CBCS SCHEME

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17EC43

Fourth Semester B.E. Degree Examination, July/August 2021
Control Systems

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. Write the difference between open loop and closed loop control system. **(04 Marks)**

b. For the mechanical system shown in Fig. Q1 (b). Write the analogous electrical network based on force-current analogy. **(08 Marks)**

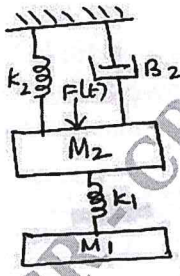

Fig. Q1 (b)

c. Obtain the overall transfer function of the block diagram, shown in Fig. Q1 (c) by block diagram reduction technique. **(08 Marks)**

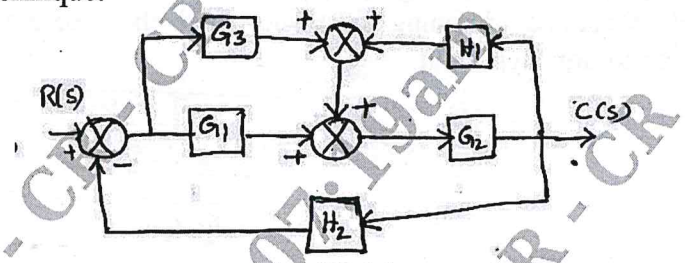

Fig. Q1 (c)

2 a. For the rotational system shown in Fig. Q2 (a), draw the torque voltage analogous circuit. **(08 Marks)**

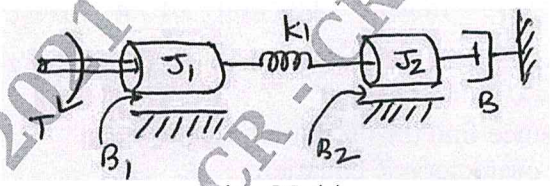

Fig. Q2 (a)

b. Explain Mason's gain formula for determining the transfer function from signal flow graph. **(04 Marks)**

c. For the system described by the signal flow graph shown in Fig. Q2 (c), obtain the closed loop transfer function $\frac{C(s)}{R(s)}$ using Mason's Gain formula. **(08 Marks)**

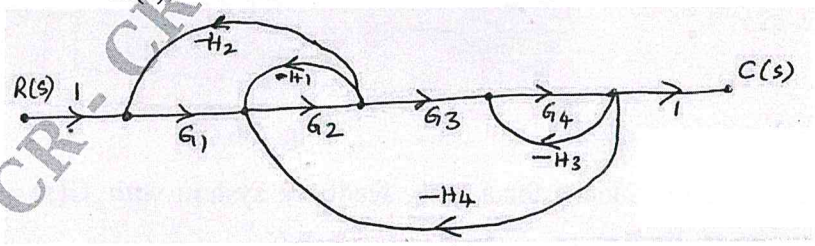

Fig. Q2 (c)

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3 a. Derive an expression for rise time in a second order underdamped system subjected to unit step input. **(04 Marks)**

b. The transfer function of a second order system subjected to a unit step input, given by

$$\frac{C(s)}{R(s)} = \frac{16}{s^2 + 2s + 16}$$

Calculate the rise time, peak time, peak overshoot and settling time. **(08 Marks)**

c. For a negative unity feed back control system with $G(s) = \frac{100}{s^2(s+4)(s+12)}$. Determine (i) Type of the system (ii) Error co-efficients (iii) Steady state error when the input $r(t) = 2t^2 + 5t + 10$ **(08 Marks)**

4 a. With general block diagram, explain PD controller and PI controller. **(06 Marks)**

b. In PD controller system shown in Fig. Q4 (b), determine the value of T_d, so that the system will be critically damped, calculate its settling time. **(06 Marks)**

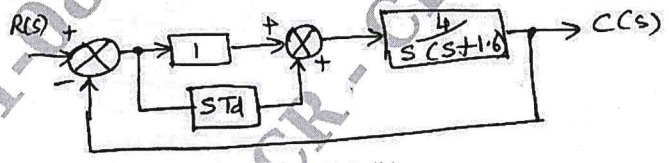

Fig. Q4 (b)

c. For the system shown in Fig. Q4 (c), obtain the closed loop transfer function, damping ratio, natural frequence, damping frequency and the expression for the output response if subjected to unit step input. **(08 Marks)**

