ECE311S: Dynamic Systems and Control

Problem Set 6

Problem 1

Given the unity feedback system of Figure 1 with

$$G(s) = \frac{Ks(s+2)}{(s^2-4s+8)(s+3)}$$

a. Find the range of K for stability.

b. Find the frequency of oscillation when the system is marginally stable.

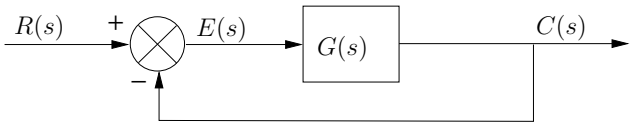


Figure 1: Unity feedback system

Problem 2

For the unity feedback system of Figure 1 with

$$G(s) = \frac{K(s+2)}{(s^2+1)(s+4)(s-1)}$$

find the range of K for which there will be only two closed-loop, right-half-plane poles.

Problem 3

Using the Routh-Hurwitz criterion and the unity feedback system of Figure 1 with

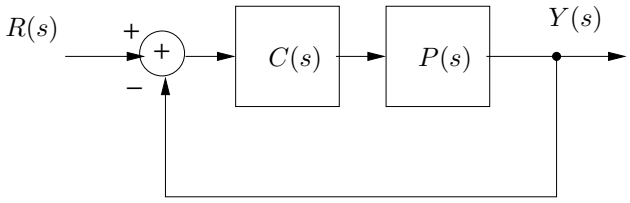
$$G(s) = \frac{K}{s(s+1)(s+2)(s+5)}$$

a. Find the range of K for stability.

b. Find the value of K for marginal stability.

c. Find the actual location of the closed-loop poles when the system is marginally stable.

Problem 4



You are given an unstable plant with a transfer function $P(s) = \frac{1}{(s+7)(s-1)}$. You are to design a proportional controller, $C(s) = K$, such that the closed-loop system is BIBO stable and meets the following performance specifications:

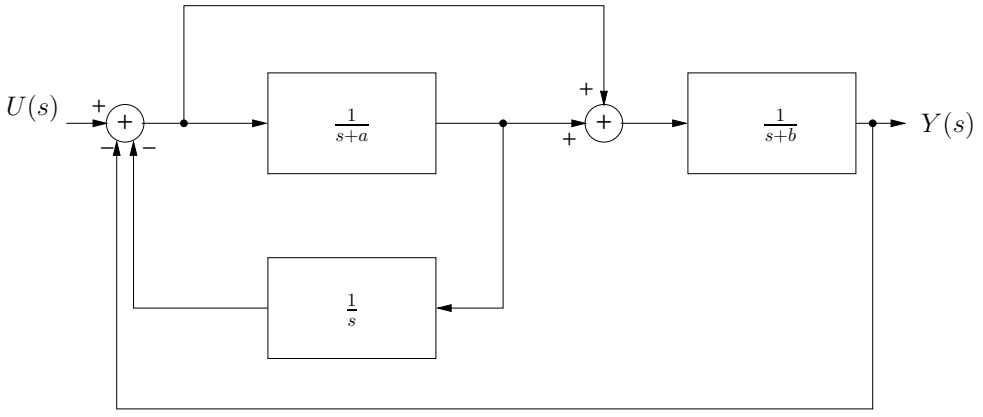
1. Rise time $T_r < 0.5$ seconds (where $T_r = \frac{1.8}{w_n}$)
2. Percent overshoot $\%OS < 50\%$

(a) Sketch the region in the complex plane where you would like the poles of the closed-loop system to be.

(b) Using any method, choose a gain K that will meet the performance specifications.

Problem 5

Consider the block diagram depicted below, where a and b are real numbers.



(a) Find the transfer function $\frac{Y(s)}{U(s)}$.

(b) Set $b = 1$ and find, if any, all values of a for which the closed-loop system is *unstable* (not BIBO stable).

(c) Set $a = 0$ and find, if any, all values of b for which the closed-loop system is BIBO stable.

Problem 6

Given the system $Y(s) = G(s)U(s)$, where

$$G(s) = \frac{1}{s^6 + s^5 + 5s^4 + s^3 + 2s^2 - 2s - 8}$$

(a) Determine if the system is BIBO stable.

(b) Determine the number of poles of the system which are in the open left half plane, the open right half plane, and on the imaginary axis (if possible).