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18EC43

Fourth Semester B.E. Degree Examination, Jan./Feb. 2023
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. Define Control System. Write the differences between open loop control system and closed loop control system. **(05 Marks)**

b. For the mechanical system shown in Fig.Q.1(b). Write: i) The mechanical network ii) The equations of performance iii) The electrical network based on Force-Current analogy. **(08 Marks)**

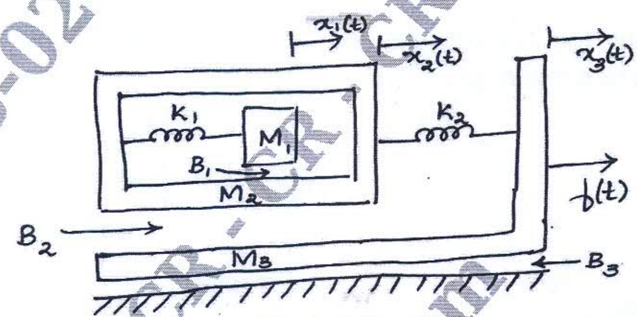

Fig.Q.1(b)

c. Find the transfer function $\frac{X_1(S)}{F(S)}$ for the system shown in Fig.Q.1(c). **(07 Marks)**

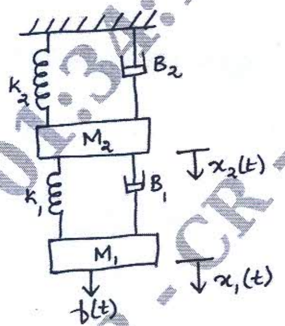

Fig.Q.1(c)

OR

2 a. What are the effects of feedback in control system? **(05 Marks)**

b. For the rotational system shown in Fig.Q.2(b) draw the mechanical network. Obtain the equations of performance and find the transfer function $\frac{\theta_1(S)}{T(S)}$. **(07 Marks)**

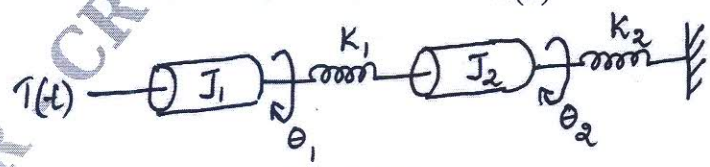

Fig.Q.2(b)

c. For the mechanical system shown in Fig.Q.2(c). Find the analogous electrical network based on Force-Voltage analogy. (08 Marks)

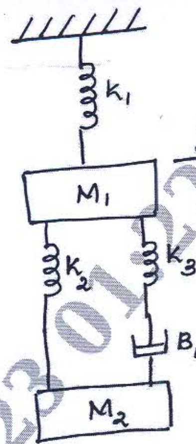

Fig.Q.2(c)

Module-2

3 a. Obtain the transfer function of the system shown in Fig.Q.3(a) using block diagram reduction technique.

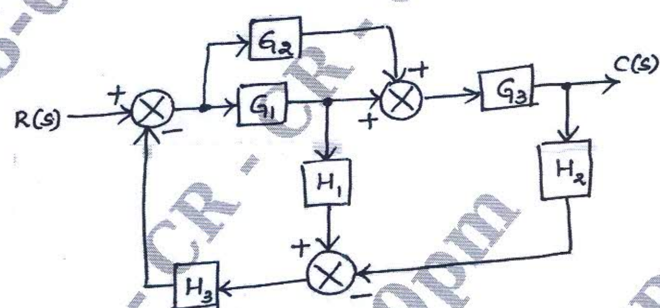

Fig.Q.3(a)

(10 Marks)

b. Find $\frac{C(S)}{R(S)}$ for the signal flow graph shown in Fig.Q.3(b) using Mason's Gain formula. (10 Marks)

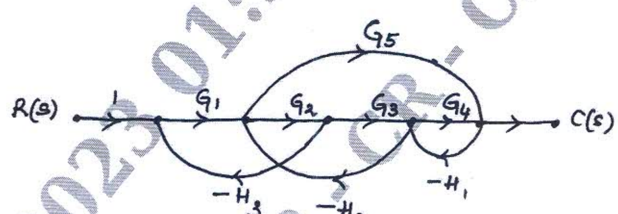

Fig.Q.3(b)

OR

4 a. Draw the corresponding SFG for the block diagram shown in Fig.Q.4(a) and obtain the transfer function using Mason's Gain formula. (10 Marks)

