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06ES43

Fourth Semester B.E. Degree Examination, June/July 2014
Control System

Time: 3 hrs. Max. Marks:100

Note: ***Answer any 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 example for each. **(08 Marks)**

b. Determine the transfer function $X_2(s)/F(s)$ for the mechanical system shown. **(06 Marks)**

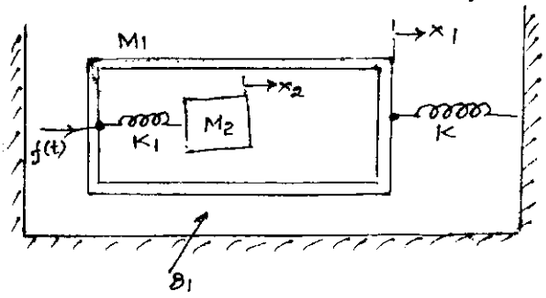

Fig.Q.1(b)

c. For the rotational mechanical system shown, draw an electrical network based on torque voltage analogy. **(06 Marks)**

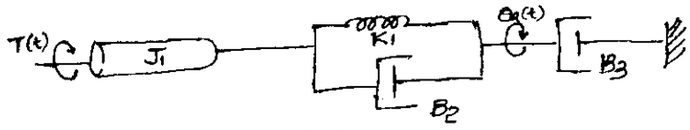

Fig.Q.1(c)

2 a. Find C/R using block diagram reduction techniques **(08 Marks)**

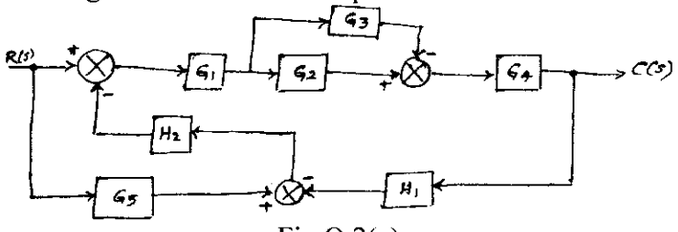

Fig.Q.2(a)

b. Find $\frac{C(s)}{R(s)}$ by Mason's gain formula for the signal flow graph shown. **(06 Marks)**

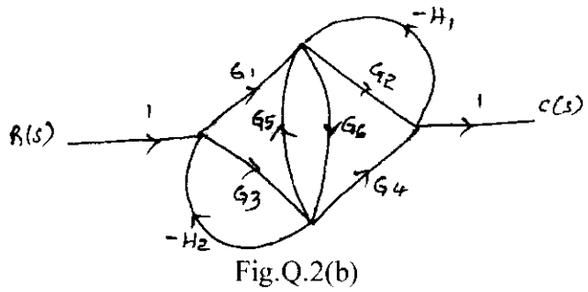

Fig.Q.2(b)

c. Find $\frac{Y_5}{Y_1}$ and $\frac{Y_2}{Y_1}$ in the signal flow graph show. **(06 Marks)**

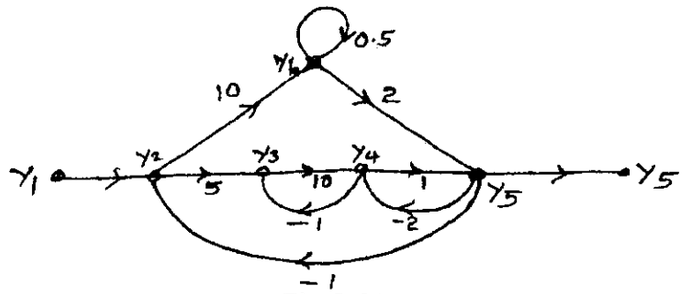

Fig.Q.2(c)

3 a. Derive an expression for the underdamped response of a second order feedback control system for step input. **(08 Marks)**

b. A unity negative feedback control system is shown below

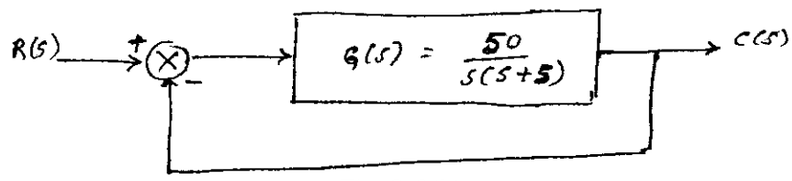

Fig.Q.3(b)

Find the following:

i) Percentage overshoot for a unit step input.
ii) Settling time for a unit step input.
iii) Steady state error for an input defined by the polynomial, $r(t) = 2 + 4t + 6t^2$, $t \geq 0$.

