CBCS SCHEME

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17AE71

Seventh Semester B.E. Degree Examination, July/August 2022
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. Define the following :
i) System ii) Input iii) Plant iv) Process v) Controller vi) Manipulated variable vii) Disturbance viii) Control system. **(08 Marks)**

b. Describe the requirement of an ideal control system. **(08 Marks)**

c. Differential between open loops and closed loop control system. **(04 Marks)**

OR

2 a. Derive the transfer function of an armature controlled DC motor, where output parameters is the angle turned by the motor shaft and input is the applied voltage to the armature circuit. **(10 Marks)**

b. Write the differential equation governing the behaviour of the mechanical system shown in Fig Q2(b). Also obtain the analogous electrical circuit based on voltage analogy and loop equations.

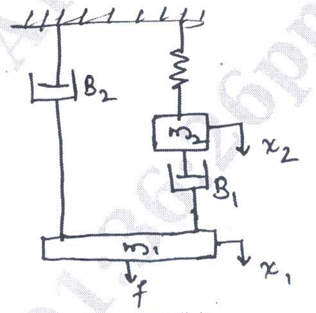

Fig Q2(b) **(10 Marks)**

Module-2

3 a. Find the transfer function of the system shown in below Fig Q3(a) using Mason's gain formula. Its input is x(t) and output is y(t).

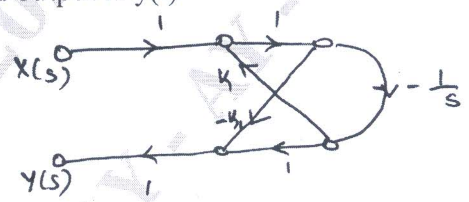

Fig Q3(a) **(10 Marks)**

b. For the system shown in below Fig Q3(b), determine :
i) Closed loop transfer function ii) Characteristics equation iii) System type
iv) System differential equation

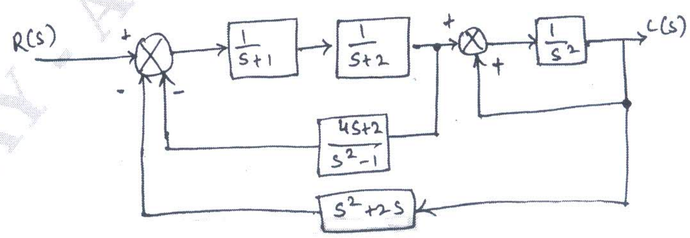

Fig Q3(b) **(10 Marks)**

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. The characteristics equation of a feedback control system is $s^4 + 20ks^3 + 5s^2 + 10s + 15 = 0$. Find the range of K for which system is stable. **(10 Marks)**

b. For the system having $G(s)\,H(s) = \dfrac{K}{s(s+5)(s+10)}$. Check $s = -2$ lies on the Root locus and also find the value of K using angle condition and magnitude condition. **(10 Marks)**

OR

6 Sketch the root locus for the system having $G(s)H(s) = \dfrac{K(s+1)}{s(s-1)(s^2+4s+16)}$ and also determine the range K for stability. **(20 Marks)**

Module-4

7 a. Describe Frequency Response. **(06 Marks)**

b. The open loop transfer function of control system is $G(s)H(s) = \dfrac{K(s+3)}{s(s-1)}$. Determine the value of K for the system to be stable using Nyquist criterion. **(14 Marks)**

OR

8 a. Describe the conclusions made for M-circles. **(06 Marks)**

b. Plot the Nyquist diagram for the open loop transfer function $G(s)H(s) = \dfrac{12}{s(s+1)(s+2)}$ and determine the nature of stability. **(14 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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