USN

Fourth Semester B.E. Degree Examination, December 2012
Control Systems

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Compare linear and non-linear control system. **(04 Marks)**

b. For the two port network shown in Fig. Q1 (b), obtain the transfer functions, i) $\frac{V_2(s)}{V_1(s)}$ and ii) $\frac{V_1(s)}{I_1(s)}$ **(08 Marks)**

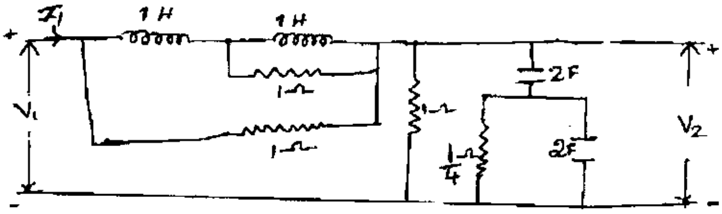

Fig. Q1 (b)

c. For the rotational system shown in Fig. Q1 (c), i) Draw the mechanical network ii) Write the differential equations iii) Obtain torque to voltage analogy. **(08 Marks)**

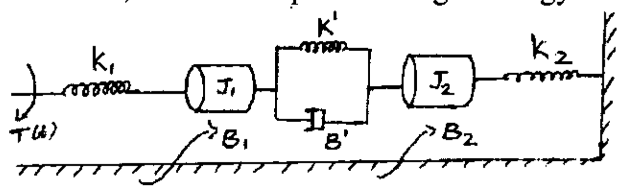

Fig. Q1 (c)

2 a. Illustrate how to perform the following, in connection with block diagram reduction rules:
i) Shifting a take-off point after a summing point.
ii) Shifting a take-off point before a summing point. **(04 Marks)**

b. The performance equations of a controlled system are given by the following set of linear algebraic equations:
i) Draw the block diagram.
ii) Find the overall transfer function $\frac{C(s)}{R(s)}$ using block diagram reduction technique.

$E_1(s) = R(s) - H_3(s)C(s)$; $E_2(s) = E_1(s) - H_1(s)E_4(s)$; $E_3(s) = G_1(s)E_2(s) - H_2(s)C(s)$
$E_4(s) = G_2(s)E_3(s)$; $C(s) = G_3(s)E_4(s)$ **(08 Marks)**

c. Draw the corresponding signal flow graph for the given block diagram is shown in Fig. Q2 (c) and obtain the overall transfer function by Mason's gain formula. **(08 Marks)**

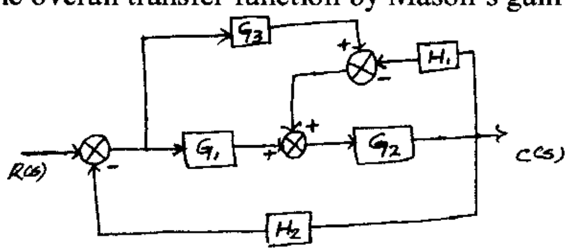

Fig. Q2 (c)

3 a. Derive the expression for peak time. **(04 Marks)**

b. The loop transfer function of a feed back control system is given by,

$$G(s)H(s) = \frac{100}{s^2(s+4)(s+12)}$$

i) Determine the static error co-efficients.

ii) Determine the steady state error for the input $r(t) = 2t^2 + 5t + 10$ **(08 Marks)**

c. A system is given by differential equation, $\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 8y(t) = 8x(t)$.

Where y(t) = output and x(t) = input.

Determine i) peak time ii) peak over shoot iii) settling time iv) expression of the output response. **(08 Marks)**

4 a. Define the term stability applied to control system and what is the difference between absolute stability and relative stability. **(04 Marks)**

b. Using Routh's criterion determine the stability of following systems:

i) Its open loop transfer function has poles at s = 0, s = -1, s = -3 and zero at s = -5. Gain K = 10.

ii) It is a type one system with an error constant of 10 sec^{-1} and poles at s = -3 and s = -6 **(08 Marks)**

c. Using RH criterion determine the stability of the system having the characteristic equation, $s^4 + 10s^3 + 36s^2 + 70s + 75 = 0$ has roots more negative than s = -2. **(08 Marks)**

PART – B

5 a. The open-loop transfer function of a feed back control system in $G(s)H(s) = \frac{K}{(s+1)(s+2)(s+3)}$, check whether the following points are on the root locus. If so, find the value of K at these points. i) s = -1.5 ii) s = -0.5 + j2 **(06 Marks)**

b. Sketch the root locus plot for a negative feed back control system characterized by an open loop transfer function, $G(s)H(s) = \frac{K}{s(s+3)(s^2+3s+11.2s)}$. Comment on stability. **(14 Marks)**

6 a. State the advantages and limitations of frequency domain approach. **(06 Marks)**

b. Determine the transfer function, of a system whose asymptotic gain plot is shown in Fig. Q6 (b). **(10 Marks)**

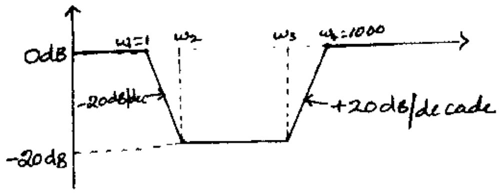

Fig. Q6 (b)

c. List the effects of lead compensation. **(04 Marks)**

7 a. Draw polar plot of $G(s)H(s) = \frac{100}{(s+2)(s+4)(s+8)}$. **(04 Marks)**

b. Explain Nyquist stability criterion. **(06 Marks)**

c. Sketch the Nyquist plot for, $GH(s) = \frac{K}{s(s+1)(s+2)}$. Then, find the range of K for closed loop stability. **(10 Marks)**

8 a. Define the following terms: i) state ii) state variables iii) state space. **(06 Marks)**

b. List the advantages of state variable analysis. **(04 Marks)**

c. Obtain the state transition matrix for, $A = \begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}$. **(10 Marks)**

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