CBCS SCHEME

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18AS72

Seventh Semester B.E. Degree Examination, July/August 2022
Control Engineering

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. What are the requirements of an ideal control system? **(05 Marks)**

b. Compare open loop and closed loop system. **(05 Marks)**

c. Obtain the transfer function $E_o(s)/E_i(s)$ for the given electrical circuit in Fig.Q.1(c).

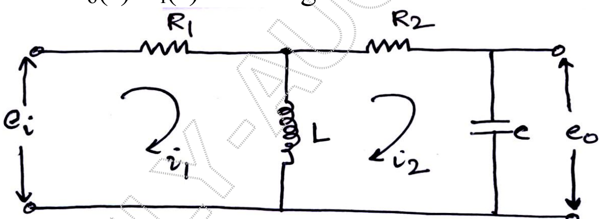

Fig.Q.1(c)

(10 Marks)

OR

2 a. Explain the concept of transfer function for a closed loop transfer function. **(08 Marks)**

b. Obtain the differential equations for the mechanical system shown in Fig.2(b) and draw the analogous electrical network based on (i) Force-voltage analogy (ii) Force-current analogy and verify by writing mesh and node equations. **(12 Marks)**

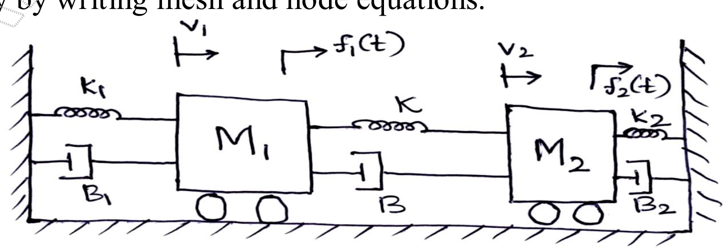

Fig.Q.2(b)

Module-2

3 a. Using block diagram reduction technique find closed loop transfer function C/R of the system shown in Fig.Q.3(a). **(10 Marks)**

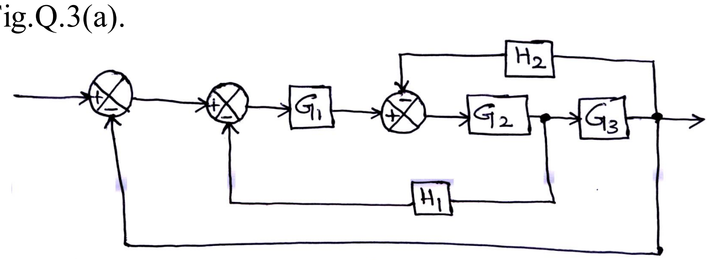

Fig.Q.3(a)

b. Find the overall transfer function of the system T(s) using Mason's gain formula whose signal flow graph is shown in Fig.Q.3(b). **(10 Marks)**

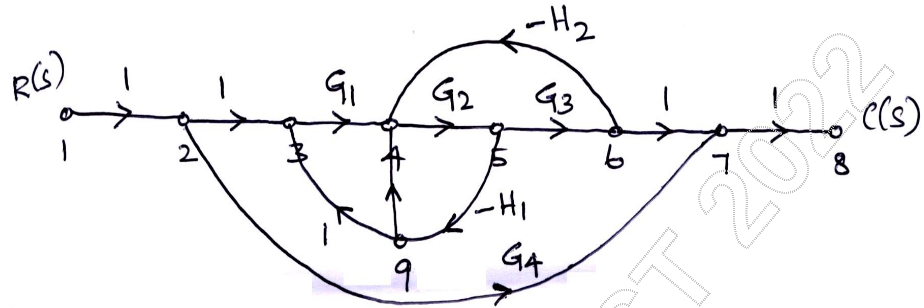

Fig.Q.3(b)

OR

4 a. Derive the expression for unit step response of critically damped second order system. **(10 Marks)**

b. The unity feedback system is characterized by an open loop transfer function $G(s) = \dfrac{K}{s(s+10)}$. Determine the value of K with system damping ratio 0.5 for this value of K. Determine peak overshoot and time at peak overshoot for a unit step input. **(10 Marks)**

Module-3

5 a. Construct Routh array and determine the stability of the system for the following characteristic equation: $s^5 + s^4 + 2s^3 + 2s^2 + 3s + 5 = 0$. **(05 Marks)**

b. Sketch the root locus of the system whose open loop transfer function $G(s) = \dfrac{K}{s(s+2)(s+4)}$.
Find the value of K and comment the stability of the system. **(15 Marks)**

OR

6 a. Write the procedure to determine phase Margin from bode plot with neat diagram. **(05 Marks)**

b. Draw the bode plot for the following open loop transfer function. From the plot determine gain and phase cross over frequency.

$$G(s) = \frac{20}{s(1+3s)(1+4s)}$$ **(15 Marks)**

Module-4

7 a. The open loop transfer function of a unity feed back system is given by $G(s) = \dfrac{1}{s(1+s)^2}$.
Sketch the polar plot using rectangular coordinates and determine the Gain Margin and phase Margin. **(12 Marks)**

b. Write short note on the following:
i) Corner frequency
ii) Frequency domain specifications
iii) Gain Margin
iv) Phase Margin. **(08 Marks)**

OR

8 a. What are M and N circles? Derive the condition of magnitude and phase of closed loop frequency response with unity feedback. **(14 Marks)**

b. Write down the steps involved to solve problems by Nyquist stability criterion. **(06 Marks)**

Module-5

9 a. What is compensation in control systems? Give explanation about lead-lag compensation with relevant expressions and diagrams. **(10 Marks)**

b. Discuss the following controllers with relevant transfer function:
i) PI controller ii) PID controller. **(10 Marks)**

OR

10 a. Consider the system with state representation

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & -1 \\ -6 & 11 & 6 \\ -6 & -11 & 5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$ **(10 Marks)**

b. Consider a system, where the state space representation is given by:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 2 & 0 \\ 4 & 0 & 1 \\ -48 & -34 & -9 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 24 & 17 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

Evaluate the observability of this system using Gilbert's test. **(10 Marks)**

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