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10ES43

Fourth Semester B.E. Degree Examination, June/July 2018
Control Systems

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define control system. Explain linear and nonlinear control system. **(06 Marks)**

b. Derive transfer function for a lag-lead network, shown in Fig.Q.1(b). **(06 Marks)**

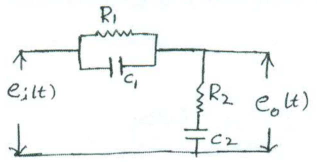


Fig.Q.1(b)

c. For the mechanical system shown in Fig.Q.1(c) i) Draw the mechanical network; ii) Write differential equations; iii) Draw force-to-voltage [F-V] analogous electric network.

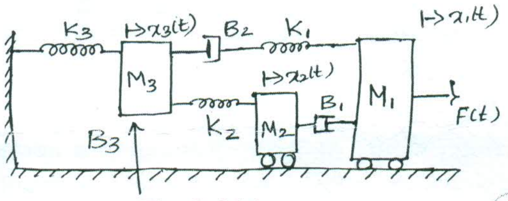


Fig.Q.1(c) **(08 Marks)**

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

b. Obtain $\dfrac{C_1(S)}{R_2(S)}$ and $\dfrac{C_2(S)}{R_1(S)}$ for the given multiple input and multiple output system shown in Fig.Q.2(b). **(06 Marks)**

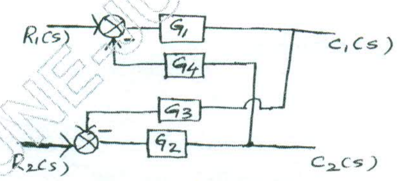


Fig.Q.2(b)

c. Draw the signal flow graph and determine the overall transfer function of the block diagram shown in Fig.Q.2(c) using Mason's gain formula. **(08 Marks)**

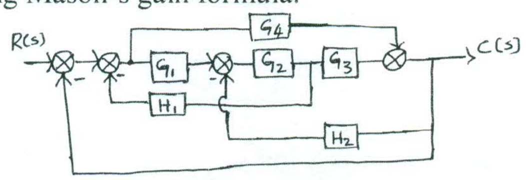


Fig.Q.2(c)

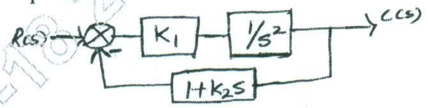
3 a. State various standard test signals commonly used in control system. Sketch their typical plots and obtain their Laplace transform. **(06 Marks)**

b. A unity feedback system has $G(S) = \dfrac{10(S+2)(S+3)}{S(S+1)(S+5)(S+4)}$. Determine:

i) Type of the system
ii) All error coefficients and
iii) Steady state error where input is $r(t) = 3 + t + t^2$. **(06 Marks)**

c. For control system shown in Fig.Q.3(c) find the values of K_1 and K_2 so that $M_P = 25\%$ and $T_P = 4$ sec. Assume unit step input. **(08 Marks)**

Fig.Q.3(c)



4 a. Define the following terms related to a control system:
i) Stable system ii) Marginally stable system iii) Relatively more stable system. **(06 Marks)**

b. For unity feedback system, $G(S) = \dfrac{K}{S(1+0.4S)(1+0.25S)}$, find range of values of K, marginal value of K and frequency of sustained oscillations. **(06 Marks)**

c. Using RH criterion determine the stability of the system having the characteristic equation $S^6 + 2S^5 + 5S^4 + 8S^3 + 8S^2 + 8S + 4 = 0$. Examine the stability. **(08 Marks)**

PART – B

5 a. Find valid break away points and inter section of root locus with imaginary axis for $G(S)H(S) = \dfrac{K(S+1)}{S(S-1)(S^2+5S+20)}$. **(08 Marks)**

b. Sketch the rough nature of the root locus of a certain control system whose characteristic equation is given as $S^3 + 9S^2 + KS + K = 0$. Comment on stability. **(12 Marks)**

6 a. Explain the correlation between time domain and frequency domain systems. **(06 Marks)**

b. For a unity feedback system $G(S) = \dfrac{242(S+5)}{S(S+1)(S^2+5S+121)}$. Sketch the bode plot, find W_{gc}, W_{pc}, GM and PM. Comment on stability. **(14 Marks)**

7 a. Draw a polar plot for a –VC feedback control system having an open loop transfer function. $G(S)H(S) = \dfrac{100}{(S+2)(S+4)(S+8)}$. **(06 Marks)**

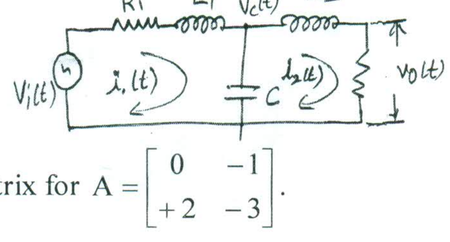
b. List the advantages of Nyquist plot. **(04 Marks)**

c. Investigate the stability of a negative feedback control system whose open loop transfer function is given by $G(S)H(S) = \dfrac{100}{(S+1)(S+2)(S+3)}$, using Nyquist stability criterion. **(10 Marks)**

8 a. Define state variables. List the properties of state transition matrix. **(06 Marks)**

b. Obtain the state and output equation for the electrical network shown in Fig.Q.8(b). **(06 Marks)**

Fig.Q.8(b)



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

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