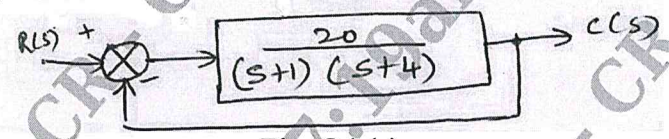

Fig. Q4 (c)

5 a. Investigate the stability of a closed loop system whose characteristic equation is given by,

$s^5 + s^4 + 2s^3 + 3s + 5 = 0$

using R–H criteria. **(06 Marks)**

b. The open loop transfer function of a unity feedback system is given by, $G(s) = \frac{K}{s(s+3)(s^2+s+1)}$, using RH criteria find the value of 'K' that will cause sustained oscillation, hence find the oscillation frequency. **(06 Marks)**

c. Consider the characteristic equation,

$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$, using RH criteria investigate the stability of the system. **(08 Marks)**

6 a. Determine the value of 'K' and 'a' so that the system shown in Fig. Q6 (a) oscillates with frequency of 2 rad/sec. **(06 Marks)**

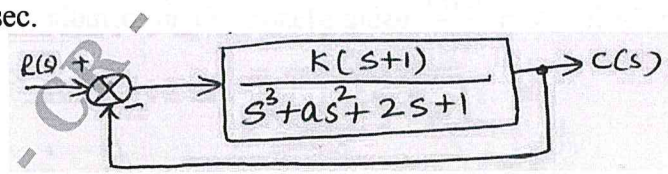

Fig. Q6 (a)

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b. Sketch the Root locus for a unity feedback system with $G(s) = \frac{K}{s(s^2+8s+17)}$. From root locus determine the value of K for a damping factor of 0.5. **(14 Marks)**

7 a. Construct the Bode plot for a unity feedback control system having $G(s) = \frac{K}{s(1+s)(1+0.1s)}$, find the (i) Value of K for a gain margin of 10 dB. (ii) Value of K to give a phase margin of 24°. **(12 Marks)**

b. Find the transfer function of the system whose Bode plot is given in Fig. Q7 (b). **(08 Marks)**

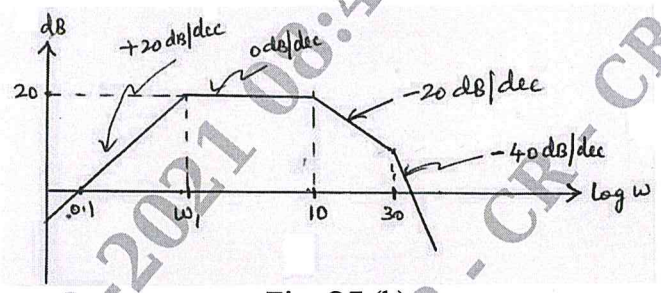

Fig. Q7 (b)

8 a. Plot the polar plot for the open loop transfer function, $G(s)H(s) = \frac{1}{1+0.1s}$. **(06 Marks)**

b. A unity feedback system has $G(s) = \frac{10}{s(s+1)(s+2)}$. Draw Nyquist plot and comment on closed loop stability. **(14 Marks)**

9 a. With a block diagram, explain a system with digital controller. **(06 Marks)**

b. Obtain state transition matrix for $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$. **(08 Marks)**

c. State the properties of state transition matrix. **(06 Marks)**

10 a. Explain signal reconstruction using sampler and zero order hold. **(06 Marks)**

b. Obtain the state model for the system represented by a differential equation,

$$\frac{d^3y}{dt^3} + 3\frac{d^2y}{dt^2} + 6\frac{dy}{dt} + 7y(t) = 2u(t)$$ **(06 Marks)**

c. For the electrical network shown in Fig. Q10 (c), find the state space representation if the output is the current through the resistor. **(08 Marks)**

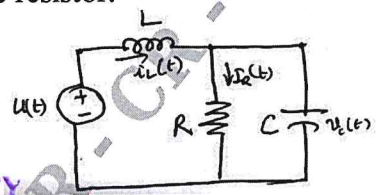

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Fig. Q10 (c)

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