CBCS SCHEME

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15MT34

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

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Define control systems. Distinguish between open loop and closed loop control systems. **(08 Marks)**

b. In the circuit below Fig.Q1(b). Determine the transfer function $E_0(S)/E_i(S)$ **(08 Marks)**

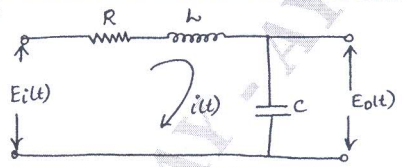

Fig.Q1(b)

2 a. Write the differential equations for the mechanical rotational system shown in Fig.Q2(a). Obtain the torque-current analogy of system. **(08 Marks)**

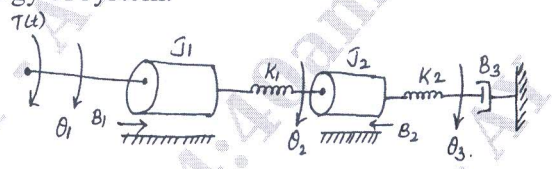

Fig.Q2(a)

b. Reduce the block diagram shown in Fig.Q2(b) to its simple form and hence obtain C(s)/R(s).

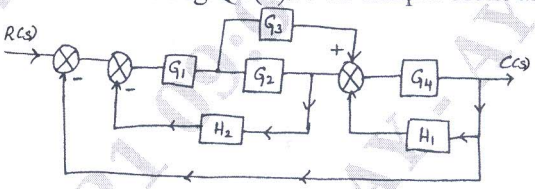

Fig.Q2(b) **(08 Marks)**

3 a. The signal flow graph shown in Fig.Q3(a) determine the transfer function $\frac{C(s)}{R(s)}$ using Mason's formula.

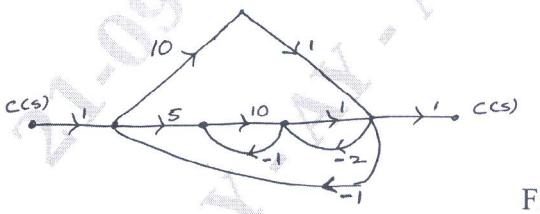

Fig.Q3(a) **(06 Marks)**

b. What are the standard test signals used in time domain analysis and give their Laplace transforms? **(04 Marks)**

c. For the shown in Fig.Q3(c), find the followings : i) System type ii) Static error constants, K_p, K_v and K_a iii) Steady state error for an input r(t) = 5u(t).

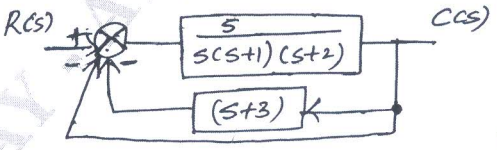

Fig.Q3(c) **(06 Marks)**

4 a. For the signal flow graph shown in Fig.Q4(a), determine the transfer function using Mason's gain formula.

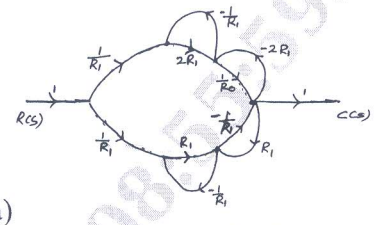

Fig.Q4(a) **(08 Marks)**

b. Derive an equation for unit step response of a second order system for under-damped case. **(08 Marks)**

5 a. For system $s^4 + 22s^3 + 10s^2 + s + K = 0$ find K_{mar} and 'w' at K_{mar}. **(08 Marks)**

b. The open loop transfer function of a feedback system is

$G(s)H(s) = \dfrac{K(s+5)}{s(1+Ts)(1+2s)}$ Parameters K and T are represented on a plane with K on x-axis and T on y-axis. **(08 Marks)**

6 Draw the approximate root locus diagram for a closed loop system whose loop transfer function is given by $G(s)H(s) = \dfrac{K}{s(s+5)(s+10)}$. Comment on the stability. **(16 Marks)**

7 a. A system of third order shows resonance peak of 2 and resonance frequency of 3 rad/sec. Determine the transfer function of equivalent second order system and hence find T_r, T_p, T_s and % overshoot. **(08 Marks)**

b. For a particular unity feedback, $G(s) = \dfrac{242(s+5)}{s(s+1)(s^2+5s+121)}$. Sketch the bode plot. Find ω_{gc} and ω_{pc}. G.M, P.M. **(08 Marks)**

8 a. Consider type2 system with transfer function $G(s)H(s) = \dfrac{1}{s^2(1+T_s)}$. Obtain its polar plot. **(08 Marks)**

b. For a certain control system $G(s)H(s) = \dfrac{k}{s(s+2)(s+10)}$. Sketch the Nyquist plot and hence calculate the range of values of k for stability. **(08 Marks)**

9 a. Define the following terms : i) state ii) state variable iii) state vector **(04 Marks)**

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

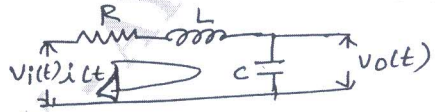

Fig.Q9(b) **(04 Marks)**

c. Obtain the solution of the homogeneous state equation $\dot{X} = AX$ where $A = \begin{bmatrix} 1 & -2 \\ 1 & -4 \end{bmatrix}$ and $X[0] = \begin{bmatrix} 0.5 \\ 1 \end{bmatrix}$. **(08 Marks)**

10 a. Construct the state model using phase variables if the system is described by the differential equation : $\dfrac{d^3y(t)}{dt^3} + 4\dfrac{d^2y(t)}{dt^2} + 7\dfrac{dy(t)}{dt} + 2y(t) = 5u(t)$ and draw the state diagram. **(06 Marks)**

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

c. Find the state transition matrix for $A = \begin{bmatrix} 0 & -1 \\ +2 & -3 \end{bmatrix}$ using Laplace transform method. **(06 Marks)**

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