CBCS SCHEME

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18EE61

# Sixth Semester B.E. Degree Examination, Dec.2023/Jan.2024
## Control Systems

Time: 3 hrs. Max. Marks: 100

**Note:** ***Answer any FIVE full questions, choosing ONE full question from each module.***



### Module-1

1 a. Distinguish between Open loop and Closed loop control system with an example for each. **(06 Marks)**

b. Determine transfer function for the system shown by Fig. Q1(b). **(06 Marks)**

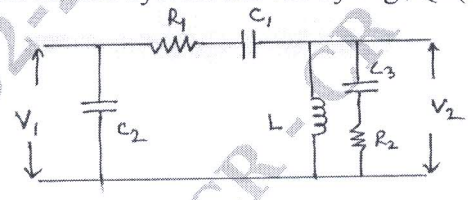


Fig. Q1(b)

c. Construct F.V. and F – I analogous electrical system for the mechanical system shown by Fig. Q1(c). **(08 Marks)**

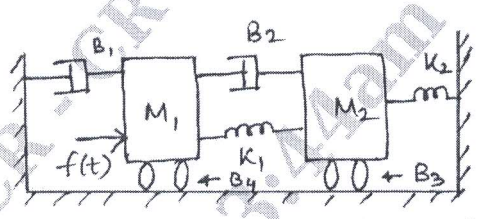


Fig. Q1(c)

**OR**

2 a. Deduce transfer function for the mechanical translational system shown by Fig. Q2(a). Consider $X_2$ as output and $X_1$ as input. **(06 Marks)**

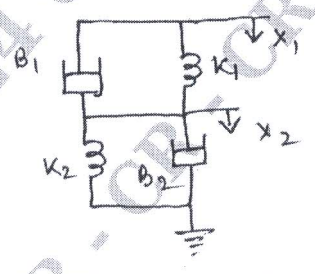


Fig. Q2(a)

b. Write the differential equations describing the mechanical rotational system shown in Fig. Q2(b) and obtain its T – V analogous electrical system. **(08 Marks)**

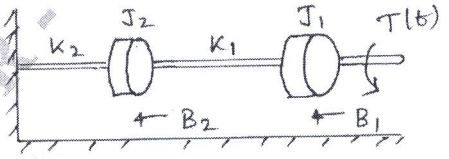


Fig. Q2(b)

c. Define Servomechanism. Explain AC servomotor and list its salient features. **(06 Marks)**

## Module-2

3 a. Obtain the overall transfer function for the system shown in Fig. Q3(a) using block diagram reduction technique. **(10 Marks)**

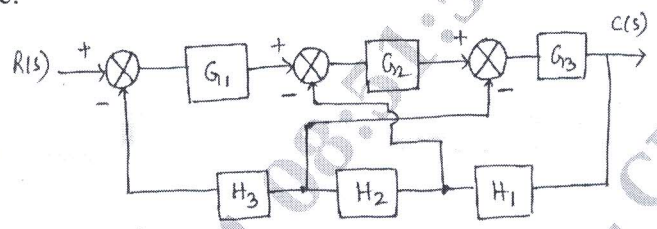


Fig. Q3(a)

b. Use Mason's gain formula to find the transfer function for the system given by signal flow graph shown in Fig. Q3(b). **(10 Marks)**

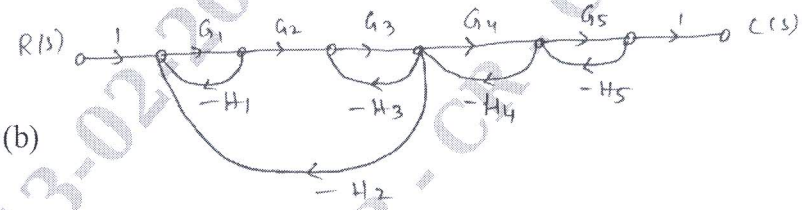


Fig. Q3(b)

**OR**

4 a. State Mason's gain formula. Construct the signal flow graph for the system expressed by the following set of equations.

$X_2 = G_1X_1 - H_1X_2 - H_2X_3 - X_6X_6$.
$X_3 = G_1X_1 + G_2X_2 - H_3X_3$
$X_4 = G_2X_2 + G_3X_3 - H_4X_5$
$X_5 = G_4X_4 - H_5X_6$.
$X_6 = G_5X_5$. **(10 Marks)**

b. For the block diagram, shown in Fig. Q4(b), determine the transfer function $\frac{C(s)}{R(s)}$. **(10 Marks)**

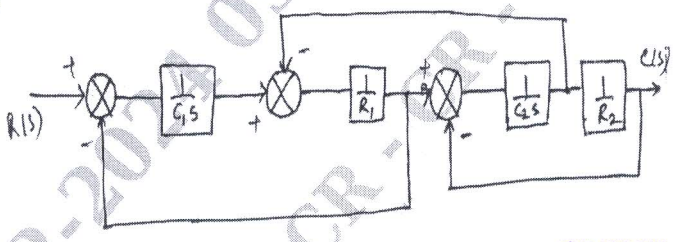


Fig. Q4(b)



## Module-3

5 a. Considering the response of a second order system to a unit step input, find an expression of rise time and peak time. **(07 Marks)**

b. An unity feedback system has $G(s) = \frac{20(1+s)}{s^2(2+s)(4+s)}$. Calculate its steady state error coefficients and error when the applied input is $r(t) = 40 + 2t + 5t^2$. **(07 Marks)**

c. The response of a servo mechanism is $C(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$, when subjected to a unit step input. Obtain an expression for closed loop transfer function. Determine undamped natural frequency and damping ratio. **(06 Marks)**

**OR**

6 a. State and explain Routh's stability criterion. **(04 Marks)**

b. A unity feedback control system has $G(s) = \frac{K(s+13)}{S(s+3)(s+7)}$. Using Routh's stability criterion calculate the range of K for which the system is i) Stable ii) Has its closed loop poles more negative than -1. **(10 Marks)**

c. Comment on the stability of a system using Routh's stability criterion whose characteristic equation is $S^4 + 2S^3 + 4S^2 + 6S + 8 = 0$. Find the number of poles in the right half of S plane. **(06 Marks)**

## Module-4

7 a. Sketch the complete root locus of system having $G(s)\,H(s) = \frac{K}{S(s+1)(s+2)(s+3)}$. Comment on the stability of the system. **(12 Marks)**

b. State and explain various frequency domain specifications. **(08 Marks)**

**OR**

8 a. Open loop transfer function of a system is given by $\frac{K}{S(s+3)(s^2+3s+11.25)}$. Find the valid breakaway point and angle of departure. **(08 Marks)**

b. Given $G(s) = \frac{80000}{S(s+2)(s+50)(s+200)}$ for a unity feedback control system. Draw the Bode plot and hence determine phase margin and gain margin.. **(12 Marks)**

## Module-5

9 a. Explain the effect of PD controller on the performance of 2nd order system. **(10 Marks)**

b. Sketch the nyquist plot for the system given by

$$G(s)\,H(s) = \frac{40}{(s+4)(s^2+2s+2)}.$$ **(10 Marks)**



**OR**

10 a. State and explain Nyquist stability criterion. **(04 Marks)**

b. List the effect of lag compensator and lead compensator. **(08 Marks)**

c. Explain the steps to design lead compensator. **(08 Marks)**

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