CBCS SCHEME

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17AE71

Seventh Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Derive an expression for transfer function of armature controlled DC motor. **(10 Marks)**

b. Write the differential equations governing the mechanical rotational system shown in Fig.Q.1(b) and determine the transfer function $\frac{\theta(s)}{T(s)}$

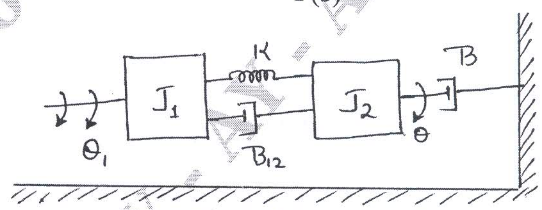

Fig.Q.1(b) **(10 Marks)**

OR

2 a. What are the requirements of ideal control system? **(04 Marks)**

b. Draw the F-V and F-I analogous circuits for the mechanical system shown in Fig.Q2(b) with necessary equations.

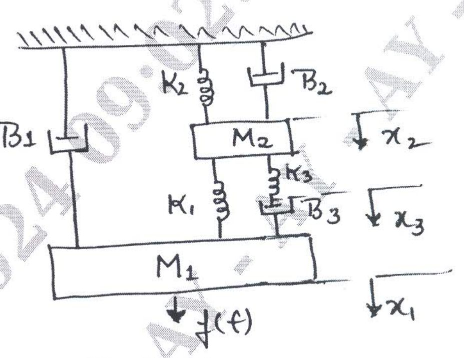

Fig.Q.2(b) **(08 Marks)**

c. Explain briefly open loop and closed control system with block diagram. **(08 Marks)**

Module-2

3 a. Find the transfer function of the system shown in below Fig.Q.3(a) using Mason's gain formula. Its input is x(t) and output is y(t).

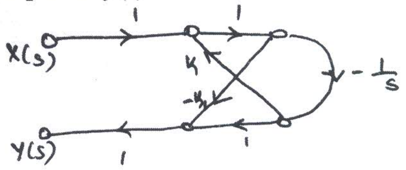

Fig.Q.3(a) **(10 Marks)**

b. For the system shown in below Fig.Q.3(b), determine :
i) Closed loop transfer function ii) Characteristics equation iii) System type
iv) System differential equation

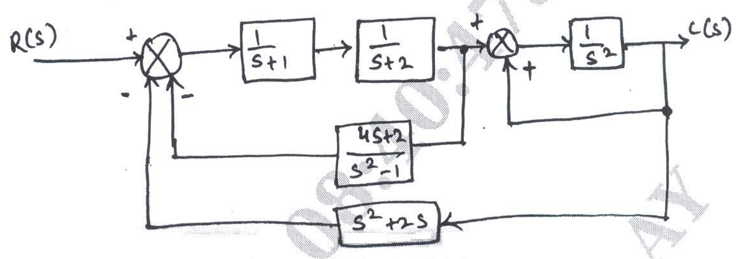

Fig.Q.3(b) **(10 Marks)**

OR

4 a. The response of system subjects to unit step input is $c(t) = 1 + 0.2\ e^{-60t} - 1.2e^{-10t}$, obtain the expression for the closed loop transfer function. Also determine the undamped natural frequency and damping ratio of the system. **(10 Marks)**

b. Derive the expression for Peak time (T_p) and Rise time (T_R). **(10 Marks)**

Module-3

5 a. Use the Routh stability criterion to determine the location of roots on the s-plane and hence the stability for the system represented by the characteristics equations $s^7 + 9s^6 + 24s^5 + 24s^4 + 24s^3 + 24s^2 + 23s + 15 = 0$. **(08 Marks)**

b. Sketch the root locus of the system whose open loop transfer function is $G(s) = \dfrac{K}{s(s+2)(4+4)}$. Find the value of K. So that the damping ratio of the closed loop system is 0.5. **(12 Marks)**

OR

6 a. Write the procedure to determine Gain Margin and phase Margin from Bode plot. **(08 Marks)**

b. Sketch Bode Plot for the following transfer function and determine the system gain K for the gain cross over frequency to be 5 rad/sec.

$$G(s) = \frac{Ks^2}{(1+0.2s)(1+0.02s)}.$$ **(12 Marks)**

Module-4

7 a. Explain the following:
i) M-circle ii) N-circle
iii) Gain cross over frequency iv) Phase cross over frequency **(10 Marks)**

b. The open loop transfer function of a unity feedback system is given by $G(s) = \dfrac{1}{s(1+s)^2}$.
Sketch the polar plot and determine the gain and phase margin. **(10 Marks)**

OR

8 Construct Nyquist plot for a feedback control system whose open loop transfer function is given by $G(s)H(s) = \dfrac{5}{s(1-s)}$. Comment on the stability of open loop and closed loop system. **(20 Marks)**

Module-5

9 a. Explain PID controller and their effect on stability. **(08 Marks)**

b. Define compensators and explain types of compensators with transfer function and the importance of compensators. **(12 Marks)**

OR

10 a. Check for observability for the system described by the state model

$\dot{X} = AX$ and $Y = CX$ when $A = \begin{bmatrix} -1 & 1 \\ 1 & -2 \end{bmatrix}$, $C = [1,\ 0]$. **(07 Marks)**

b. Determine the solution of state equation. **(07 Marks)**

c. $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} u \quad Y = [1 \quad 0 \quad 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ check for controllability for Kalman's test. **(06 Marks)**

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