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06ES43

Fourth Semester B.E. Degree Examination, Dec 08 / Jan 09
Control Systems

Time: 3 hrs. Max. Marks:100

Note : ***Answer FIVE full questions, selecting atleast TWO questions from each part.***

PART - A

1 a. Distinguish between open loop and closed loop control system. Describe two examples for each. **(10 Marks)**

b. Write the differential equations for the mechanical system shown in fig. 1(b) and obtain f – v and f – I analogous electrical circuits. **(10 Marks)**

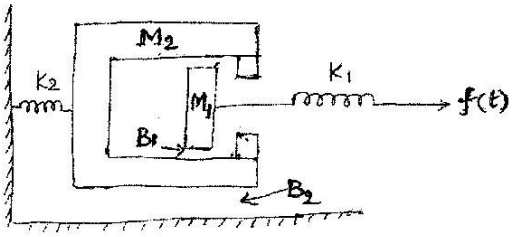


Fig. 1(b)

2 a. Draw a block diagram for the bridge circuit shown in fig.2(a), where vi and io are the input and output variables respectively. Also determine $\frac{I_o(s)}{V_i(s)}$ by block diagram reduction technique. **(12 Marks)**

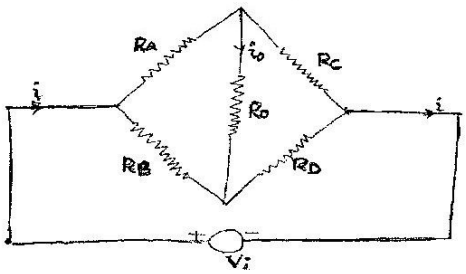


Fig. 2(a)

b. For the system represented by the following equation, find the transfer function $\frac{X(S)}{U(S)}$ by signal flow graph.

$x = x_1 + \alpha_3 U \quad ; \quad \dot{x}_1 = -\beta_1 x_1 + x_2 + \alpha_2 U \quad ; \quad \dot{x}_2 = -\beta_2 x_1 + \alpha_1 U$ **(08 Marks)**

3 a. Considering the response of a second order system to a unit step input, derive the following : i) Peak time (t_p) ii) Rise time (t_r) iii) Maximum overshoot (M_p). **(08 Marks)**

b. Assuming the time constant T of the controller to be 3 sec and the ratio of the torque to inertia K/J to be 3 rad^2/sec^2, find the damping ratio, rise time, peak time and maximum overshoot (M_p) of the system shown in fig 3(b). **(06 Marks)**

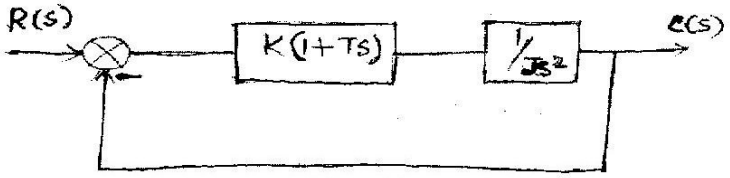


Fig.3(b)

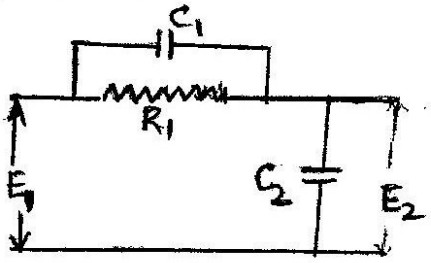
c. For a unity feedback system given by $G(s) = \frac{20(S+2)}{S(S+3)(S+4)}$

i) Find the static error constant

ii) Find the steady state error for $r(t) = 3\,u(t) + 5(t)\,u(t)$. **(06 Marks)**

4 a. What are the difficulties encountered while assessing the R-H criteria and how do you eliminate these difficulties, explain with examples. **(06 Marks)**

b. The open loop transfer function of a unity feedback control system is given by $G(S) = \frac{50}{S(1+0.05S)(1+0.2S)}$. Apply R-H criteria. Show that the system is unstable. Confirm that the introduction of the two terminal pair network connected in cascade with G(S) makes the system stable. **(08 Marks)**



$C_1 = 0.5\mu F$
$C_2 = 10\mu F$
$R_1 = 1M\Omega$.

c. Ascertain the stability of the system given by the characteristic equation
$S^6 + 3S^5 + 5S^4 + 9S^3 + 8S^2 + 6S + 4 = 0$. **(06 Marks)**

PART - B

5 a. State the different rules for the construction of root locus. **(08 Marks)**

b. Sketch the root locus for the system $G(S)\ H(S) = \frac{K}{S(S+1)(S+2)(S+3)}$ **(12 Marks)**

6 a. State and explain Nyquist stability criterion. **(08 Marks)**

b. Draw the complete Nyquist plot of the system whose loop transfer function is given by $G(S) = \frac{50}{S(1+0.1S)(1+0.2S)}$ and hence determine whether system is stable or not. **(12 Marks)**

7 a. Explain the correlation between time and frequency response. **(08 Marks)**

b. The open loop transfer function of a unity feedback system is $G(S) = \frac{1}{S(1+0.5S)(1+0.1S)}$.

Find gain and phase margin. If a phase-lag element with transfer function of $\left(\frac{1+2S}{1+5S}\right)$ is added in the forward path find by how much the gain must be changed to keep the margin same. **(12 Marks)**

8 a. Define state transition matrix and list the properties of the state transition matrix. **(08 Marks)**

b. The state equation of a certain system is $\dot{x} = Ax$, where A is a 2×2 constant matrix.

If $x(0) = \begin{bmatrix} 1 \\ -3 \end{bmatrix}$ then $\bar{x}(t) = \begin{bmatrix} e^{-3t} \\ -3e^{-3t} \end{bmatrix}$ and if $\bar{x}(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ then $\bar{x}(t) = \begin{bmatrix} e^{t} \\ e^{t} \end{bmatrix}$

Determine the state transition matrix for the system and the system matrix A. **(12 Marks)**

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