ME 41100 System Dynamics and Control Dr. B. Wang

Homework 4

Problem 1. Consider the following characteristic equations:

$$D_1(s) = s^4 + Ks^3 + s^2 + s + 1 = 0$$
$$D_2(s) = s^4 + 2s^3 + (4 + K)s^2 + 9s + 25 = 0$$

Using the Routh stability criterion, determine the range of K for stability.
(Hint: it is possible that the system cannot be stable for any K.)

Problem 2. Consider the closed-loop system shown in Figure 1. Determine the range of K for stability. Assume that $K > 0$.

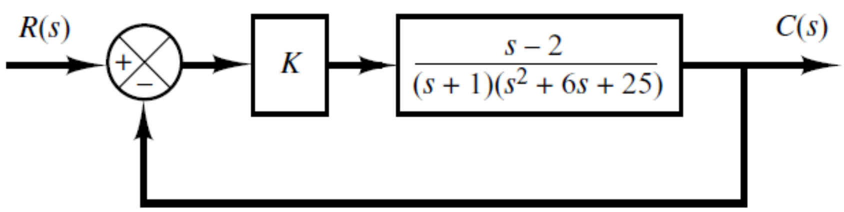

Figure 1: Block diagram of a system.

Problem 3. Consider the servo system with tachometer feedback shown in Figure 2. Determine the ranges of stability for K and K_h. (Note that K_h must be positive.)

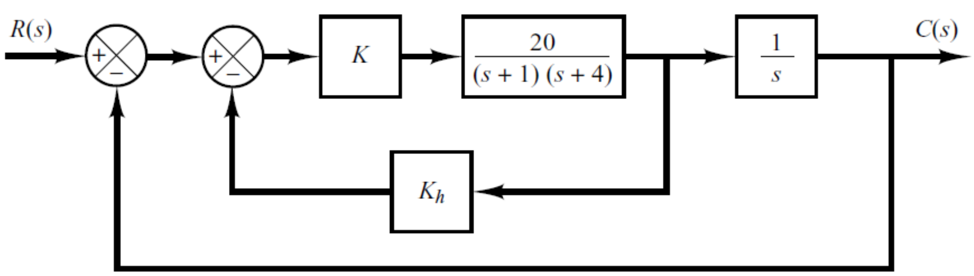

Figure 2: Block diagram of a system.

Problem 4. Consider a unity-feedback control system whose open-loop transfer function is

$$G(s) = \frac{K}{s(Js + B)}$$

Discuss the effects that varying the values of K and B has on the steady-state error in unit-ramp response. Sketch typical unit-ramp response curves for a small value, medium value, and large value of K, assuming that B is constant.

Problem 5 (MATLAB)**.** Read the following MATLAB Documentation:

- PID Controller: `https://www.mathworks.com/help/simulink/slref/pidcontroller.html`
- PID Tuner: `https://www.mathworks.com/help/control/ref/pidtuner-app.html`

1) In MATLAB/Simulink, build the transfer function model.

$$G_p(s) = \frac{1}{s^2 - 1}$$

Provide your MATLAB/Simulink simulation by plotting the open-loop unit step response.

2) Then, apply the PID controller and construct the feedback system. Use PID Tuner to obtain the value of control gains. Provide your MATLAB/Simulink simulation by plotting the closed-loop unit step response.