CBCS SCHEME

USN | | | | | | | | | |

20MCM14

First Semester M.Tech. Degree Examination, Feb./Mar. 2022
Control System Engineering

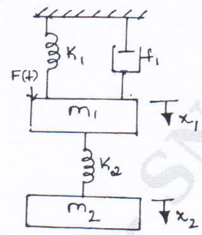
Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Write the differential equation governing the behavior of the mechanical system shown in Fig.Q.1(a). Also obtain the analogous electrical circuit based on i) Force current analogy ii) Force voltage analogy. **(10 Marks)**

Fig.Q.1(b)

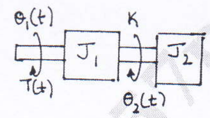


b. What are the requirements of an ideal control system? With a neat sketch, explain working of a temperature control system. **(10 Marks)**

OR

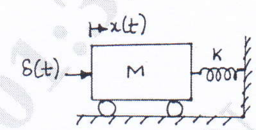
2 a. Write the torque equation of the rotational system shown in Fig.Q.2(a). Find the transfer function $\theta_1(S)/T(S)$. **(08 Marks)**

Fig.Q.2(a)



b. Consider the mechanical system shown in Fig.Q.2(b) suppose that the system is set into motion by unit impulse force. Find the resulting oscillation. Assume that the system is at rest initially. **(06 Marks)**

Fig.Q.2(b)



c. Distinguish between open loop and closed loop control system. **(06 Marks)**

Module-2

3 a. Derive the transient response of the second order system to the unit step input. **(10 Marks)**

b. A unity feedback system is characterized by open loop transfer function:

$$G(S) = \frac{1}{S(0.5S+1)(0.2S+1)}$$

Determine the steady state error for unit step, unit ramp and unit acceleration input. **(10 Marks)**

OR

4 a. The open loop transfer function of a unity feedback system is $G(S) = \frac{4}{S(S+1)}$. Determine the nature of response of the closed loop system for a unit step input. Also determine the rise time, peak time, peak overshoot and settling time. **(12 Marks)**

b. The characteristic equation of a feedback control system is given by $S^4 + 20S^3 + 15S^2 + 2S + K = 0$. Determine the range of values of K for the system to be stable, can the system be marginally stable? If so find the required value of K and the frequency of the sustained oscillation. **(08 Marks)**

Module-3

5 a. List out and briefly explain the frequency domain specification. **(08 Marks)**

b. Draw the bode plot for the system whose open loop transfer function is

$$G(S)H(S) = \frac{500K(S+2)(S+20)}{S^3(S+100)(S+200)}$$

Determine the range of values of K for which the system is stable. **(12 Marks)**

OR

6 a. Draw the Nyquist plot and assess the stability of the closed loop system whose open loop transfer function is $G(S)H(S) = \frac{(S+4)}{(S+1)(S-1)}$. **(12 Marks)**

b. Briefly explain i) Stability condition ii) Stability problem iii) Open loop stability iv) Closed loop stability. **(08 Marks)**

Module-4

7 a. Sketch the root locus of the open loop transfer function given below:

$$G(S)H(S) = \frac{K}{S(S+2)(S^2+2S+5)}.$$ **(12 Marks)**

b. Briefly explain:
i) Dominant poles ii) Asymptote iii) Break angle iv) Angle of departure. **(08 Marks)**

OR

8 a. For a unity feedback system, the open loop transfer function is given by

$G(S) = \frac{K}{S(S+2)(S^2+6S+25)}$. Sketch the root locus for $0 < K < \infty$. At what value of K, the system becomes unstable. **(13 Marks)**

b. What is the effect of adding poles and zeros to the G(S)H(S) an the root locus? **(07 Marks)**

Module-5

9 a. Test the controllability and observability of the system described by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ -3 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u, \quad y = [1 \quad 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$ **(10 Marks)**

b. Given the system $\dot{x}(t) = Ax(t) + Bu(t)$, $y(t) = C.x(t)$ where $A = \begin{bmatrix} 0 & 1 \\ -1 & 3 \end{bmatrix}$ $B = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$ $C = [1 \quad 1]$.

Determine the state and output controllability. **(10 Marks)**

OR

10 a. Show that the following system is not completely observable.

$\dot{x}(t) = Ax(t) + Bu(t)$

$y(t) = cx(t)$

where $x(t) = \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix}$ $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$ $B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$ $C = [4 \quad 5 \quad 1]$. **(10 Marks)**

b. Determine whether the system described by the state equation.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

is completely stable controllable. **(10 Marks)**

* * * * *