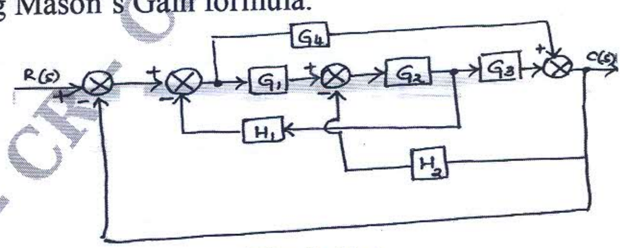

Fig.Q.4(a)

b. Find $\frac{C}{R}$ using block diagram reduction technique. **(10 Marks)**

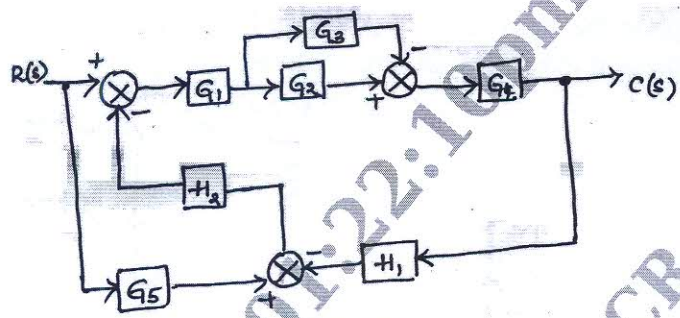

Fig.Q.4(b)

Module-3

5 a. Explain the following test signals with the help of graph and mathematical expression:
i) Step signal ii) Ramp signal iii) Parabolic signal. **(06 Marks)**

b. Derive the expression for the underdamped response of a second order feedback control system for step input. **(08 Marks)**

c. Derive the expression for rise time (T_r) of an underdamped second order system. **(06 Marks)**

OR

6 a. A unity feedback control system is characterized by an open loop transfer function $G(S)H(S) = \frac{K}{S(S+10)}$. Determine the system gain K, so that the system will have a damping ratio of 0.5. For this value of K, find the rise time, peak time, settling time and peak overshoot. Assume the system is subjected to a step of 1V. **(10 Marks)**

b. Find the position, velocity and acceleration error constants for a control system having open loop transfer function $G(S) = \frac{50}{S(S+5)}$. Also calculate, percentage overshoot for a unit step input, settling time for a unit step input and steady state error for an input defined by the polynomial $r(t) = 2 + 4t + 6t^2, t \geq 0$. **(10 Marks)**

Module-4

7 a. For the characteristic equation given by $S^4 + 25S^3 + 15S^2 + 20S + K = 0$. Determine: i) The range of value of K, so that the system is asymptotically stable ii) The value of K so that the system is marginally stable and find the frequencies of sustained oscillations. **(06 Marks)**

b. The open loop transfer function of a control system is given by

$G(S).H(S) = \frac{K}{S(S+1)(S+2)}$. Sketch the complete Root Locus. **(14 Marks)**

OR

8 a. Define:
i) Gain Margin
ii) Phase Margin
iii) Phase Cross Over Frequency. **(06 Marks)**

b. Plot the Bode diagram for the open loop transfer function of a unity feed back system given by $G(S) = \frac{100(0.1S+1)}{S(S+1)^2(0.01S+1)}$. Find Gain Margin and phase Margin. Also comment on the closed loop stability of the system. **(14 Marks)**

Module-5

9 a. Explain the steps involved in using Nyquist criterion. (06 Marks)

b. Represent the electrical circuit shown in Fig.Q.9(b) by a state model. (10 Marks)

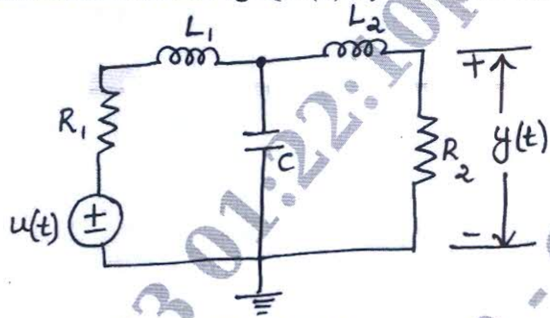

Fig.Q.9(b)

c. Write a short note on advantages of state variable approach. (04 Marks)

OR

10 a. Find the state transition matrix for

$$A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}.$$

(10 Marks)

b. Obtain state model for the given mechanical system shown in Fig.Q.10(b). (10 Marks)

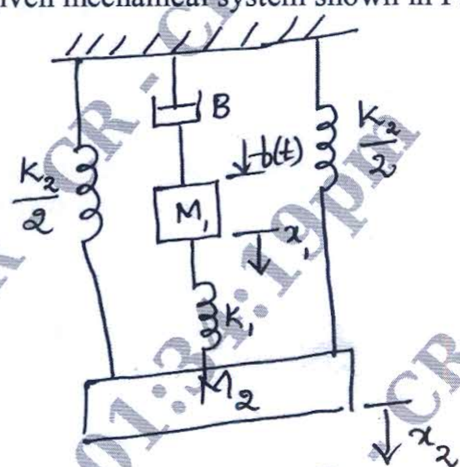

Fig.Q.10(b)

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