Aerospace Engineering Department, IIT Bombay
AE 308 & AE 775 - Control Theory
Tutorial 4

Q1

For a unity feedback system with the forward transfer function

$$G(s) = \frac{K(s+20)}{s(s+2)(s+3)},$$

find the range of K to make the system stable.

Q2

Use the Routh-Hurwitz criterion to find how many poles of the following closed-loop system, $T(s)$, are in the rhp, in the lhp, and on the jw-axis:

$$T(s) = \frac{s^3 + 7s^2 - 21s + 10}{s^6 + s^5 - 6s^4 - s^2 - s + 6}.$$

Q3

A unity feedback control system has the open-loop transfer function

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

Compute the sensitivity of the closed-loop transfer function to changes in the parameters A and a.

Q4

Consider the second-order plant with the transfer function

$$G(s) = \frac{1}{(s+1)(5s+1)},$$

in a unity feedback structure. Determine the system type and error constant with respect to tracking polynomial reference inputs of the system for PID $[D_c = 19 + \frac{0.5}{s} + \frac{4}{19}s]$.

Q5

Let the transfer function of the plant is $G(s) = \frac{K_0}{4s+1}$. The system is in a unity feedback structure. Compute the steady-state error of the closed-loop plant when reference is a step input. Design a controller to make the steady-state error zero.

Q6

Consider a plant with nominal model given by $G(s) = \frac{1}{s+2}$. Compute the parameters of a PI controller so that the natural modes of the closed loop response decay at least as fast as e^{-5t}.

Q7

Consider the system shown in Figure 1. This is a PID control of a second-order plant $G(s)$. Assume that disturbances $D(s)$ enter the system as shown in the diagram. It is assumed that the reference input $R(s)$ is normally held constant, and the response characteristics to disturbances are a very important consideration in this system. Design a control system such that the response to any step disturbance will be damped out quickly (in 2 to 3 sec in terms of the 2% settling time). Choose the configuration of the closed-loop poles such that there is a pair of dominant closed-loop poles.

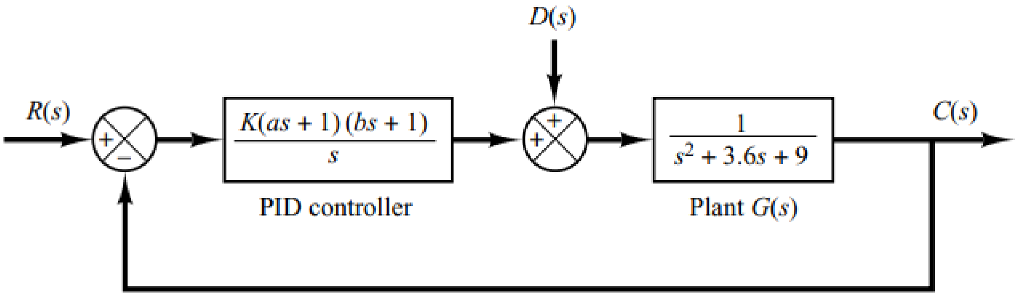

Figure 1:

Q8

The block diagram of a control system with a series controller is shown in Figure 2. Find the transfer function of the controller $G_c(s)$ so that the following specifications are satisfied:

1. The ramp error constant K_v is 5.
2. The closed loop transfer function is of the form $M(s) = \dfrac{Y(s)}{R(s)} = \dfrac{K}{(s^2 + 20s + 200)(s + a)}$ where K and a are real constants. Find the values of K and a.

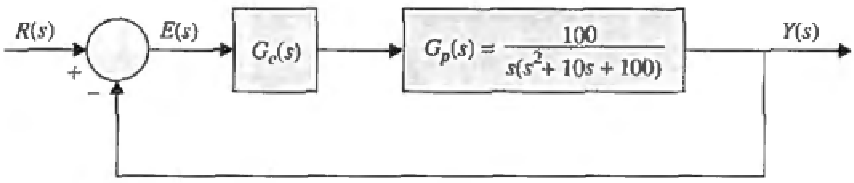

Figure 2: