CBCS SCHEME

USN | | | | | | | | | | |

18RA43

Fourth Semester B.Tech. Degree Examination, July/August 2022

Control Systems

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Define control system. List the advantages and disadvantages to open loop and closed loop control system. **(06 Marks)**

b. For the mechanical system shown in Fig.Q1(b).
(i) Draw the mechanical network
(ii) Write a differential equations
(iii) Draw force to voltage analogous electric network.

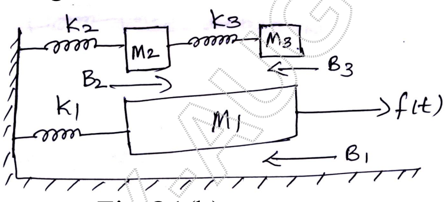

Fig.Q1(b) **(08 Marks)**

c. Find the transfer function $\frac{C(s)}{R(s)}$ of the block diagram shown in Fig.Q1(c).

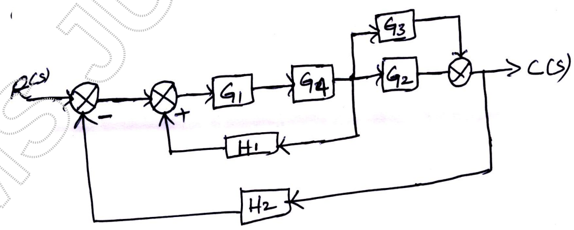

Fig.Q1(c) **(06 Marks)**

OR

2 a. Define linear and non-linear control system. **(04 Marks)**

b. Draw the equivalent mechanical system of the given system shown in Fig.Q2(b). Write set of equilibrium equations and obtain electrical analogous circuit using F-V analogy.

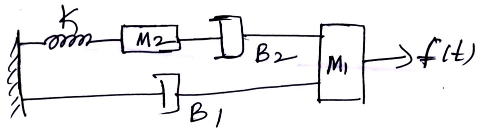

Fig.Q2(b) **(06 Marks)**

c. Obtain $\frac{C(s)}{R(s)}$ ratio for the block diagram shown in Fig.Q2(c) using block diagram reduction formula.

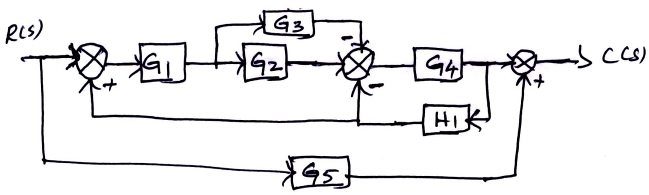

Fig.Q2(c) **(10 Marks)**

Module-2

3 a. Explain Mason's Gain Formula. **(06 Marks)**

b. Find $\dfrac{C(s)}{R(s)}$ using Mason's gain formula for the signal flow graph shown in Fig.Q3(b) .

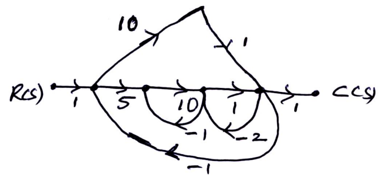

Fig.Q3(b) **(06 Marks)**

c. Find k_p , k_v , k_a and steady state error for a system with open loop transfer function

$$G(s)H(s) = \frac{10(s+2)(s+3)}{s(s+1)(s+5)(s+4)}$$

where the input is $r(t) = 3 + t + t^2$. **(08 Marks)**

OR

4 a. The signal flow graph shown in Fig.Q4(a). Find the ratio $\dfrac{I_o(s)}{V_i(s)}$ by using Mason's gain formula.

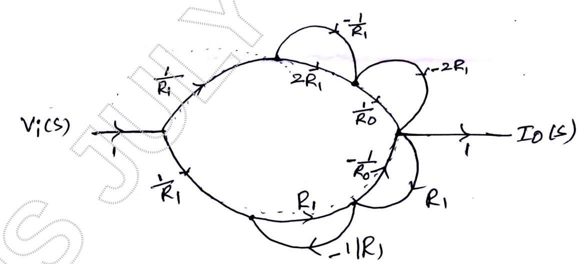

Fig.Q4(a) **(10 Marks)**

b. List the standard test signals and write their Laplace transform. **(04 Marks)**

c. Consider a simple closed loop system with Negative feedback, derive and show that steady state error $e_{ss} = \lim_{s \to 0} \dfrac{s\,R(s)}{1+G(s)H(s)}$ **(06 Marks)**

Module-3

5 a. The system with characteristic equation $F(s) = s^6 + 3s^5 + 4s^4 + 6s^3 + 5s^2 + 3s + 2 = 0$.
Examine the stability by checking the roots on imaginary axis. **(10 Marks)**

b. Derive an expression for resonant peak (M_r) and resonant frequency (w_r) for a second order system in terms of ξ and ω_n. **(10 Marks)**

OR

6 a. The characteristic equation is $s^6 + 4s^5 + 3s^4 - 16s^2 - 64s - 48 = 0$
Find the number of roots of this equation with positive real part, zero real part and negative real part using RH criterion. Comment on stability. **(10 Marks)**

b. List the advantages of frequency domain approach. **(05 Marks)**

c. Find the open loop transfer function of a unity feedback second order control system for which resonant peak = 1.1 units and resonant frequency = 11.2 rad/sec. **(05 Marks)**

Module-4

7 a. Sketch the complete root locus of a system having

$$G(s)H(s) = \frac{k}{s(s+1)(s+2)(s+3)}$$

Comment on stability. **(12 Marks)**

b. Explain the calculation of Gain margin and Phase margin from Bode plot. **(08 Marks)**

OR

8 a. The characteristic equation of a single loop unity feedback control system is given by

$F(s) = s^3 + 8s^2 + 20s + k = 0$

Sketch the complete root locus. **(12 Marks)**

b. List the advantages of Bode plots. **(08 Marks)**

Module-5

9 a. Define the following terms:

(i) State (ii) State variable (iii) State space **(06 Marks)**

b. Obtain the state model of the given electrical network shown in Fig.Q9(b).

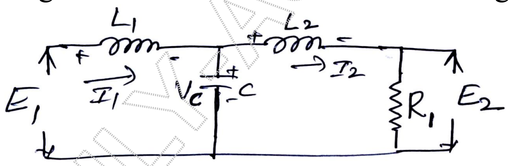

Fig.Q9(b) **(06 Marks)**

c. Consider a system having state model.

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} -2 & -3 \\ 4 & 2 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} + \begin{bmatrix} 3 \\ 5 \end{bmatrix} u \quad \text{and} \quad y = \begin{bmatrix} 1 & 1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} \quad \text{and} \quad D = 0$$

Find the transfer function. **(08 Marks)**

OR

10 a. Construct the state model using phase variables if the system is described by the differential equation

$$\frac{d^3y(t)}{dt^3} + 4\frac{d^2y(t)}{dt^2} + 7\frac{dy(t)}{dt} + 2y(t) = 5u(t)$$ **(06 Marks)**

b. List the properties of state transition matrix. **(04 Marks)**

c. Find the state transition matrix for $A = \begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}$ **(10 Marks)**

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