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18MT34

Third Semester B.E. Degree Examination, Feb./Mar. 2022
Control Systems

Time: 3 hrs. Max. Marks: 100

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

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-1

1 a. Explain the difference between open loop and closed loop control systems. Describe two example for each. **(10 Marks)**

b. Obtain the transfer function for the following mechanical system shown below in Fig.Q.1(b). **(10 Marks)**

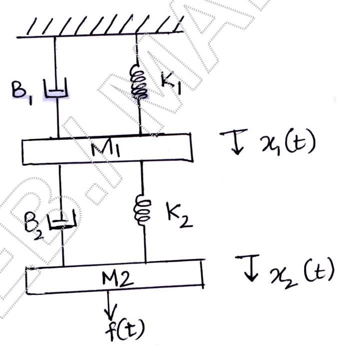

Fig.Q.1(b)

OR

2 a. Write the differential equations for the mechanical system shown in Fig.Q.2(a) and obtain F-V and F-I analogous electrical networks. **(10 Marks)**

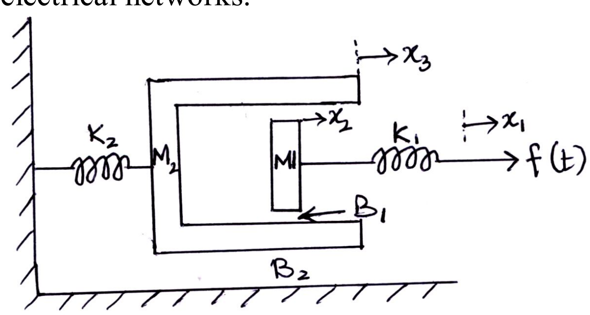

Fig.Q.2(a)

b. Obtain the transfer function for the block diagram shown in Fig.Q.2(b) using block diagram reduction technique. **(10 Marks)**

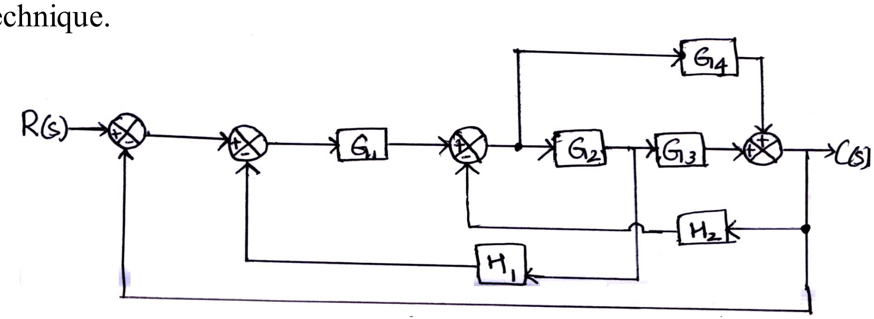

Fig.Q.2(b)

Module-2

3 a. Discuss the terminologies used in signal flow graph shown in Fig.Q.3(a)

i) Forward path
ii) Feedback loop
iii) Self loop
iv) Path gain
v) Non-touching loops.

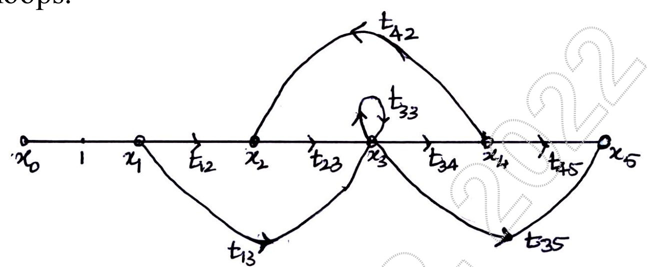

Fig.Q.3(a)

(10 Marks)

b. For the signal flow graph of figure below, Fig.Q.3(b), determine the transfer function $\dfrac{C(S)}{R(S)}$ using Mason's gain formula.

