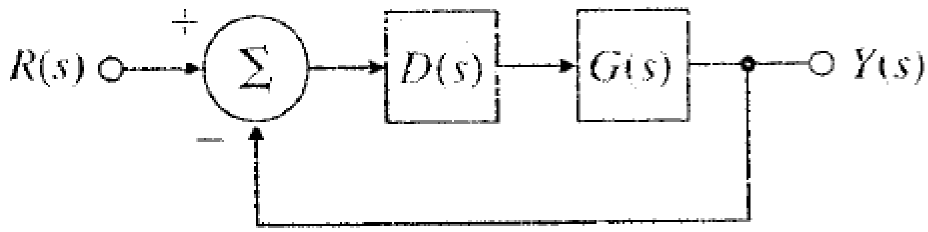


(b)



Problem 4 [20 pts]

Suppose you have the following closed-loop system:



where

$$G(s) = \frac{1}{s(s+3)} \quad \text{and} \quad D(s) = \frac{K(s+z)}{s+p}.$$

You're first take on a new job as a controls engineer is to design the controller D(s) so that the closed-loop system has a particular behavior. Answer these questions (show all your work):

a) What is the order of the open-loop system?
b) What is the order of the closed-loop system?
c) Design the values for K, z, and p in D(s) so that the system when a step input R(s) is applied exhibits 10% overshoot and 1.5 second settling time (+/-2% settling time). Show all your work.
d) Prove that your design works by showing a step response of the closed-loop system using Matlab. Include of plot of output vs. time, and also your Matlab code.