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18EC43

Fourth Semester B.E. Degree Examination, Dec.2024/Jan.2025
Control Systems

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of semilog graph sheets are permitted.

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.

Module-1

1 a. Define control system. Distinguish between open loop and closed loop systems with examples. **(07 Marks)**

b. For the mechanical system shown in Fig. Q1 (b),
(i) Draw mechanical network.
(ii) Write difference equations of performance.
(iii) Draw electrical network based on force voltage analogy. **(08 Marks)**

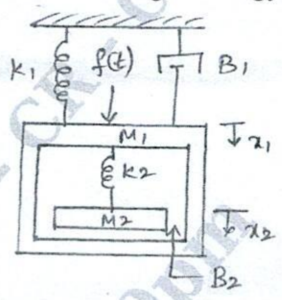

Fig. Q1 (b)

c. Discuss the effect of feedback on,
(i) Overall gain (ii) Stability **(05 Marks)**

OR

2 a. For the electromechanical system shown in Fig. Q2 (a), determine the transfer function $\frac{X(s)}{E(s)}$. **(10 Marks)**

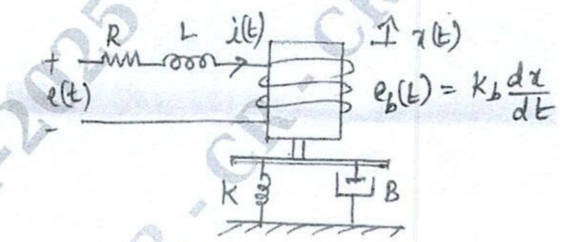

Fig. Q2 (a)

b. For the mechanical system shown in Fig. Q2 (b),
(i) Draw the mechanical network
(ii) Draw electrical network based on torque-current analogy
(iii) Write performance equations. **(10 Marks)**

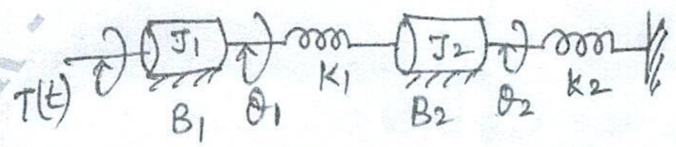

Fig. Q2 (b)

Module-2

3 a. Write Mason's gain formula for signal flow graph. Indicate what each term represents. **(05 Marks)**

b. Reduce the block diagram shown in Fig. Q3 (b), using block diagram reduction rules and obtain $\frac{C(s)}{R(s)}$. **(08 Marks)**

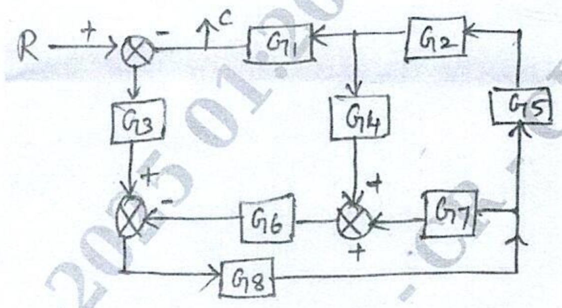

Fig.Q3 (b)

c. Find the transfer function for the following network shown in Fig.Q3 (c) using Mason's gain formula.

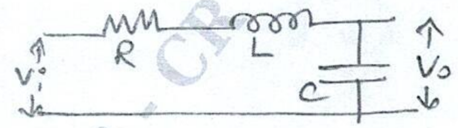

Fig.Q3 (c) **(07 Marks)**

OR

4 a. Obtain the transfer function of the system shown in Fig. Q4 (a) using Mason's gain formula. **(12 Marks)**

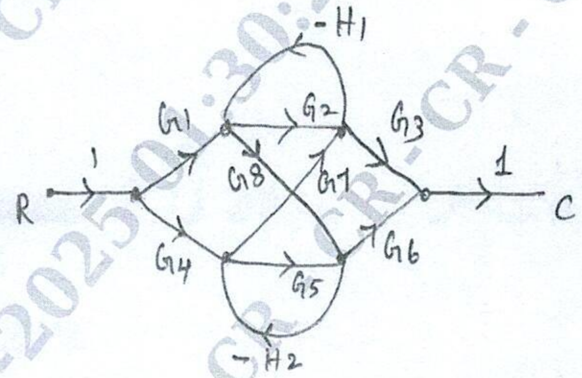

Fig. Q4 (a)

b. Determine the overall transfer function for the block diagram shown in Fig. Q4 (b). **(08 Marks)**

