Fourth Semester B.E. Degree Examination, Dec. 2013/Jan. 2014
Control Systems

Time: 3 hrs.   Max. Marks:100

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

PART – A

1 a. Define control system? what are the requirements of a good control system. **(04 Marks)**

  b. Show that the two systems shown in Fig. Q1(b)(i) and (ii) are analogous systems by comparing their transfer functions. **(08 Marks)**
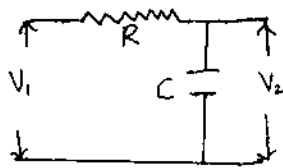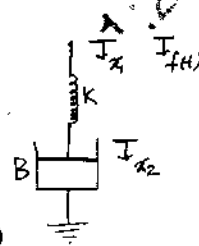

Fig. Q1(b)(i)   Fig. Q1(b)(ii)

  c. For the electromechanical system show in Fig. Q1(c). Find the transfer function $\dfrac{X(S)}{E(S)}$ **(08 Marks)**
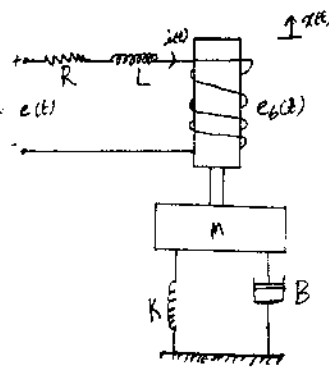

Fig. Q1(c)

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

  b. Find the closed loop transfer function of the system shown in Fig. Q2(b), using block diagram reduction rules. **(08 Marks)**
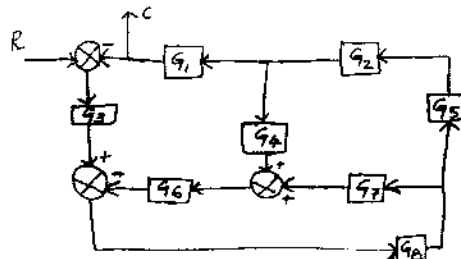

Fig. Q2(b)

  c. For the network shown in Fig. Q2(c), construct the signal flow graph and determine the transfer function using Mason's gain formula. **(08 Marks)**
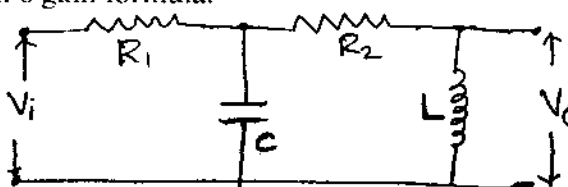

Fig. Q2(c)

3   a.   Define the following terms :   i) Transient response   ii) Steady state response.   **(04 Marks)**

     b.   The system given in Fig.Q3(b) is a unity feed back system with minor feed back loop.
        i)   In the absence of derivative feedback ($a = 0$), determine the damping ratio and undamped natural frequency
       ii)   Determine the constant 'a' which will increase damping ratio to 0.7
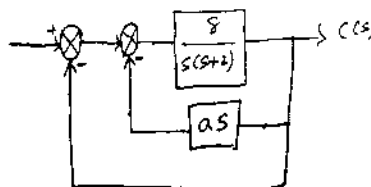   iii)   Find the overshoot in both the case.   **(08 Marks)**

Fig. Q3(b)

     c.   A plotter may be represented by the block diagram shown in Fig. Q3(c). i) Determine the value of gain 'K' that gives a peak over shoot of 4.32% ii) For this value of K, determine the steady state error for a unit ramp input iii) For what range of K is the 2% of settling time less than one, sec.   **(08 Marks)**
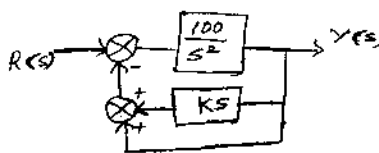

Fig. Q3(c)

4   a. $s^6 + 4s^5 + 3s^4 - 16s^2 - 64s - 48 = 0$. Find the number of roots of this equation with positive real part, zero real part and negative real part.   **(06 Marks)**

     b.   The block diagram of a feedback control system is shown in Fig. Q4(b). applying RH criterion to determine the range of K for stability if
$$G(s) = \frac{K}{(s+4)(s+5)}.$$ **(06 Marks)**

