USN

10ES43

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)**

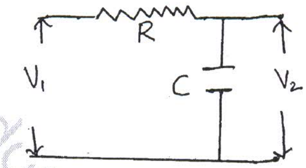

Fig. Q1(b)(i)

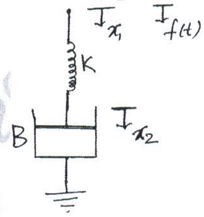

Fig. Q1(b)(ii)

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

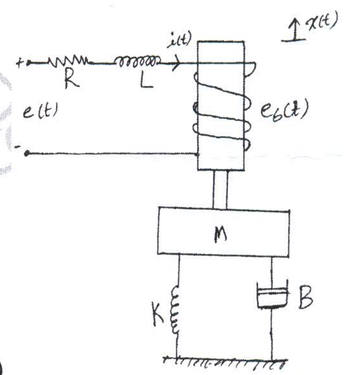

Fig. Q1(c)

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)**

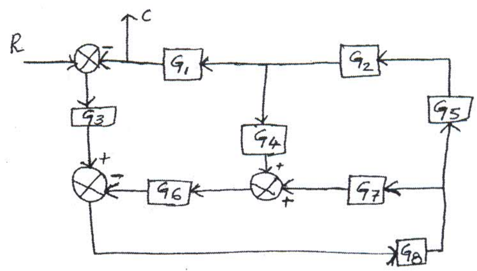

Fig. Q2(b)

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)**

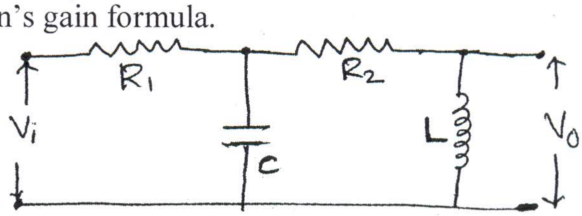

Fig. Q2(c)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

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)**

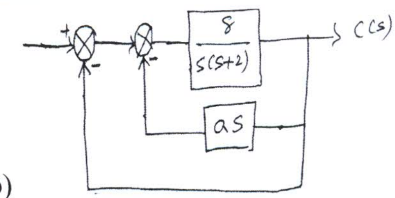

Fig. Q3(b)

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)**

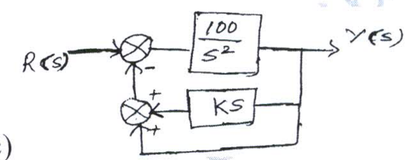

Fig. Q3(c)

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)**

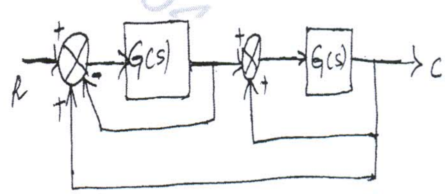

Fig. Q4(b)

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)**

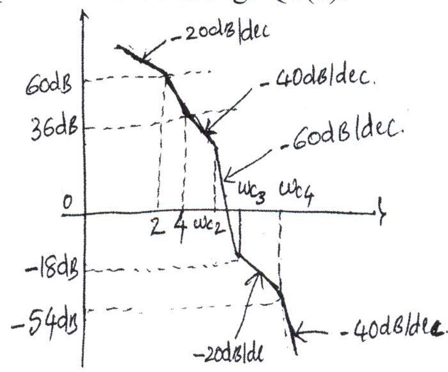

Fig. Q6(c)

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

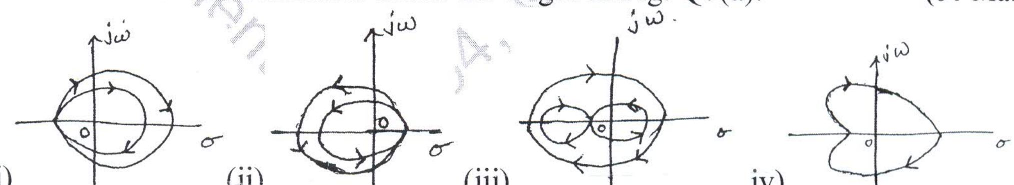

Fig.Q7(a)(i) (ii) (iii) iv)

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 $Y = \left[V_{R_2} \ i_{R_2}\right]^T$. **(10 Marks)**

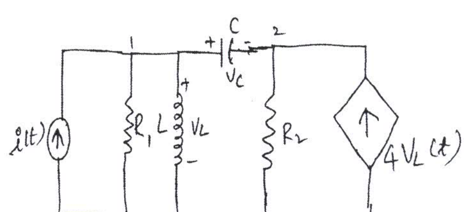

Fig. Q8(b)

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