قسم الهندسة الكهربائية والالكترونية
ربيع 2025/2024

جامعة مصراتة – كلية الهندسة
الامتحان النهائي
نظم تحكم 1

الأربعاء 2025/06/18
الزمن: ساعتان ونصف

***Q1** (10 points).* For the closed loop control system shown in figure (*1*).

- Determine the value of the two system variables K and α so that the maximum overshoot is 35% and the peak time is 1.5 sec.

- Find also the value of the rise time and the setting time.

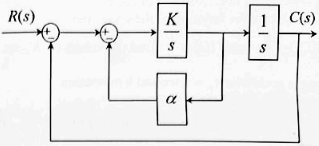


Figure (*1*)

***Q2** (10 points).* Consider the open loop system described by the transfer function *G(s)* and configured as in the block diagram of figure (*2*). If the input signal is given as ($u(t) = 20\sin 5t$) and

$$G(s) = \frac{(s+5)}{(s+2)(s+1+j)(s+1-j)}.$$

(a) Is this system being a stable system? Why?
(b) If the system is stable, find the response of this system as a function of time ($y(t)$).
(c) If the system was configured in a closed loop control with a gain K, sketch an approximate plot of the root locus of the system.

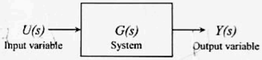


Figure (2)

***Q3** (10 points).* For the system described by the block diagram of figure (*3*) with: $G_1 = 1,\ G_2 = \frac{K}{s+3},\ G_3 = \frac{1}{s+2},\ G_4 = 1$ and $G_5 = \frac{1}{s+4}$.

a - Find the overall all transfer function that relates the output signal *Y(s)* to the input signal *U(s)*.
b - Find the values of K for which this control system is stable.

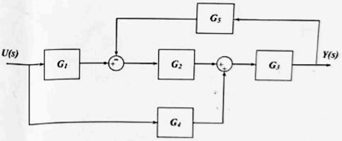


Figure (*3*)

***Q4** (10 points).* For the control system of the figure *(4)*,
$G(s) = \dfrac{(s+4)}{(s^2+5s+5)}, C(s) = K,\ H(s) = \dfrac{1}{(s+4)}$ and $U(s) = \dfrac{1}{s}$. Find the following:

a) The overall transfer function of the system.
b) The expression of the error signal as a function of time e(t), for K=1.
c) The relation between the steady state error and the controller gain.
d) The values of the gain K that keeps this control system stable.

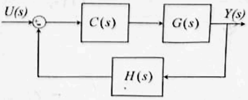


Figure (4)

Q5 (*10 points*). For the control system shown in the block diagram of figure (*5*):

a- What is the time constant of the process.

b- If the transfer function of the controller is $G_c(s) = \frac{K_I}{s}$ and $U(s) = \frac{1}{s}$, find the values of K_I to have a peak time $t_p = 2\,\text{sec}$ and a maximum overshoot $M_p = 15\%$.

c- What is the time constant of the overall system.

d- Find the transfer function that relates the output signal to the load *L(s)*.

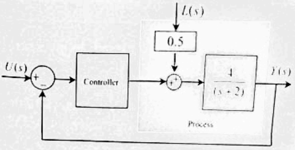


Figure (5)

Q6 (10 *points*). For the control system described by the open loop transfer function,

$$G(s) = \frac{(1+10\,s)}{s\,(1+s)\,(1+0.1\,s)\,(1+.01s)}$$, plot Bode diagram and find the gain and phase margins.

Control theory I	Second Exam (Spring 2024-2025)	Date 02/06/2025 Time: 1:15 hour

***Q1** (4 points)*. Consider the open loop system described by the transfer function *G(s)* and configured as in the block diagram of figure (*1*). If the input signal is given as ($u(t) = 20 \sin 5t$) and

$$G(s) = \frac{(s+5)}{(s+2)(s+1+j)(s+1-j)}.$$

(a) Is this system being a stable system? Why?
(b) If the system is stable, find the response of this system as a function of time ($y(t)$).
(c) If the system was configured in a closed loop control with a gain K, sketch an approximate plot of the root locus of the system.

