Spring 2020

İSTANBUL BİLGİ UNIVERSITY
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

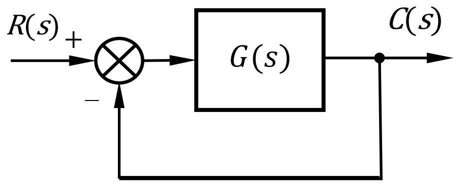
EEEN 352 System Dynamics and Control

Homework 03

Due: 01-May-2020
Friday 23:59

Problem 1) For the unity-feedback system given, where

$$G(s) = \frac{K}{s(s+10)}$$



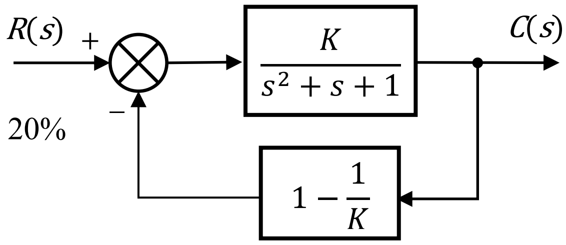
(a) Obtain the closed-loop transfer function and calculate the value of gain K in order to obtain a 12% overshoot to a unit step input

(b) Propose a new underdamped system to produce unit step response with the same percent overshoot and steady-state value but two times faster in terms of settling time.

(c) Write the unit step response in a general form.

(d) Sketch the time responses for **(a)** and **(b)** on the dame plane.

Problem 2) For the system given in the figure on the right-hand side, where the input is unit step.



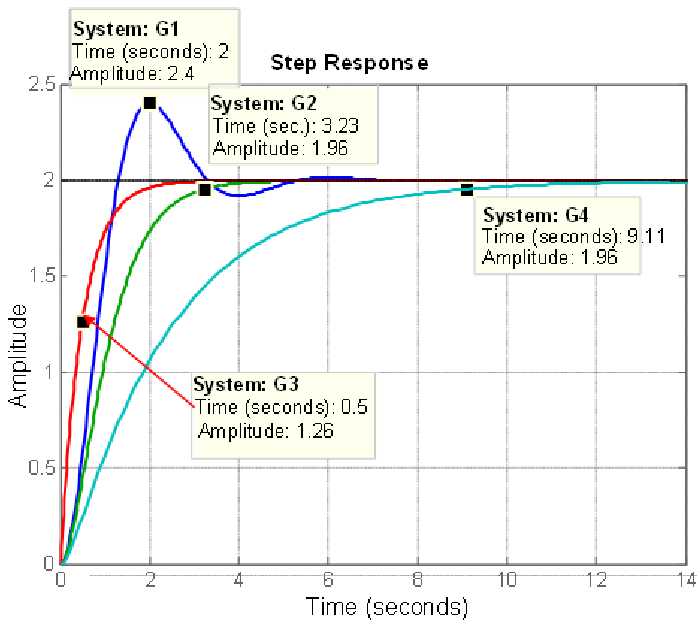
(a) Find the value of gain K that yields maximum 20% overshoot,

(b) Find the peak time for this gain,

(c) Find the settling time for this gain,

(d) Find the value of gain K to obtain the fastest response without any oscillation.

Problem 3) Considering the four different unit step responses plotted on the right-hand side,



(a) Propose a transfer function that produced underdamped response.

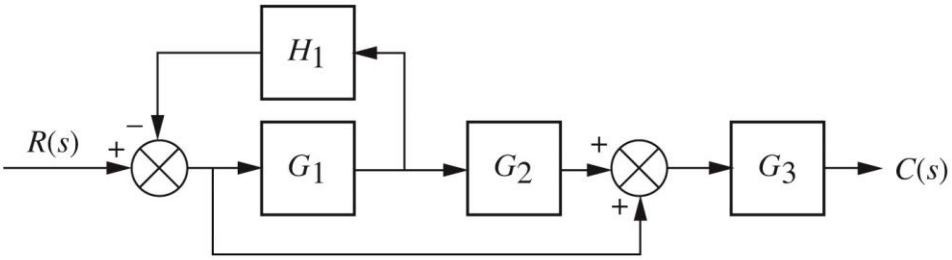
(b) Write a general expression for the response of G1.

(c) What would be the order of the system G3? Why? Propose a transfer function.

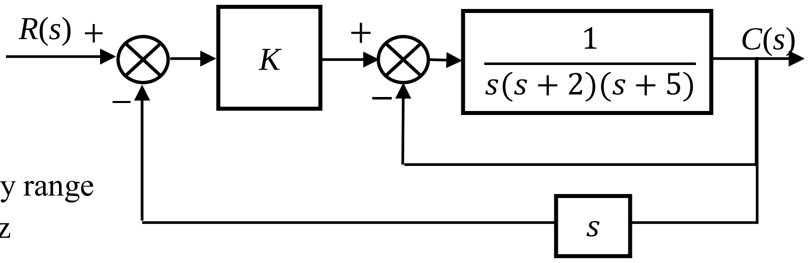
(d) Which system would be critically damped? Why? Write its transfer function with the same ω_n of G1.

$T_p = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}}$, $T_s \cong \frac{4}{\zeta\omega_n}$, $\%OS = 100.e^{-\zeta\pi/\sqrt{1-\zeta^2}}$, $\zeta = \frac{-\ln(\%OS/100)}{\sqrt{\pi^2+\ln^2(\%OS/100)}}$, $\lim_{t\to\infty} f(t) = \lim_{s\to 0} sF(s)$,

Problem 4) Find the closed-loop transfer function, $T(s) = C(s)/R(s)$ for the system presented below.



Problem 5) For the feedback control system given in the figure below,



- **(a)** Find the closed-loop transfer function, $T(s) = C(s)/R(s)$,
- **(b)** Determine the system's stability range for gain K using Routh-Hurwitz criterion,
- **(c)** The system type for K=20 (convert the system to a simple unity feedback),
- **(d)** The steady-state error for an input step of $5u(t)$ for this gain,
- **(e)** The steady-state error for an input ramp of $5tu(t)$ for this gain.