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15ME73

Seventh Semester B.E. Degree Examination, Feb./Mar.2022
Control Engineering

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. With block diagrams and examples, explain open loop control system and closed loop control system. **(08 Marks)**

b. Illustrate with necessary block diagrams and characteristics:
(i) Proportional controller.
(ii) Proportional plus integral controller. **(08 Marks)**

OR

2 a. Describe briefly about the requirements of an ideal control system. **(05 Marks)**

b. With necessary block diagrams and examples, explain
(i) Regular system
(ii) Follow up system **(06 Marks)**

c. Draw the block diagram of proportional plus integral plus derivative (PID) controller and explain its effects on the system. **(05 Marks)**

Module-2

3 a. Derive the transfer function $\frac{X_1(s)}{F(s)}$ for the mechanical system shown in Fig. Q3 (a) below. Also draw an equivalent electrical circuit using Force-voltage analogy. **(10 Marks)**

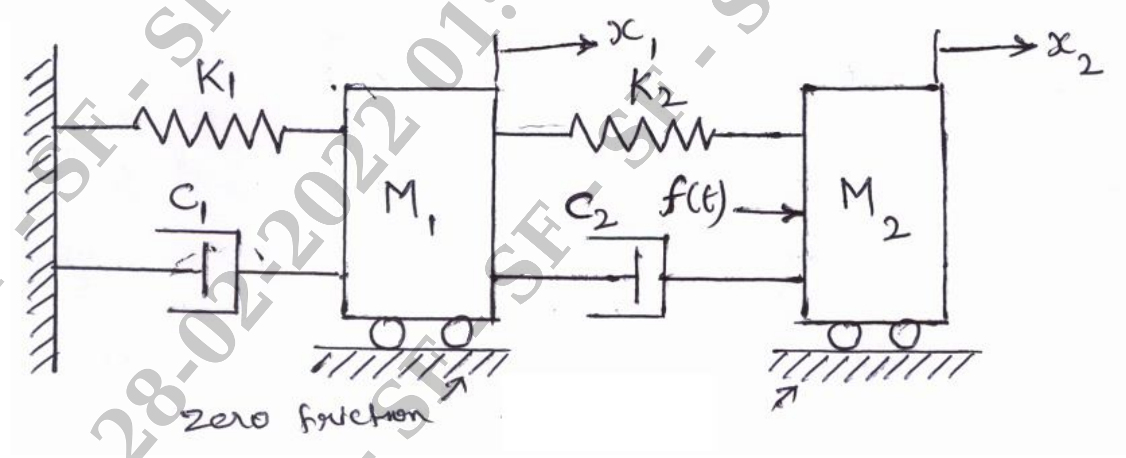

Fig. Q3 (a)

b. Derive the transfer function for an armature controlled DC motor. Assume that the coil has a back emf of $E_b = K_b.\frac{d\theta}{dt}$, and the coil current produces a torque T. **(06 Marks)**

OR

4 a. Determine the transfer function of the block diagram shown in Fig. Q4 (a) by block diagram reduction technique. **(08 Marks)**

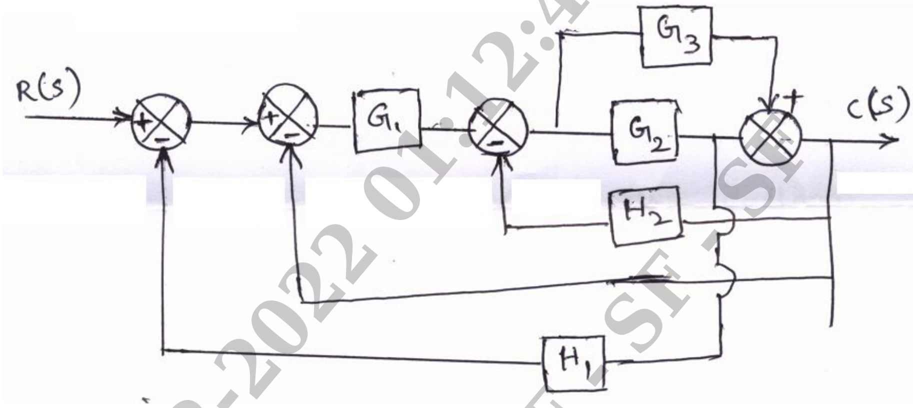

Fig. Q4 (a)

b. Determine the overall transfer function for the system shown in Fig. Q4 (b) using Mason's gain formula. **(08 Marks)**

