FRA331: Basic Control Theory

Homework 5: Time Response

1.) In this problem, you will have to find the zeros and poles of a closed system.

Given, the transfer function of the plant to be

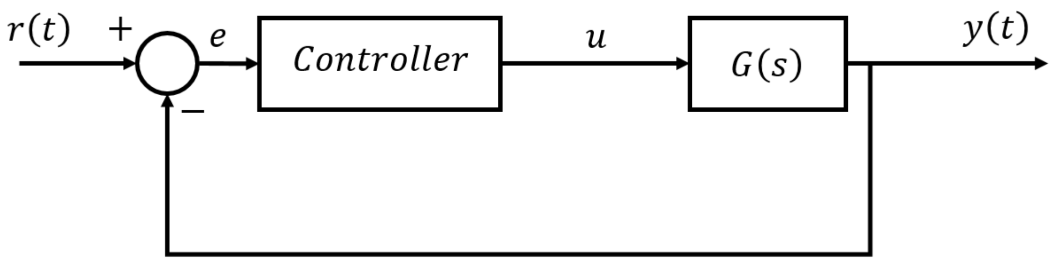
$$G(s) = \frac{a}{s+a}$$

Let the controller be the following PID controller

$$u = K_p(e) + K_i \int_0^t (e)\, d\tau + K_d \frac{d}{dt}(e)$$

Where

$$e = r - y$$



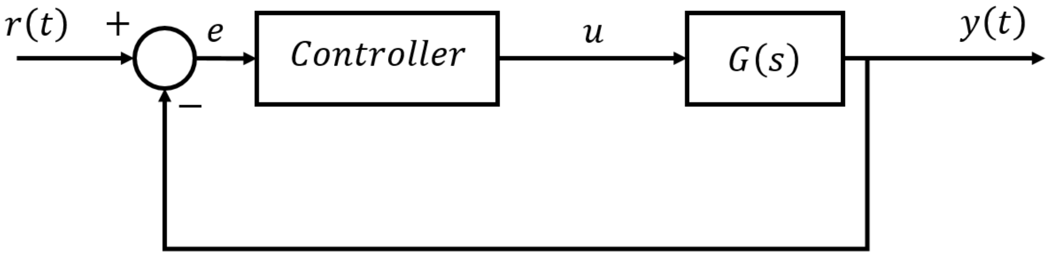
a.) Find the closed-loop transfer function of the system $T(s) = \frac{Y(s)}{R(s)}$ in term of a, K_p, K_i, K_d

b.) Determine the poles and zeros of the closed-loop transfer function. If

$$a = 0.2, \qquad K_p = 10, \qquad K_i = 4, \qquad K_d = 6$$

c.) Sketch the poles and zeros of the closed-loop system in the plane

2.) Let the closed-loop system



$$G(s) = \frac{1}{s(s+a)}$$

a.) If the controller is

$$u = K(r - y)$$

$$a = 2$$

Find the value of K that makes the Settling Time equals to $4\ seconds$

b.) If the controller is

$$u = K(r - y)$$

$$K = 5$$

Find the value of a that makes the Peak Time equals to 2.

c.) Given the constant a , determine the range of K for these 3 cases

a. Overdamped

b. Critically-damped

c. Underdamped

3.) Given the following specification

$$T_s = 2\ seconds$$

$$\%OS = 20$$

a.) Sketch the poles of the systems in an imaginary plane

b.) Write the transfer function of the system where the unit step response reaches 1.