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15ME73

Seventh Semester B.E. Degree Examination, June/July 2023
Control Engineering

Time: 3 hrs. Max. Marks: 80

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

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. Explain open and closed loop control systems with examples. **(08 Marks)**

b. With block diagram, explain:
i) Proportional controller
ii) Integral controller
iii) Proportional plus differential controller. **(08 Marks)**

OR

2 a. List the advantages and disadvantages of open loop and closed loop control system. **(08 Marks)**

b. Explain requirements of automatic control system. **(08 Marks)**

Module-2

3 a. Obtain the transfer function for an armature controlled D.C motor, which relates output angular displacement (Q) with input voltage (e). **(08 Marks)**

b. A thermometer is dipped in a vessel containing liquid at a constant temperature of θ_1. thermometer has a thermal capacitance for storing heat as C and thermal resistance to limit heat flow as R. If the temperature indicated by thermometer is θ_r, obtain the transfer function of the system. **(08 Marks)**

OR

4 a. Obtain the overall transfer function of the block diagram shown in Fig.Q4(a) by reduction technique. **(10 Marks)**

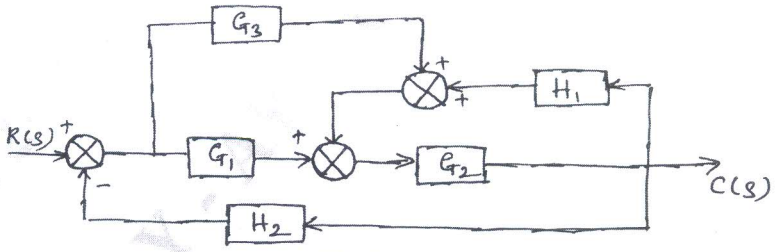

Fig.Q4(a)

b. Discuss Mason's gain formula and define the following terms used in signal flow graphs.
(i) Node (ii) Branch gain (iii) Forward path (iv) Path gain (v) Feedback loop
(vi) Self loop **(06 Marks)**

Module-3

5 a. Derive an expression for unit step response of first order system. **(06 Marks)**

b. The unity feedback system characterized by an open loop transfer function $G(s) = \frac{K}{S(S+10)}$. Determine the gain K, so that the system will have a damping ratio 0.5 for this value of K. Determine Settling time , Rise time , Peak overshoot and Peak time for unit step input. **(06 Marks)**

c. Using Routh Criteria, determine stability of a system its characteristic equation is $S^4 + 8S^3 + 18S^2 + 16S + 5 = 0$. **(04 Marks)**

OR

6 Sketch the root locus of the system whose open loop transfer function is $G(S)\ H(S) = \frac{K}{S(S+2)(S+4)}$. **(16 Marks)**

Module-4

7 Draw the Bode plot for the following transfer function and determine gain margin and phase margin.

$$G(s)H(s) = \frac{10.5}{(s+0.2)(s+0.8)(s+10)}$$ **(16 Marks)**

OR

8 Using Nyquist criterion, investigate the stability of a system whose open loop transfer function is $G(s)H(s) = \frac{k}{(s+1)(s+2)(s+3)}$ **(16 Marks)**

Module-5

9 a. Explain the following : i) Lead Compensator ii) Lag compensator. **(06 Marks)**

b. If the system is described by :

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u \quad ; \quad Y = [20\ 9\ 1]\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}.$$

Check System Completely State Controllable and Completely Observable. Use Kalman's method. **(10 Marks)**

OR

10 a. Choosing suitable state variable, construct a state model for a spring , mass and damper system. **(07 Marks)**

b. Determine the state controllability and observability of the system described by

$$\dot{x} = \begin{bmatrix}-3 & 1 & 1\\ -1 & 0 & 1\\ 0 & 0 & 1\end{bmatrix}x + \begin{bmatrix}0 & 1\\ 0 & 0\\ 2 & 1\end{bmatrix}u \quad ; \quad Y = \begin{bmatrix}0 & 0 & 1\\ 1 & 1 & 0\end{bmatrix}x$$ **(09 Marks)**

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