Swansea University

College of Engineering

EGLM03 Modern Control Systems

Homework 1: Revision

Problems

1. Find the closed-loop characteristic equation of the system illustrated in Figure 1 when:
   A. $$G(s) = \frac{1}{s+1}$$
   when
   $$H(s) = 1,\ \frac{1}{s+2} \text{ and } s.$$
   B. $$G(s) = \frac{K(s+2)}{s\left(s^2+s+1\right)}$$
   when
   $$H(s) = \frac{s+1}{s+10}.$$

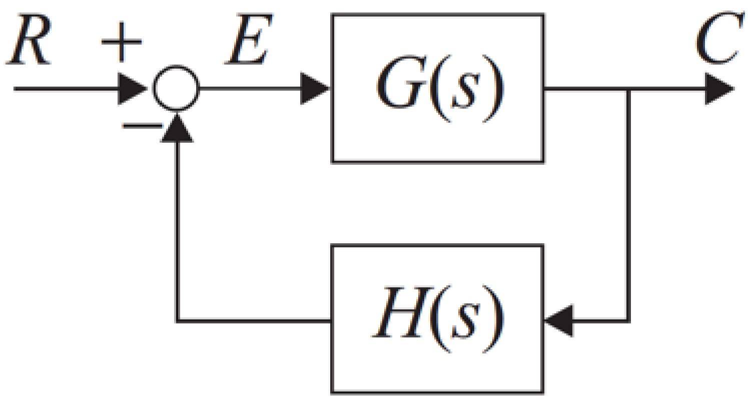

Figure 1: A Closed Loop System

1. A feedback control system has an open-loop transfer function
   $$G(s) = \frac{K(s+2)}{(s+1)(s-5)}$$
   and unity gain feedback. Find the values of K for which the system is closed-loop stable.

1. A control system has the root-locus shown in Figure 2. Find the closed-loop poles, natural frequency ω_n and gain K when the damping ratio $\zeta = 0.0,\ 0.1,\ 0.5$ and 1.0.

   What values of gain and damping ratio satisfy the constraints $2 < \omega_n \leq 10$ rads^{-1}.

   Is it possible to satisfy the following constraints: rise-time $T_r \leq 0, 4$ seconds and peak overshoot $M_p \leq 0.2$ (20%) by adjusting the forward loop gain only?

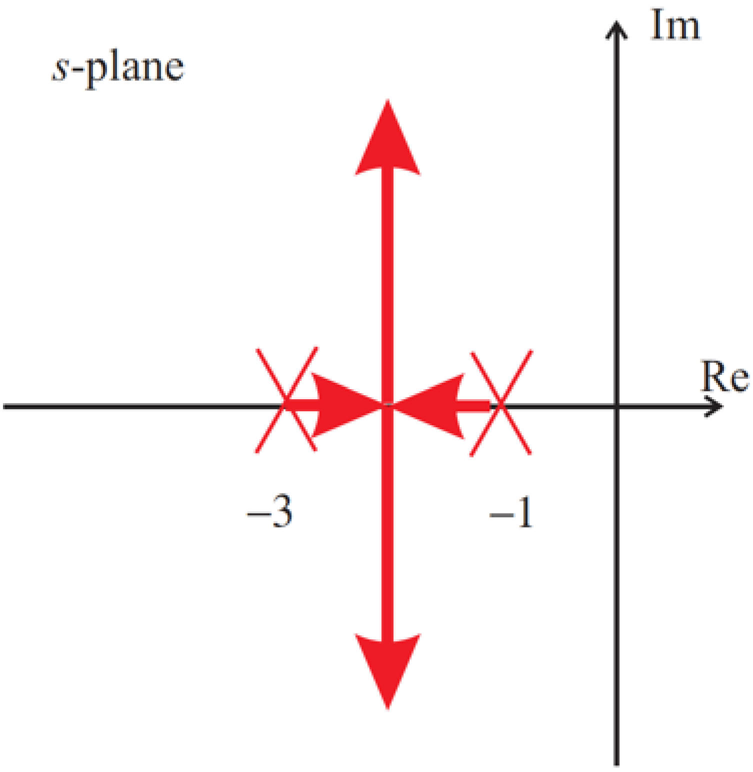

Figure 2: Root Locus Diagram for Question 3

1. Sketch the root-locus diagram for the system of Question 2. Find the value of the open-loop gain that yields closed-loop poles having ideal damping $\left(\zeta = 1/\sqrt{2}\right)$.

1. For the system shown in Figure 1

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

   and

$$H(s) = h.$$

   Find the steady-state step error of of the closed-loop system and determine its system type number. What is the system type number when $h = 1$?

1. A general second-order closed-loop control system has the transfer function

$$G_c(s) = \frac{b_1 s + b_0}{s^2 + a_1 s + a_0}$$

Find suitable values of the parameters b_1 , b_0 , a_1 , and a_0 that provide rise-time $Tr \leq 0.1$ s, settling-time $T_s \leq 0.5$ s, peak-overshoot $\%\mathrm{OS} \leq 20\%$, zero steady-state step error and a ramp error of 0.01.