Ref. No. Ex/EE/PC/B/T/313/2024(S)

B.E. ELECTRICAL ENGINEERING THIRD YEAR FIRST SEMESTER SUPPLEMENTARY EXAM - 2024

LINEAR CONTROL SYSTEM

Part - I

Time: Three Hours; Full Marks: 100 (50 Marks for each Part)
Use Separate Answer script for each part

Answer any *three* questions from this part.
Two marks reserved for neat and well-organized answer

1. a) Explain the difference between a static system and a dynamic system with appropriate examples. 4x4

   b) What do you understand by the terms *dominant poles* and *non-dominant poles* of a system.

   c) Define voltage resolution of a potentiometer. What is the voltage resolution of a carbon potentiometer?

   d) Briefly discuss the effect of addition of a non-minimum phase zero to a critically damped second order system.

2. For the system shown in Fig. 1, determine the values of gain K and velocity feedback constant K_h so that the maximum overshoot in the unit step response is 0.2 and the peak time is 1 sec. With these values of K and K_h, obtain the rise time and settling time. 16

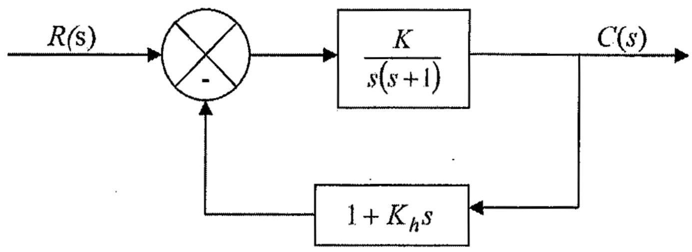

Fig. 1

3. a) Find the position, velocity and acceleration error constants and corresponding steady-state errors for the unity feedback control system having open-loop transfer function 8+8

$$G(s) = \frac{20}{s(s+5)(s+2)},$$

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b) Find the steady state errors for the system shown in Fig. 2 to the following:
(i) unit step input (ii) unit ramp input (iii) unit parabolic input.

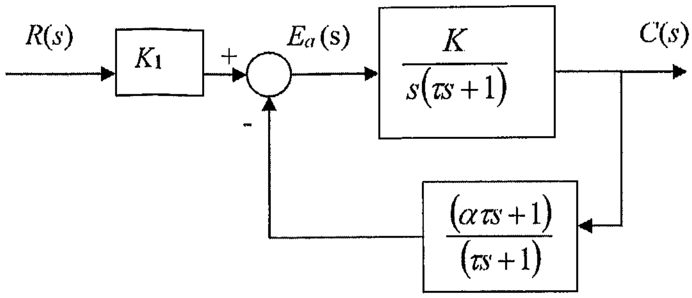

Fig.2

4. Write short notes on (*any two*): 8+8

a) Effect of output rate feedback on a standard second order system

b) Armature controlled D.C. servo motor

c) Voltage regulator

5. The transfer function of a plant is given by 16

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

Design a suitable compensator to meet the following specifications:

a) Velocity constant $K_v \geq 10\ \text{sec}^{-1}$.

b) Phase margin $\phi_m \geq 30^\circ$.

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B.E. ELECTRICAL ENGINEERING THIRD YEAR FIRST SEMESTER SUPPLEMENTARY EXAMINATION, 2024

Linear Control System

Part-II

Use a separate Answer-script for each part

Time: Three Hours **Full Marks: 100/50√**

Answer any Three questions. Two Marks are reserved for neat and well organized answers.

Q1a) By means of Routh's criterion, determine the stability of the system represented by the following characteristic equation. 08

$$q(s) = s^5 + s^4 + 3s^3 + 9s^2 + 16s + 10 = 0$$

Q1b) Determine the range of gain K such that the feedback system having the following characteristic equation will remain stable. 08

$$q(s) = s^3 + 3Ks^2 + (K+2)s + 4 = 0$$

Q2) Plot the Root-Locus for a unity feedback system whose open-loop transfer function is as follows

$$G(s)H(s) = \frac{K}{s(s+2)(s+4)}$$

Also determine and indicate on the sketch i) number and angles of asymptotes, ii) the centroid, iii) the breakaway point/ points, if any, iv) intersection of the root locus and the asymptotes with the imaginary axis, if any v) the range of gain K for which the closed loop system remains stable, vi) any other value that has relevance to the plotting of root locus. 16

Q3) By use of Nyquist criterion, determine whether the closed-loop system having the following open-loop transfer function is stable or not. If not, how many closed-loop poles lie in the right half s-plane? 16

$$G(s)H(s) = \frac{s+2}{(s+1)(s-1)}$$

Q4a) A system is described by

$$T(s) = \frac{C(s)}{U(s)} = \frac{6s^3 + 4s^2 + 3s + 10}{s^3 + 8s^2 + 4s + 20}$$

Define Phase Variables. Find the State Model of the system in Bush Form. 08

Q4b) A linear time invariant system is described by the following state equation. Obtain eigenvalues, eigenvectors and the state equation in canonical form. 08

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

Q5) Write short notes any two. 08+08

i) Signal flow graph
ii) Diagonalization of a non-diagonal system matrix
iii) Ascertaining phase margin and gain margin from open loop polar plot.