بسم الله الرحمن الرحيم

King Abdulaziz University
Engineering College
Department of Production and Mechanical System Design

MENG 366 Automatic Control

Final Exam
Closed-book Exam
Saturday: 25/11/1424 H
Time Allowed: Two Hours

Name:	Sec. No.:	ID No.:

Question 1		10
Question 2		10
Question 3		10
Question 4		10
Question 5		10
TOTAL		50

إِن اللَّهَ يُمْسِكُ السمَاوَاتِ وَالأَرْضَ أَن تَزُولا وَلَئِن زَالَتَا إِنْ أَمْسَكَهُمَا مِنْ أَحَدٍ من بَعْدِهِ
إِنهُ كَانَ حَلِيماً غَفُورا

Instructions

1. There are totally 5 problems in this exam.
2. Show all work for partial credit.
3. Assemble your work for each problem in logical order.
4. Justify your conclusion. I cannot read minds.

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1. Are these statements **true** or **false**?

		True	False
a.	The initial value theorem relates the steady state behavior of $sF(s)$ in the neighborhood of s=0.	☐	☐
b.	In control theory, the transfer functions are commonly used to characterize the input-output relationship of linear time-invariant systems	☐	☐
c.	The transient response of a practical control system often exhibits damped oscillations before reaching a steady state.	☐	☐
d.	A linear time-invariant control system is stable if the output eventually comes back to its equilibrium state when the system is subjected to initial conditions.	☐	☐
e.	The open-loop poles are the roots of the characteristics equation.	☐	☐
f.	The main advantage of using the Bode plot is that multiplication of magnitudes can be converted into addition.	☐	☐
g.	Nyquist plot are polar plots, while Bode plots are rectangular plots.	☐	☐
h.	The Nyquist stability criterion determines the stability of an open-loop system from its closed-loop poles.	☐	☐
i.	If there is one clockwise encirclement of Nyquist contour of $G(s)H(s)$ of the -1+0j point, the system is NOT stable.	☐	☐
j.	While conventional control theory is based on the transfer function, modern control theory is based on the description of system in state space.	☐	☐

2. Consider the system shown in Figure (1)

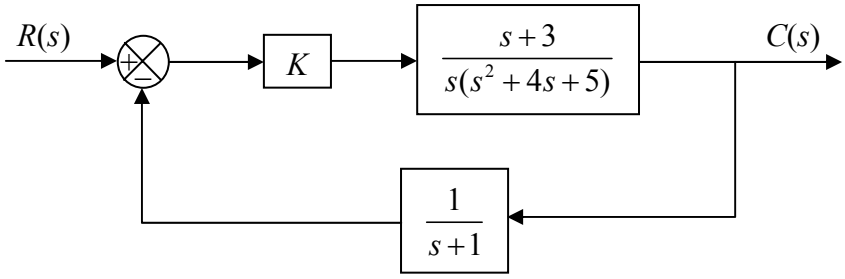

Figure (1)

a) Find the open-loop transfer function of the system.

b) Find the closed-loop transfer function of the system.

c) Find the characteristics equation of the system.

d) Using Routh's stability criterion, determine all values of K for which the system is STABLE.

3. Obtain a state space representation of the mechanical system shown below in Figure (2) where u_1 and u_2 are inputs and y_1 and y_2 are outputs.

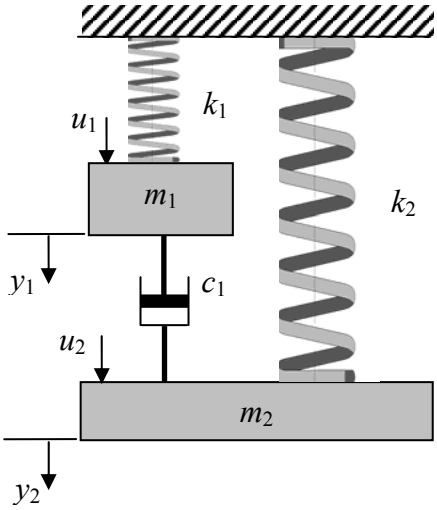

Figure (2)

4. Referring to the system shown in Figure (3), determine the values of K_1 and K_2 such that maximum overshoot will be 4.6 % and settling time will be 1.5 second (2% percent criterion).

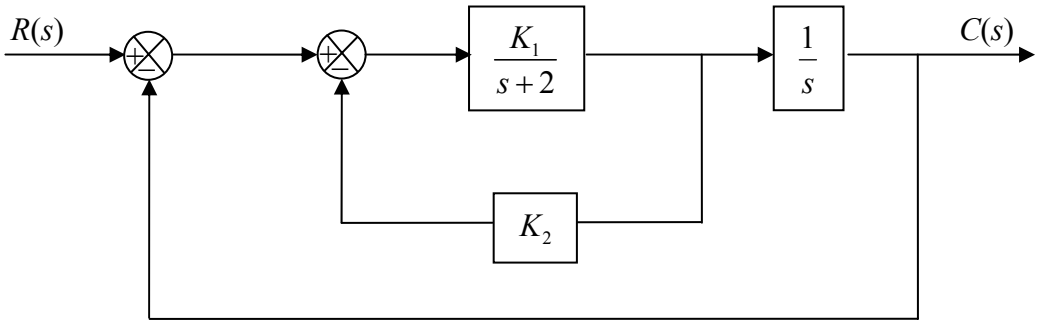

Figure (3)

5. Consider the following equation of motion of a mechanical system:

$$\ddot{y} + 5\dot{y} + 6y = \dot{u} + 6u$$

a) Determine the transfer function $Y(s)/U(s)$ of the system.

b) Obtain the state space representation of the system in controllable canonical form.

c) Is the system completely state controllable? Why?

d) Is the system completely state observable? Why?