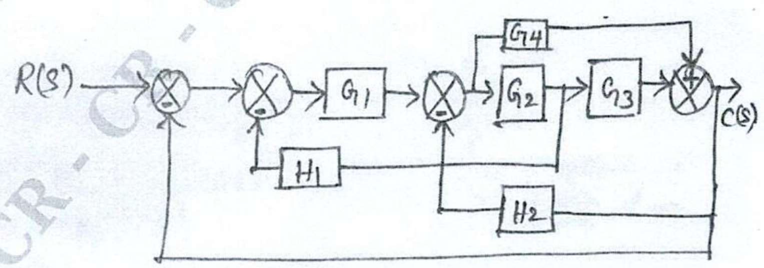

Fig. Q4 (b)

Module-3

5 a. With the help of graphical representation and mathematical expression, explain the following test signals : (i) Step signal (ii) Ramp signal (iii) Parabolic signal (iv) Impulse signal. **(08 Marks)**

b. For a unity negative feedback control system with $G(s)=\frac{50}{s(s+5)}$, find the following :

(i) Percentage overshoot for unit step input.
(ii) Settling time for a unit step input.
(iii) Steady state error for an input defined by polynomial $r(t)=2+4t+6t^2;\ t\geq 0$. **(08 Marks)**

c. Define rise time and maximum overshoot and also write their formula for II order systems. **(04 Marks)**

OR

6 a. For a unity feedback control systems, the open loop transfer function $G(s)=\frac{10(s+2)}{s^2(s+1)}$ find,

(i) The position, velocity and acceleration error constants.
(ii) The steady state error when input is R(s) where $R(s)=\frac{3}{s}-\frac{2}{s^2}+\frac{1}{3s^3}$ **(08 Marks)**

b. With the help of general block diagrams, explain the following :
(i) PD type of controller.
(ii) PI type of controller. **(08 Marks)**

c. The unit step response of a system is given by $C(t)=\frac{5}{2}+5t-\frac{5}{2}e^{-2t}$. Find transfer function and identify order of system. **(04 Marks)**

Module-4

7 a. The open loop transfer function of unity feedback system is given by, $G(s)=\frac{K(s+1)}{s^3+as^2+2s+1}$. Determine the value of K and a so that system oscillates at frequency of 2 rad/sec. **(08 Marks)**

b. State and explain Routh's stability criterion for determining the stability of the system and mention its limitations. **(06 Marks)**

c. Sketch the root locus plot for a negative feedback control system having an open loop transfer function,
$$G(s)H(s)=\frac{K}{s(s+1)(s+2)}.$$ **(06 Marks)**

OR

8 a. The open loop transfer function of a system is $G(s)=\frac{K}{s(1+s)(1+0.1s)}$. Determine the values of K such that,
(i) Gain margin = 10 dB
(ii) Phase margin = 24°.
Use Bode plot. **(12 Marks)**

b. Define the following terms in connection with bode plots :
(i) Gain cross over frequency
(ii) Phase cross over frequency
(iii) Gain margin
(iv) Phase margin **(08 Marks)**

Module-5

9 a. Sketch the polar plot for open loop transfer function, $G(s)H(s)=\frac{10}{(s+2)(s+4)}$. Determine gain cross over frequency, phase cross over frequency, gain margin, phase margin. Also comment on stability. **(10 Marks)**

b. Explain Nyquist stability criterion and also list the advantages of Nyquist plot. **(05 Marks)**

c. Write a short note on lead compensator. **(05 Marks)**

OR

10 a. List the properties of state transistion matrix. **(05 Marks)**

b. Obtain state transition matrix $\phi(t)$ of the following system:
$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$. Also obtain the inverse of state transition matrix $\phi^{-1}(t)$. **(10 Marks)**

c. Define : (i) State variables
(ii) State vector
(iii) State space **(05 Marks)**

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