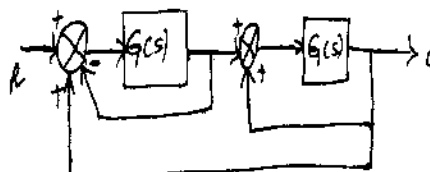Fig. Q4(b)

     c.   Determine the value of 'K' and 'b' so that the system whose open loop transfer function is
$$G(s) = \frac{K(s+1)}{s^3 + 6s^2 + 3s + 1}$$
Oscillates at a frequency of oscillations of 2 rad/sec. [assume unity feedback].   **(08 Marks)**

PART – B

5   a.   Consider the system with
$$G(s)H(s) = \frac{K}{s(s+2)(s+4)}.$$ Find whether s = -0.75 and s = - 1 + j4 is on the root locus or not using angle condition.   **(04 Marks)**

     b.   The open loop transfer function of a control system is given by
$$G(s)H(s) = \frac{K(s+1)}{s(s-1)(s^2 + 5s + 20)}$$
Determine the valid break away points.   **(08 Marks)**

     c.   Show that the part of root locus of a system with
$$G(S)H(s) = \frac{K(s+3)}{S(s+2)}$$ is a circle having center (-3, 0) and radius at $\sqrt{3}$.   **(08 Marks)**

6 a. For a closed loop control system $G(s) = \dfrac{100}{s(s+8)}$ $H(s) = 1$. Determine resonant peak and resonant frequency. **(04 Marks)**

b. List the limitations of lag and lead compensation. **(08 Marks)**

c. Find the open loop transfer function of a single loop unity feedback system whose asymptotic bode magnitude plot is shown in Fig. Q6(c). **(08 Marks)**
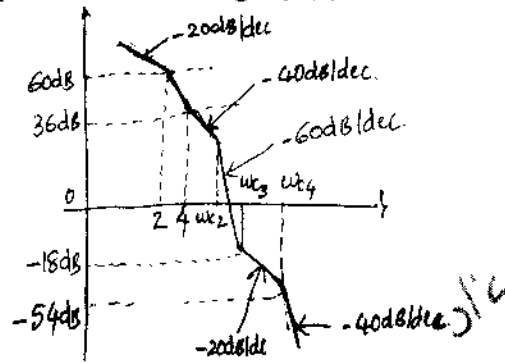

Fig. Q6(c)

7 a. Determine the number of encirclements about the origin in Fig. Q7(a). **(04 Marks)**
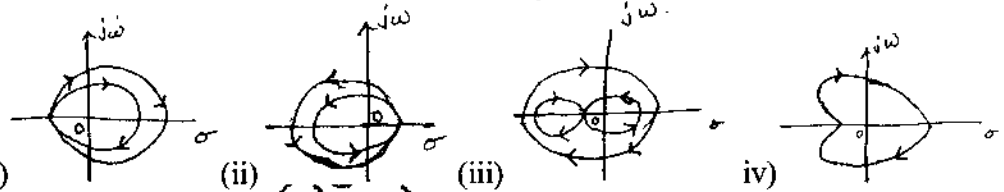

Fig.Q7(a)(i)   (ii)   (iii)   iv)

b. Draw polar plot of $G(s)H(s) = \dfrac{100}{(s+2)(s+4)(s+8)}$. **(08 Marks)**

c. Using Nyquist stability criterion, investigate the closed loop stability of a negative feedback control system whose open – loop transfer function is given by

$$G(s)H(s) = \frac{K(ST_a + 1)}{S^3} \ , \ K, \ T_a > 0.$$
(08 Marks)

8 a. Obtain the state transition matrix for the following system.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & -0.5 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0.5 \\ 0 \end{bmatrix} u \ .$$
(10 Marks)

b. Develop a state model for the electrical network shown in Fig. Q8(b) choosing the current through the inductance and voltage across the capacitor as states. The output is

$$Y = \begin{bmatrix} V_{R_2} & i_{R_2} \end{bmatrix}^T \ .$$
(10 Marks)

Fig. Q8(b)

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