Kafrelsheikh University
Faculty of Engineering
Electrical Engineering Department
Final Exam, 2018/2019
Dr. Abdel-Fattah Heliel

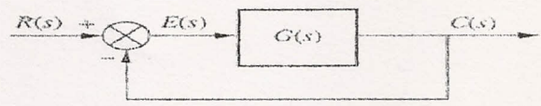
3rd Year (Electrical Engineering)
Automatic Control (2)
Time: 180 minutes
Marks= 90
Date: 6 / 1 / 2019

Intended learning outcomes (ILOs): [a1, a4, a12 , b2, b6, b11, b12, b14, c3,c14]

Problem 1: (35 Marks) - ILOs: [a1, a12, b2, b6, c3]

i. Construct the configuration of the electronic lag compensator using operational amplifiers and drive the transfer function of the compensator. (5 Marks)

ii. For a unity feedback system given below, with $G(s) = \dfrac{K}{s(s+5)(s+11)}$ (15 Marks)



do the following

(a) Find the gain K, for the uncompensated system to operate with a 30% overshoot. (10 Marks)

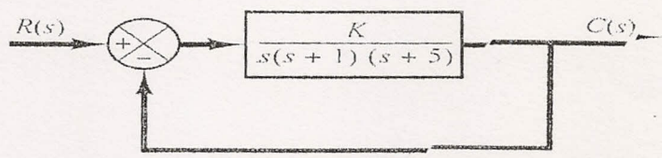
(b) Find the peak time and K_v for the uncompensated system. (10 Marks)

(c) Design a lag-lead compenator to decrease the peak time by a factor of 2, decrease the percent overshoot by a factor of 2, and improve the steady-state error by a factor of 30. Specify all poles, zeros and gains. (10 Marks)

Problem 2: (30 Marks) - - (ILOs): [a12, b2,b6, b11]

a) Define gain margin, phase margin and explain graphically. What are the gain margin and the phase margin indicate? (10 Marks)

b) Obtain the phase and gain margins of the system shown in following figure for the two cases where K=10 and K=100. (10 Marks)



c) Draw the polar plot of the system and Comment on the stability of the system. (10 Marks)

Problem 3 (30 Marks) - - (ILOs): [a1, b2, b14, c3, c14]

a) What are controllability and observability of control systems? (5 Marks)

b) For the following system, compute by hand the controllability matrix, observability matrix and determine whether the system is observable. (10 Marks)

$$\dot{x} = \begin{bmatrix} 1 & 1 & 2 \\ 3 & 5 & 8 \\ 13 & 21 & 34 \end{bmatrix} x + \begin{bmatrix} \cdot \\ \cdot \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 0 & 3 & -5 \end{bmatrix} x$$

c) Find the transfer function and poles of the system represented in state space below. (10 Marks)

$$\dot{x} = \begin{bmatrix} 8 & -4 & 1 \\ -3 & 2 & 0 \\ 5 & 7 & -9 \end{bmatrix} \times \begin{bmatrix} -4 \\ -3 \\ 4 \end{bmatrix} u(t)$$

$$y = \begin{bmatrix} 2 & 8 & -2 \end{bmatrix} \quad x(0) = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$