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21AE72

Seventh Semester B.E./B.Tech. Degree Examination, Dec.2024/Jan.2025

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. Discuss the concept of control system and briefly explain about the requirements of an ideal control system. (10 Marks)
- b. Obtain the transfer function of the given electrical circuit.

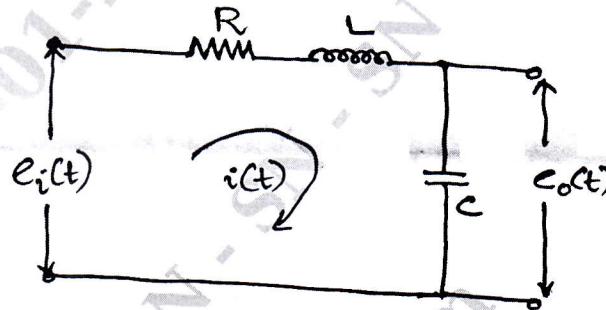


Fig Q1(b)

(10 Marks)

OR

- 2 a. Differentiate open loop and closed loop control system. (08 Marks)
- b. Obtain the differential equations for the mechanical system shown in Fig Q2(b), and draw the analogous electrical network based on :
 - i) Force – voltage analogy
 - ii) Force current analogy and verify by writing mesh and mole equation.

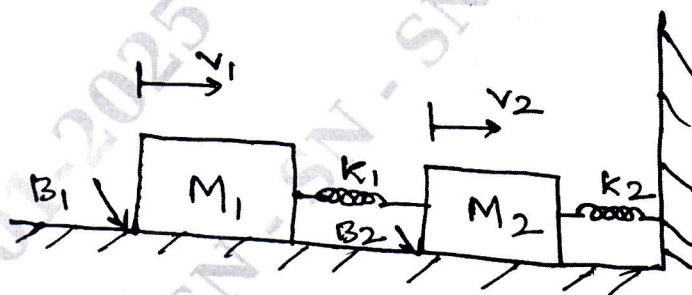


Fig 2(b)

(12 Marks)

Module-2

- 3 a. Using block diagram reduction technique, find the closed loop transfer function of the system whose block diagram is shown in Fig Q3(a)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

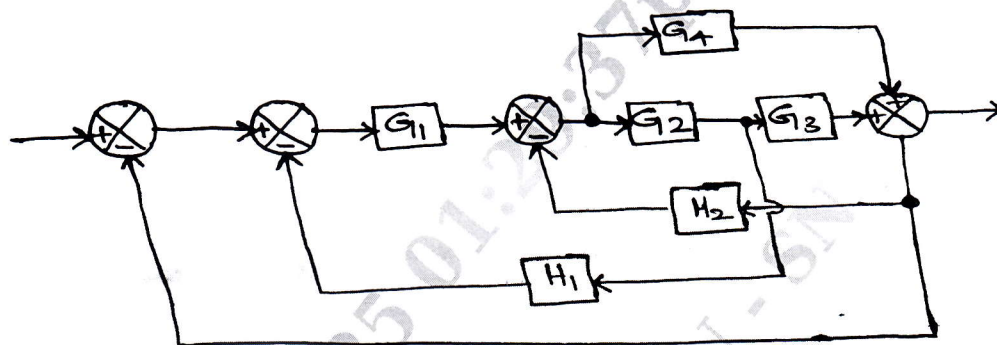


Fig Q3(a)

(10 Marks)

- b. Find the overall gain $C(s)/R(s)$ for the signal flow graph shown in Fig Q3(b).

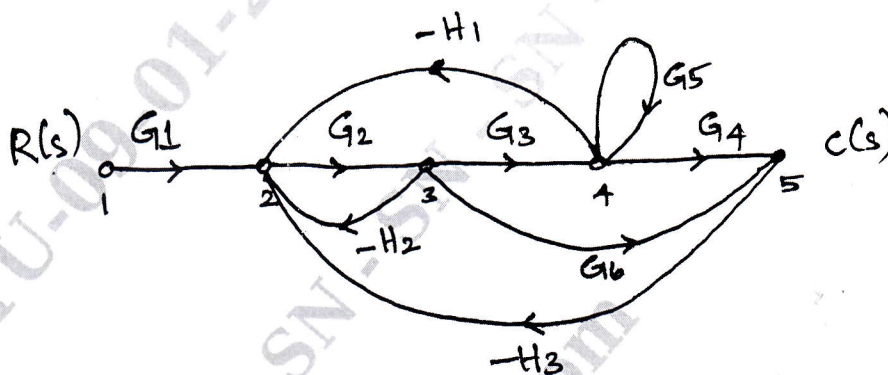


Fig Q3(b)

(10 Marks)

OR

- 4 a. Derive the expression for the response of critically damped second order system for unit step input. (12 Marks)
- b. A unity feedback system whose open loop transfer function is $G(s) = \frac{10}{s(s+2)}$. Find the damping ratio, rise time, percentage of overshoot and peak time. (08 Marks)

Module-3

- 5 a. Use the Routh stability criterion to determine the location of roots on the S-plane and stability for the system represented by the characteristics equation $s^5 + 4s^4 + 8s^3 + 8s^2 + 7s + 4 = 0$. (05 Marks)
- b. The open loop transfer function of a unity feedback system is given by $G(s) = \frac{k(s+9)}{s(s^2 + 4s + 11)}$. Sketch the root locus of the system. (15 Marks)

OR

- 6 Plot the Bode diagram for the following transfer function and obtain gain and phase cross over frequencies. (20 Marks)
- $$G(s) = \frac{10}{s(1+0.4s)(1+0.1s)}$$

Module-4

- 7 a. Describe about the frequency response specification with relevant expressions. (10 Marks)
 b. The open loop transfer function for a unity feedback system is given by

$$G(s) = \frac{10}{s(1+s)(1+2s)}$$
 Sketch the polar plot and determine the gain margin and phase margin. (10 Marks)

OR

- 8 a. Draw the Nyquist plot for the system whose open loop transfer function is

$$G(s)H(s) = \frac{K}{s(s+2)(s+10)}$$
 Determine the range of K for which closed loop system is stable. (12 Marks)
 b. Derive the conditions of M and N circles. (08 Marks)

Module-5

- 9 a. What are the controllers? Explain briefly of all types of controller with their transfer function. (10 Marks)
 b. Discuss about compensation methods. Derive their transfer functions of phase lead and phase lag network. (10 Marks)

OR

- 10 a. Write a note on the following terms :
 i) State variables
 ii) State equation
 iii) State space
 iv) State vector (08 Marks)

- b. Consider the system with state representation.

$$\dot{x} = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & -3 \\ 0 & 1 & -4 \end{bmatrix} x + \begin{bmatrix} 40 \\ 10 \\ 0 \end{bmatrix} u \quad \dot{y} = \begin{bmatrix} 0 & 0 & 1 \end{bmatrix} x$$

Evaluate the state controllability and output controllability.

(12 Marks)

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