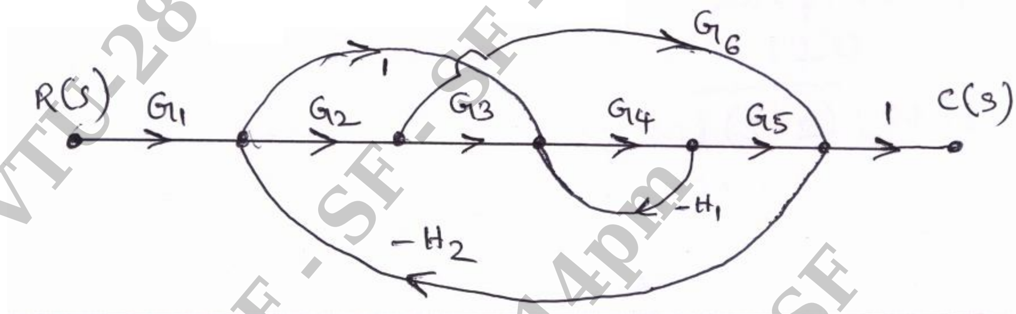

Fig. Q4 (b)

Module-3

5 a. For a control system shown in Fig.Q5 (a), find the values of K_1 and K_2 so that $M_P = 25\%$ and $T_P = 4$ sec. Assume unit step input. **(08 Marks)**

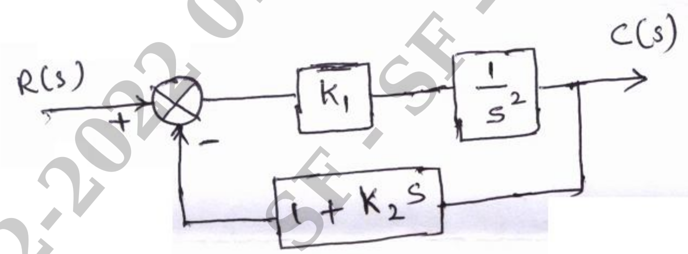

Fig. Q5 (a)

b. Construct the Routh's array and find the stability of the system whose characteristic equation is,

$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$ **(08 Marks)**

OR

6 Sketch the root locus plot for $G(s)H(s) = \dfrac{K}{s(s+2)(s+4)(s+6)}$. For what value of K the system becomes on stable. **(16 Marks)**

Module-4

7 a. Sketch the polar plot for the system with open loop transfer function,

$$G(s) = \frac{10}{s(s+1)(s+2)}$$ **(06 Marks)**

b. Sketch the complete Nyquist diagram for a system whose open loop transfer function is

$$G(s)H(s) = \frac{120}{(s+1)(s+2)(s+3)}$$

And ascertain the system stability. **(10 Marks)**

OR

8 The open loop transfer function of a certain unity feedback system is,

$G(s) = \frac{K}{s(s+2)(s+20)}$. Construct the Bode plot and determine (i) Value of K for gain margin of 10 dB, (ii) Value of K for phase margin of 50°. **(16 Marks)**

Module-5

9 a. What is system compensation? Explain the,
(i) Series compensation (ii) Feed back compensation **(08 Marks)**

b. Explain with block diagrams,
(i) Lag compensator (ii) Lead compensator **(08 Marks)**

OR

10 a. Consider the system with state equations,

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & 11 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U(t)$$

Estimate the state controllability by,
(i) Kalmans test and (ii) Gilbert's test **(10 Marks)**

b. Find the controllability and observability of the system described by the state equation,

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

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$ **(06 Marks)**

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