CBCS SCHEME

USN

20MCM14

First Semester M.Tech. Degree Examination, Jan./Feb. 2021
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. Drive the differential equation for the liquid level system to relate outflow with inflow of liquid. **(08 Marks)**

b. Obtain the transfer function $\frac{Y_1(s)}{F(s)}$ for the mechanical system shown in Fig.Q1(b).

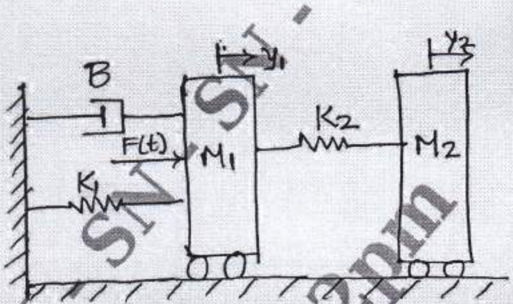

Fig.Q1(b) **(12 Marks)**

OR

2 Sketch armature–controlled DC motor and derive its transfer function. Also obtain its statespace representation by choosing the angular displacement of shaft θ(t), angular velocity of shaft ω(t) and armature current as state variables and angular shaft displacement θ(t) as output variable. **(20 Marks)**

Module-2

3 a. Obtain an expression for the time response of a second order underdamped system subjected to a unit step input and draw its response curve. **(12 Marks)**

b. A second order mechanical system has a natural frequency of 10rad/sec, a damping ratio of 0.5. The system is given a unit step input. Determine :

i) The response equation
ii) Time for complete response
iii) Response when time elapsed is 0.5sec. **(08 Marks)**

OR

4 a. A second order system is represented by its transfer function $\frac{C(s)}{R(s)} = \frac{25}{(s^2+6s+25)}$ find its rise time, peak time, maximum overshoot and settling time. **(08 Marks)**

b. A unity negative feedback control system has an open-loop transfer function consisting of two poles, two zeros and a variable gain 'K'. The zeros are located at –2 and –1 and poles at –0.1 and +1. Using Routh stability criterion, determine the range of values of 'K' for which the closed-loop system has 0, 1 and 2 roots in the right half of S-plane. **(12 Marks)**

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-3

5 A unity feedback system has, $G(s) = \frac{242(s+5)}{s(s+1)(s^2+5s+121)}$ sketch the bode plot and determine : i) Phase cross over and gain cross over frequencies
ii) Gain margin and phase margin comment on system stability. **(20 Marks)**

OR

6 a. A control system is having, $G(s)H(s) = \frac{10}{s(s+1)(s+2)}$ draw Niquist plot. **(12 Marks)**

b. Write a note on Robust stability test and robust performance test. **(08 Marks)**

Module-4

7 Draw root locus for system having open loop transfer function $G(s)H(s) = \frac{K}{s(s+2)(s+4)}$ also determine the values of K for which the system is stable. **(20 Marks)**

OR

8 A feedback control system has an open loop transfer function $G(s)H(s) = \frac{K(s+3)}{s(s+2)}$.
Determine the root sensitivity of the dominant roots of the system to variation in :
i) gain K = 4 ii) open loop pole at s = –2 iii) Open loop zeros at s = –3. Also obtain the new root location for small change of ±0.4 in nominal gain K. **(20 Marks)**

Module-5

9 a. Briefly explain the terms : i) State variables ii) State vector. **(04 Marks)**

b. The equation of motion of a two degrees of freedom spring mass system is given by

$$m_1\ddot{y}_1 + k_1 y_1 + k_2(y_1 - y_2) = F(t)$$

$$m_2\ddot{y}_2 + k_1 y_2 + k_2(y_1 - y_2) = 0$$

Write its state space model. **(06 Marks)**

c. The linear time invariant system is described by the following state equations :

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

Comment on the controllability and observability of the system. **(10 Marks)**

OR

10 a. Determine the eigen values and eigen vectors of the matrix A.

$$A = \begin{bmatrix}0 & 1 & 0\\ 3 & 0 & 2\\ -12 & -7 & -6\end{bmatrix}.$$ **(12 Marks)**

b. A control system is represented by the following state model

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}1\\ 1\end{bmatrix}u \quad \text{and} \quad \begin{bmatrix}x_1(0)\\ x_2(0)\end{bmatrix} = \begin{bmatrix}0\\ 1\end{bmatrix}, u = \text{unit step}$$

Obtain the time response. **(08 Marks)**

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