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06ES43

Fourth Semester B.E. Degree Examination, June/July 2011
Control Systems

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer FIVE full questions selecting at least TWO questions from each part.***
2. Missing data, if any may be suitably assumed.

PART – A

1 a. Distinguish closed loop control system from open loop control system with suitable examples. **(06 Marks)**

b. For the circuit shown in Fig. Q1 (b).
   i) Draw the mechanical network
   ii) Write the differential equation describing the system.
   iii) Draw the force-voltage analogous electrical circuit after writing the corresponding electrical equation. **(10 Marks)**

c. Obtain the transfer function of the system shown in Fig. Q1 (c). **(04 Marks)**

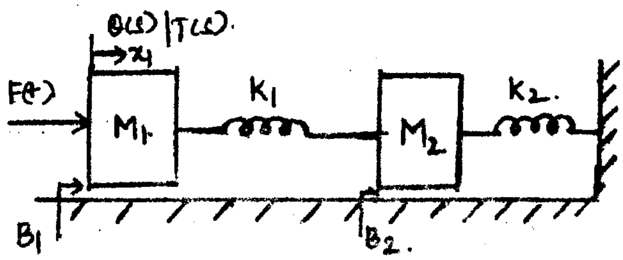

Fig. Q1 (b)

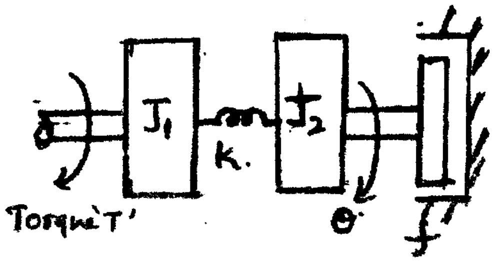

Fig. Q1 (c)

2 a. Explain the block diagram rule regarding:
   i) Combining block in cascade.
   ii) Moving a slimming point after a block.
   iii) Moving a take off point beyond a block. **(06 Marks)**

b. Reduce using block diagram reduction technique the circuit shown in Fig. Q2 (b) and hence find its transfer function C(s)/ R(s).

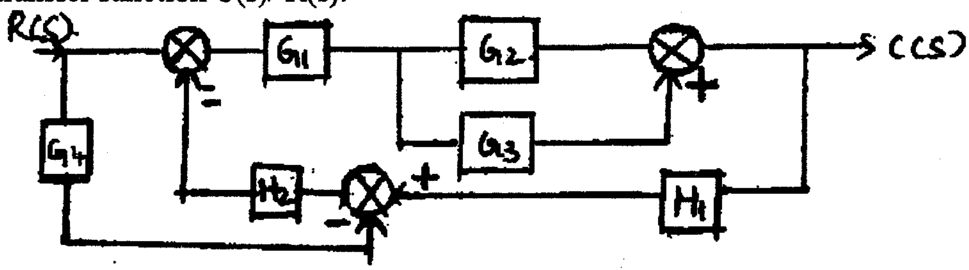

Fig. Q2 (b) **(08 Marks)**

c. For the network shown in Fig. Q2 ©construct the signal flow graph.

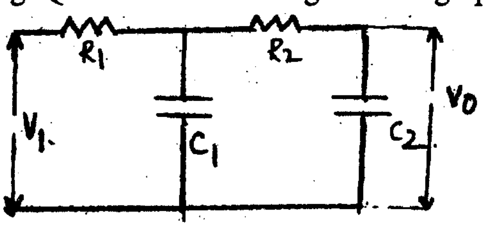

Fig. Q2 (c) **(06 Marks)**

3 a. Explain the following time domain specification of a second order system:
i) Rise time ii) Delay time iii) Peak time iv) Maximum over shoot. **(06 Marks)**

b. A signal is represented by the equation $\frac{d^2\theta}{dt^2} + 10\frac{d\theta}{dt} = 150e$ where e = (r - θ) is the actuating signal. Calculate the value of damping ratio, undamped and damped frequency of oscillation. Also draw the block diagram of the system and find its closed loop transfer function. **(08 Marks)**

c. For a unity feed back system $G(s) = \frac{s(s+1)}{s^2(s+3)(s+10)}$. Determine the type of the system, error co-efficient and steady state error for input $r(t) = 1 + 3t + \frac{t^2}{2}$.. **(06 Marks)**

4 a. State R-H criterion and discuss its limitation. **(06 Marks)**

b. The open loop transfer function of a unity feed back system is given by $G(s) = \frac{k}{s(s+3)(s^2+s+1)}$. Find the value of k that will cause sustained oscillation and hence find the oscillation frequency. **(10 Marks)**

c. Test the stability of the system characterized by its characteristics equation $s^4 + 2s^3 + 3s^2 + 4s + 5 = 0$. **(04 Marks)**

PART – B

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

b. Sketch the root locus for a negative feedback control system given by
$G(s)\,H(s) = \frac{k(s+a)}{s(s+1)(s+2)}$. **(12 Marks)**

6 a. Explain Nyquist stability criterion. **(06 Marks)**

b. For the given system $G(s)\,H(s) = \frac{k(s+a)}{s(s-1)}$ sketch the Nyquist plot and determine whether the system is stable or unstable. **(14 Marks)**

7 a. Define the following terms:
i) Gain cross over frequency ii) Phase cross over frequency
iii) Gain margin iv) Phase margin **(06 Marks)**

b. Construct the Bode plot for a unity feedback control system with $G(s) = \frac{10(s+10)}{s(s+2)(s+5)}$. Find its gain margin and phase margin. Comment on the stability. **(14 Marks)**

8 a. List the properties of state Transition matrix. **(04 Marks)**

b. Consider a system given by $\dddot{y} + 9\ddot{y} + 26\dot{y} + 24y = 6u$. Obtain its state model. **(06 Marks)**

c. Obtain the state transition matrix Q (t) of the following system.
$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$. Also obtain the inverse of the state transition matrix $\phi^1(t)$. **(10 Marks)**

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