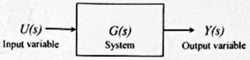
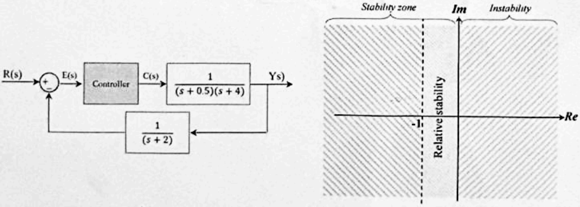


Figure (*1*)

Q2 (4 *points*). For the control system described by the open loop transfer function,
$G(s) = \frac{K\,(s+1)}{s(s+10)\,(s+100)}$, plot Bode diagram and find the gain and phase margins for $K = 10000$.

***Q3** (7 points (5+2))*. For the control system of figure *(2-a)*:

1. If the control strategy is a proportional control with an amplification term *K*.
   a. Find the overall transfer function of the system.
   b. Find the open-loop transfer function of the system.
   c. The characteristic equation of the system.
   d. Find the values of *K* that keeps stable this control system.
   e. Find the values of *K* that keeps the roots of the characteristic equation of this system out of the relative stability zone (refer to figure (*2-b*)).



(a) (b)

Figure (*2*)

2. If we want to use the PID controller schematized in figure (*3*). Using the Ziegler-Nichols methods, what values of K_C, T_I and T_D we must use to obtain an optimal response of the system.

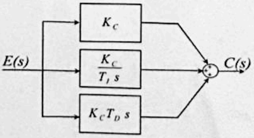


Figure (*3*)

Control theory I	First Exam (Spring 2024-2025)	Date 29/04/2025 Time: 1:15 hour

***Q1** (3 points).* Consider the system described by the following differential equation:

$$2\,x'' + 6\,x' + 8\,x - u(t) = 0$$

Knowing that $u(t)$ is the input signal to the system, $x(t)$ is the output signal of the system, and all the initial conditions are zeros.

a) Find the transfer function $G(s)$ that relates the output to the input.
b) Is the system in the standard form? If not identify it to the standard form.
c) Find the values of the undamped naturel frequency (ω_n) and the damping ratio (ζ) of the system.

***Q2** (2 points).* Consider the system described by the following transfer function:

$$G(s) = \frac{k}{s^2 + 4k\,s + k}$$

Find the value of the variable k that gives the most rapid response without any oscillations to a step input to the system.

***Q3** (4 points).* For the control system of the figure *(1)*,
$G(s) = \dfrac{(s+4)}{s(s+2)(s+3)}$, $C(s) = K$ and $H(s) = \dfrac{1}{(s+1)}$.

Find :
a) The overall transfer function of the system.
b) The open loop transfer function of the system.
c) The characteristic equation of this system.
d) The values of the gain K that keeps this control system stable.

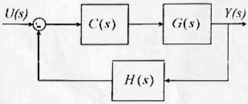


Figure (1)

***Q4** (6 points).* Consider the control system of figure (2-a) with $G_c(s) = \dfrac{1}{\alpha}$ and $G(s) = \dfrac{1}{s^2 + 0.8s + 1}$. The response of the system, $y(t)$, to a <u>step input of amplitude 10</u> is shown in figure (2-b).

(a) Find the value of the parameter α.
(b) Find the value of the damping ratio (ξ_p) and the time constant (τ_p) of the process $G(s)$.
(c) Find the value of the damping ratio (ξ) and the time constant (τ) of the overall system.
(d) Find the peak time t_p, the rise time t_r and the setting time t_s of the response of the overall system.

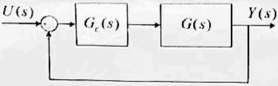


Figure (2-a)

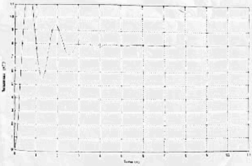


Figure (2-b)

Figure (2)