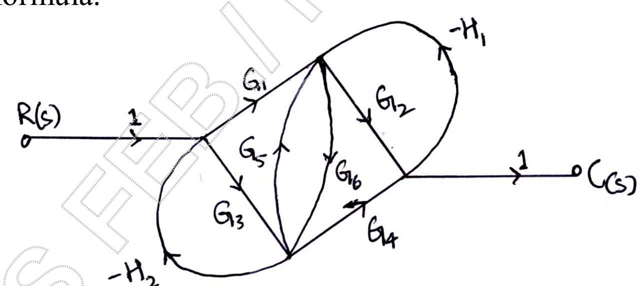

Fig.Q.3(b)

(10 Marks)

OR

4 a. Derive the expression for unit step response of under damped second order system. **(10 Marks)**

b. A second order system is given by $\dfrac{C(s)}{R(s)} = \dfrac{25}{s^2 + 6s + 25}$, find its rise time, peak time, peak overshoot and settling time if subjected to unit step input. Also calculate expression for its output response. **(10 Marks)**

Module-3

5 a. Check the stability of the given characteristic equation using Routh's method:
$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$ **(10 Marks)**

b. The block diagram of the feedback control system is shown in the Fig.Q.5(b). Apply RH criterion to determine the range of K for stability if

$$G(s) = \frac{K}{(s+4)(s+5)}$$

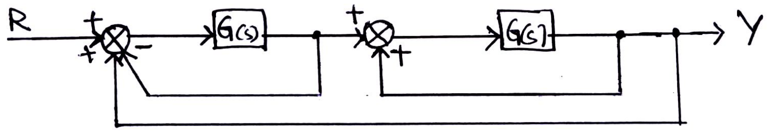

Fig.Q.5(b)

(10 Marks)

OR

6 a. Derive the expression for resonant peak M_r and resonant frequency w_r for a standard second order system interms of ε and w_n. **(10 Marks)**

b. For unity feedback system with $G(s) = \dfrac{100}{s(s+5)}$ determine:

i) Resonance Peak
ii) Resonance frequency. **(10 Marks)**

Module-4

7 a. Sketch the complete root locus of system having $G(s)H(s) = \dfrac{K}{s(s+1)(s+2)(s+3)}$. **(10 Marks)**

b. Explain the following as applied to the root locus:
i) Centroid
ii) Asymptotes
iii) Breakaway points
iv) Angle of departure
v) Angle of arrival. **(10 Marks)**

OR

8 a. State and explain the various frequency domain specifications. **(10 Marks)**

b. i) Explain the procedure to obtain gain margin and phase margin from the bode plot. **(06 Marks)**

ii) What should be values of GM and PM of a good system? **(04 Marks)**

Module-5

9 a. Obtain the appropriate state model for a system represented by an electric circuit in Fig.Q.9(a). **(10 Marks)**

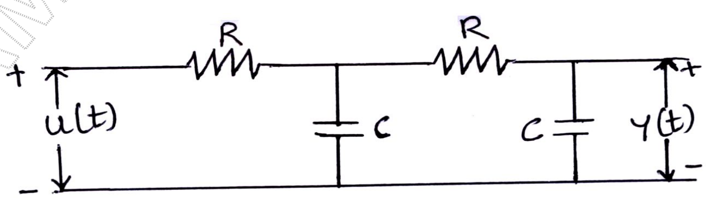

Fig.Q.9(a)

b. Obtain the state transition matrix for the following system:

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} -1 & -0.5 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0.5 \\ 0 \end{bmatrix} u$$ **(10 Marks)**

OR

10 a. i) Explain the derivation of transfer function from the state model. **(08 Marks)**

ii) Explain the advantages of phase variable. **(02 Marks)**

b. Find the transfer function for a system having state model as given below:

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$$

$$Y = \begin{bmatrix} 1 & 0 \end{bmatrix} x.$$ **(10 Marks)**

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