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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)

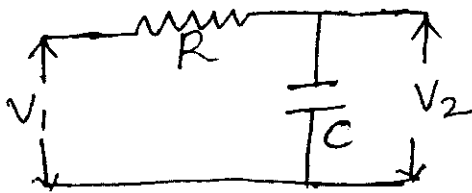


Fig.Q1(b)(i)

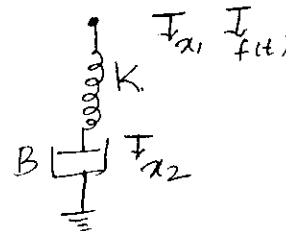


Fig.Q1(b)(ii)

- 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)

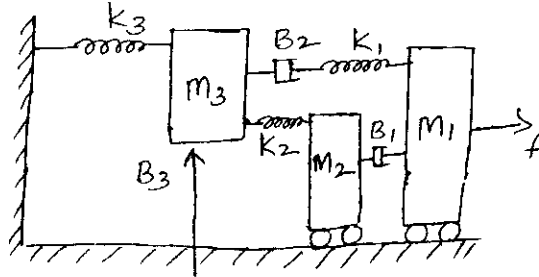


Fig.Q1(c)

- 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)

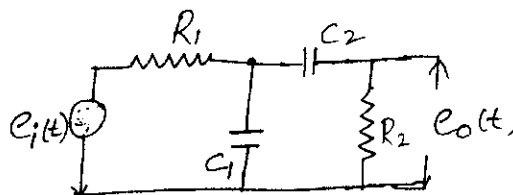


Fig.Q2(c)

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. Show that the steady state error $e_{ss} = \lim_{s \rightarrow 0} \frac{SR(s)}{1 + G(s)H(s)}$ 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)

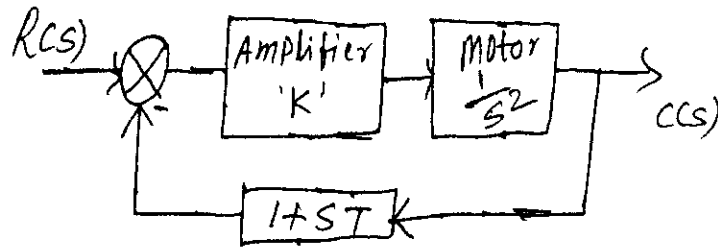


Fig.Q3(b)

- 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 $K = 33 \text{ N/m}$, $B = 15 \text{ N-s/m}$, $M = 3 \text{ kg}$. (08 Marks)

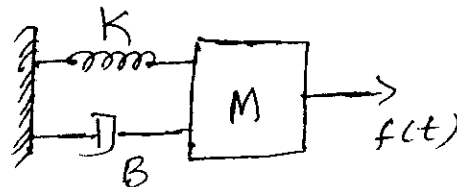


Fig.Q3(c)

- 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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