USN

10ES43

Fourth Semester B.E. Degree Examination, Dec.2015/Jan.2016
Control Systems

Time: 3 hrs. Max. Marks: 100

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

PART – A

1 a. Briefly explain the requirements of a good control system. **(06 Marks)**

b. Show that the two systems shown in Fig.Q1(b)(i) and Fig.Q1(b)(ii) are analogous system by comparing their transfer functions. **(06 Marks)**

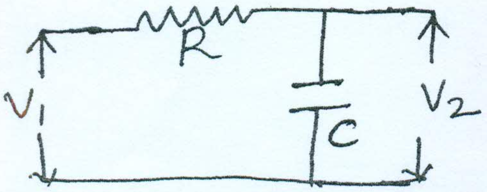

Fig.Q1(b)(i)

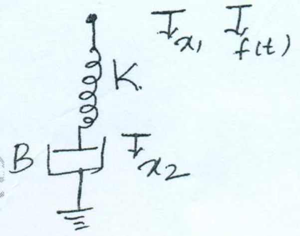

Fig.Q1(b)(ii)

c. For the mechanical system shown in Fig.Q1(c), i) Draw the mechanical network ii) write the differential equations iii) draw force – voltage analogous electric network. **(08 Marks)**

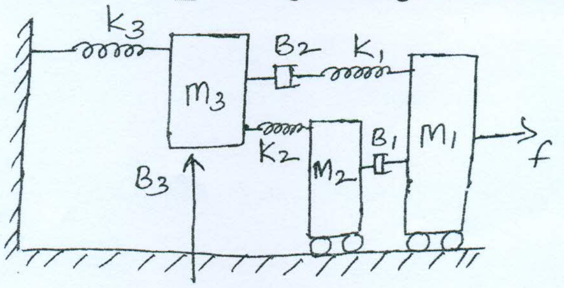

Fig.Q1(c)

2 a. Illustrate how to perform the following in connection with block diagram reduction techniques.
  i) Shifting take – off point after a summing point
  ii) Shifting take – off point before a summing point
  iii) Removing minor feedback loop. **(06 Marks)**

b. What is signal-flow graph representation? Briefly explain the properties of signal flow graph. **(06 Marks)**

c. Draw a block diagram for the electric circuit shown in Fig.Q2(c) and obtain the transfer function $\frac{E_0(s)}{E_i(s)}$. **(08 Marks)**

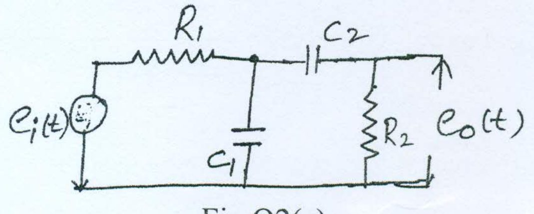

Fig.Q2(c)

3 a. Show that the steady state error $e_{ss} = \lim_{s \to 0} \frac{SR(s)}{1 + G(s)H(s)}$ using simple closed loop system with –ve feedback. **(06 Marks)**

b. The block diagram of a simple servo system is shown in Fig. Q3(b). Compute the values of K and T to give overshoot of 20% and peak time of 2 sec. **(06 Marks)**

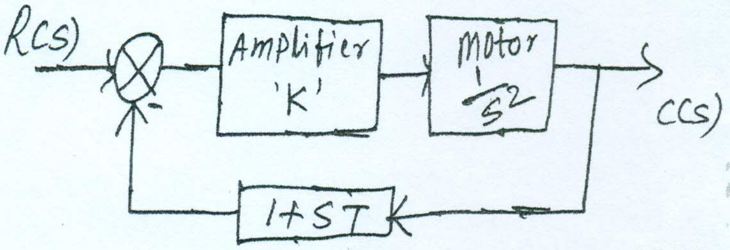

Fig.Q3(b)

c. Referring to Fig.Q3(c), find the following : i) transfer function : $\frac{X(s)}{F(s)}$ ii) ξ, W_n iii) % M_p, T_s and T_p. where K = 33 N/m, B = 15 N – s/m, M = 3 kg. **(08 Marks)**

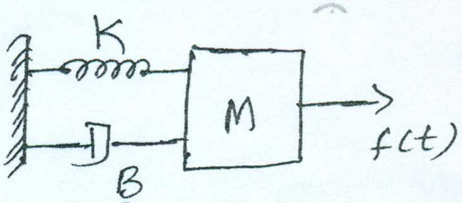

Fig.Q3(c)

4 a. What is stable and unstable systems? What is the difference between absolute and relative stable systems? **(06 Marks)**

b. A unity feedback 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 has its closed loop poles more negative than –1. **(06 Marks)**

c. The open loop transfer function of a unity feedback, open loop control system is given by $G(s) = \frac{K(s+10)}{s^2(s^2+2s+10)}$, i) find the value of K so that the steady state error for a unity parabolic input is ≤ 0.1 ii) for the value of K found in part i) verify the closed loop system is stable or not. **(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 using angle condition. **(04 Marks)**

b. For a system having $G(s)H(s) = \frac{K}{s(s+3)(s^2+3s+11.25)}$. Find the valid break away points and angle of departure. **(06 Marks)**

c. Show that the part of the 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 $\sqrt{3}$.(Using both graphical and analytical method). **(10 Marks)**

6 a. List the advantages and limitations of frequency domain approach. **(04 Marks)**

b. What is lead and lag network? List the effects of lead and lag compensator. **(06 Marks)**

c. For a control system having $G(s) = \frac{k(1+0.5s)}{s(1+2s)(1+0.05s+0.125s^2)}$, draw bode plot, with K = 4 and find gain margin and phase margin. **(10 Marks)**

7 a. Draw polar plot of :

$$G(s)H(s) = \frac{100}{(s+2)(s+4)(s+8)}.$$ **(06 Marks)**

b. State and explain Nyquist stability criterion. **(04 Marks)**

c. For the given system $G(s) = \frac{10}{s^2(1+0.25s)(1+0.5s)}$ sketch the Nyquist plot and determine whether the system is stable or not. **(10 Marks)**

8 a. Construct the state model using phase variables if the system is described by the differential equation : $\frac{d^3y(t)}{dt^3} + \frac{4d^2y(t)}{dt^2} + \frac{7dy(t)}{dt} + 2y(t) = 5u(t)$. Draw the state diagram. **(06 Marks)**

b. List the properties of the state transition matrix. **(06 Marks)**

c. Obtain the state transition matrix for : $A = \begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}$. **(08 Marks)**

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