(06 Marks)

c. A negative feedback system is shown in figure, obtain the response to the unit step function **(06 Marks)**

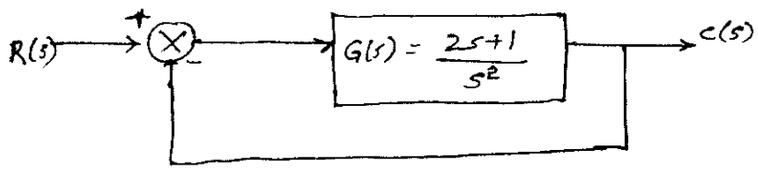

Fig.Q.3(c)

4 a. Define the following:

i) Relative stability.
ii) Absolute stability.
iii) Marginal stability.
iv) Conditional stability. **(08 Marks)**

b. For a system with characteristic equation $F(s) = s^6 + 3s^5 + 4s^4 + 6s^3 + 5s^2 + 3s + 2 = 0$ examine stability. **(06 Marks)**

c. A unit feedback system control system, has $G(s) = \frac{k(s+13)}{s(s+3)(s+7)}$. Using Routh's criterion, calculate the range of K for which the system is i) Stable; ii) has its closed loop, poles more negative than -1. **(06 Marks)**

PART – B

5 a. Sketch the root locus plot for all values of K from 0 to ∞ for a negative feedback control system having

$$G(s)H(s) = \frac{K(s+1)}{s^2(s+a)}.$$ **(10 Marks)**

b. Sketch the root locus plot for a negative feedback control system characterized by

$$G(s)H(s) = \frac{K}{s(s^2+6s+12)}$$ for all values of K ranging from 0 to ∞. **(10 Marks)**

6 a. For a certain control system

$$G(s)H(s) = \frac{K}{s(s+2)(s+10)}.$$

Sketch the Nyquist plot and hence calculate the range of values of K for stability. **(10 Marks)**

b. The transfer function of a control system is

$$G(s) = \frac{1}{s(1+2s)(1+5s)}$$

Sketch the polar plot and hence determine the phase cross-over frequency and gain margin. **(10 Marks)**

7 a. The forward-path transfer function of a unity feedback control system is given by

$$G(s)H(s) = \frac{K}{(s+3)^3}$$

i) Find the value of K such that gain margin = 10dB.

ii) Find the value of K such that phase margin = 20°. **(10 Marks)**

b. For the plot shown below determine the transfer function **(10 Marks)**

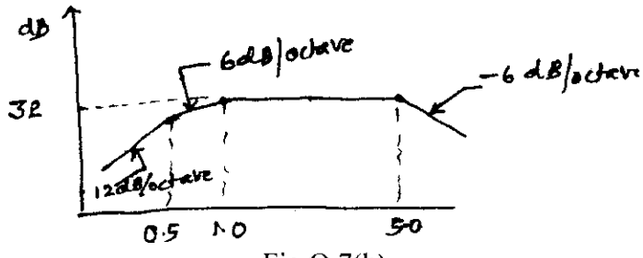

Fig.Q.7(b)

8 a. Define state transition matrix and list the properties of the state transition matrix. Find the state transition matrix for $A = \begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}$ **(10 Marks)**

b. Represent the electrical circuit shown, by its state model. **(10 Marks)**

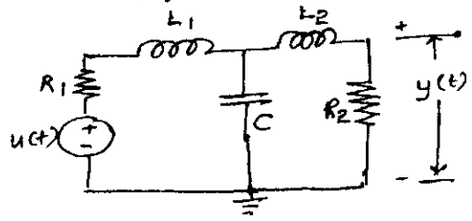

Fig.Q.8(b)

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