CBCS SCHEME

USN | | | | | | | | | | | **20MCM14**

First Semester M.Tech. Degree Examination, July/August 2021
Control System Engineering

Time: 3 hrs.   Max. Marks: 100

Note: Answer any FIVE full questions.

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.

1 a. Define control system. Classify control system and explain. **(08 Marks)**

b. Draw the equivalent mechanical system of the given system. Hence write the set of equilibrium equations for it and obtain electrical analogous circuit using Force-Voltage (F-V) analogy. [Refer Fig.Q1(b)]

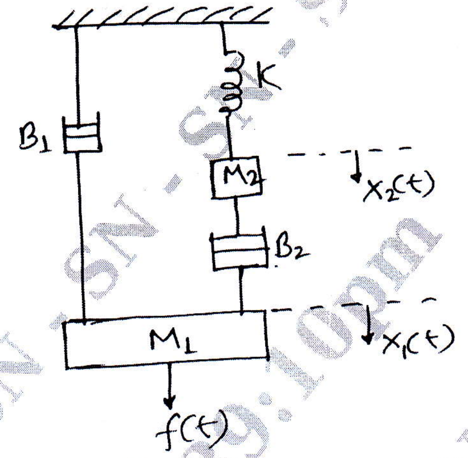

Fig.Q1(b) **(12 Marks)**

2 a. Find the transfer function of the system shown in Fig.Q2(a). Obtain impulse response from the transfer function.

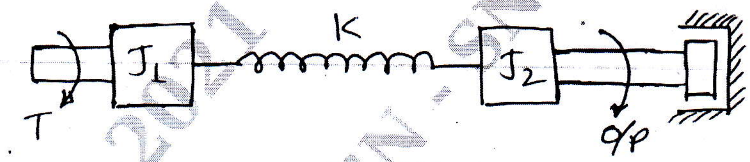

Fig.Q2(a) **(10 Marks)**

b. Construct the state variable model for a system characterized by the following differential equation.

$$\frac{d^3y}{dt^3}+6\frac{d^2y}{dt^2}+11\frac{dy}{dt}+6y=u$$ **(10 Marks)**

3 a. A unity feedback system has $G(s)=\frac{40(s+2)}{s(s+1)(s+4)}$. Determine:

(i) Type of the system
(ii) All error coefficients
(iii) Error for ramp input with magnitude 4. **(12 Marks)**

b. Derive an expression for error in steady state for following inputs:
(i) Step (ii) Ramp **(08 Marks)**

4 a. For a closed loop transfer function

$$G(s) = \frac{25}{s^2 + 6s + 25}$$

Considering step input, determine: (i) Rise time (ii) Peak time (iii) Peak overshoot error (iv) Settling time **(10 Marks)**

b. Investigate the stability of a closed-loop system whose characteristic equation is given by $s^4 + 2s^3 + 3s^2 + 8s + 2 = 0$. **(10 Marks)**

5 a. Elaborate the corrections between time domain and frequency domain specifications. **(06 Marks)**

b. A unity feedback control system has $G(s)H(s) = \frac{K}{s(s+4)(s+10)}$. Draw the Bode plot and find the value of 'K' for which the system is marginally stable. **(14 Marks)**

6 a. State and explain Nyquist stability criterion. **(05 Marks)**

b. Discuss the stability of the system using Nyquist criterion for a system with open loop transfer function, $G(s)H(s) = \frac{10}{s^2(1+0.25s)(1+0.5s)}$ **(15 Marks)**

7 a. With reference to the root locus. Explain how to find the following quantities:
(i) Angles and centroid of axymptotes
(ii) Break away points
(iii) Intersection of root locus with imaginary axis **(06 Marks)**

b. Draw the approximate root locus diagram for a closed loop system whole loop transfer function is given by $G(s)H(s) = \frac{K}{s(s+5)(s+10)}$. Comment on stability. **(14 Marks)**

8 a. Sketch the root locus plot for all values of K ranging from 0 to ∞ for a negative feedback control system characterized by $G(s)H(s) = \frac{K(s+6)}{s(s+)(s+2)}$. Show all the salient points on the root locus and comment on stability. **(14 Marks)**

b. Define breakaway point and break in point. Discuss the general predictions about the existence of the same. **(06 Marks)**

9 a. Consider a system with state representation.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u; \quad y = \begin{bmatrix} 3 & 4 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

Evaluate the observability of the system. **(08 Marks)**

b. For a given linear dynamic time invariant system of order n = 3, is represent by

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 & 1 \\ 0 & 0 \\ 1 & 0 \end{bmatrix} u$$

Check the controllability of his system. **(12 Marks)**

10 a. Explain the properties of state transition matrix. **(08 Marks)**

b. Consider a control system with state model

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u; \quad \begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

Compute the state transition matrix and therefore find the state response. **(12 Marks)**