Kafrelsheikh University
Faculty of Engineering
Electrical Engineering Department
Final Exam, 2019/2020
Dr. Abdel-Fattah Heliel

3rd Year (Electrical Engineering)
Automatic Control Engineering
Time: 180 minutes
Marks= 90
Date: 5-1-2020

Answer all the following questions:

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

Problem 1: (30 Marks) - - (ILOs): [a1, a12, b2, b6, c3]

a) Construct the configuration of the electronic lag compensator using operational amplifiers and drive the transfer function of the compensator. **(10 Marks)**

b) Design a lag-lead compensator for the system of Figure 1 so that the system will operate with 20% overshoot and a twofold reduction in settling time. Further, the compensated system will exhibit a tenfold improvement in steady-state error for a ramp input. **(20 Marks)**

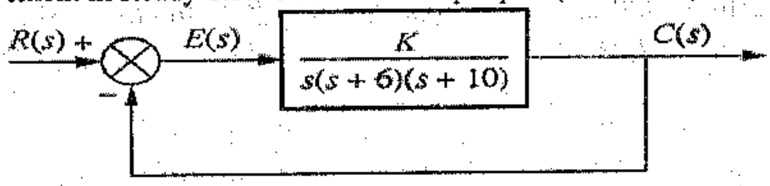

Figure 1

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) Consider a unity feedback system having an OLTF $G(s) = \frac{K}{S(1+0.5S)(1+4S)}$, Sketch the polar plot and determine the value of K so that: (i) GM = 20 dB, **(8 Marks)** and (ii) PM = 30^{0} , **(8 Marks)**. Comment on the stability of the system **(4 Marks)**.

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

a) Draw the bode plot of the system and Comment on the stability of the system. **(15 points)**

$$G(s) = \frac{K(s+3)}{s(s+1)(s+2)}$$

b) Consider the type 1 servo system shown in Figure 2. Matrices A, B, and C in Figure 3 are given by: **(15 points)**

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -5 & -6 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad \text{and } C = [1 \quad 0 \quad 0]$$

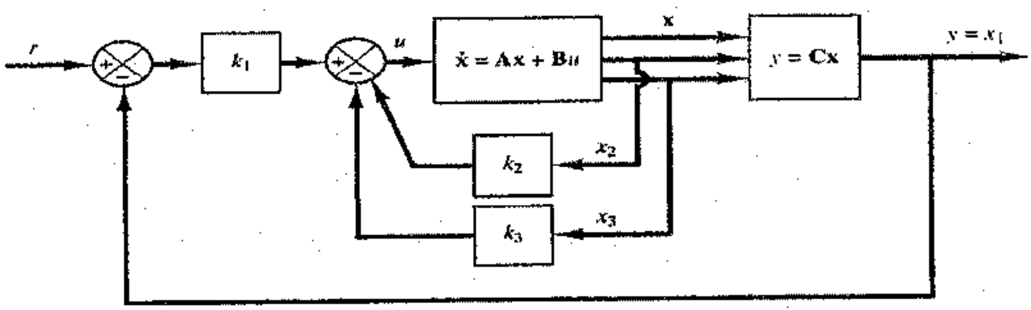

Figure 2

i. Determine the feedback gain constants k_1, k_2, and k_3, such that the closed-loop poles are located at $s_1 = -2 + j4$, $s_2 = -2 - j4$, $s_3 = -10$.

ii. Find the closed-loop transfer function (controller and plant)