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10ES43

Fourth Semester B.E. Degree Examination, June/July 2019
Control Systems

Time: 3 hrs. Max. Marks:100

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

PART – A

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

b. Determine the transfer function $\frac{I(s)}{V_i(s)}$ for the circuit diagram shown in Fig.Q.1(b). Where 'K' is the gain of an ideal op-amp. **(08 Marks)**

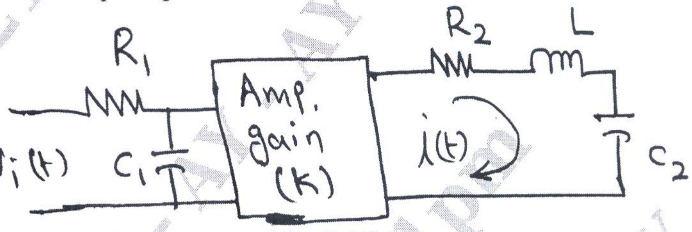

Fig.Q.1(b)

c. Show that the two system shown in Fig.Q.1(c) are analogous system by comparing their transfer functions: **(08 Marks)**

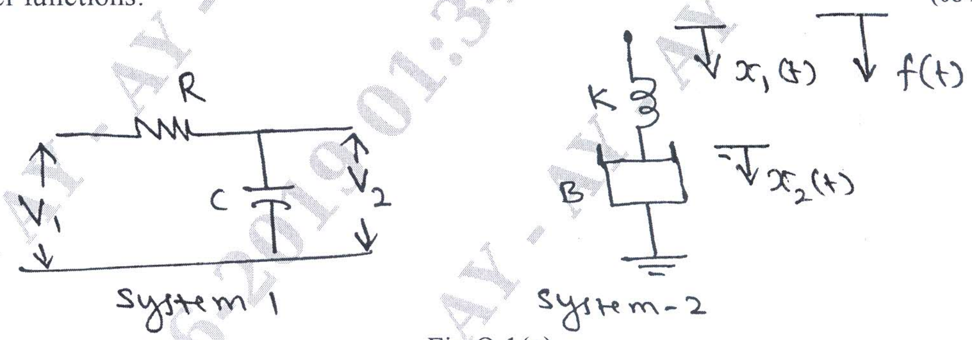

Fig.Q.1(c)

2 a. Draw the block diagram for the electric circuit shown in Fig.Q.2(a) and evaluate the transfer function $\frac{E_o(s)}{E_i(s)}$. **(10 Marks)**

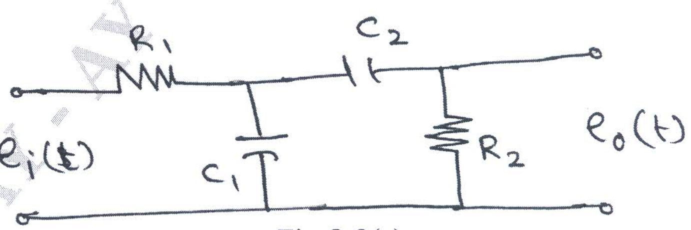

Fig.Q.2(a)

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.

b. Draw the signal flow graph and determine the overall transfer function of the block diagram shown in Fig.Q.2(b) using Mason's gain formula. **(10 Marks)**

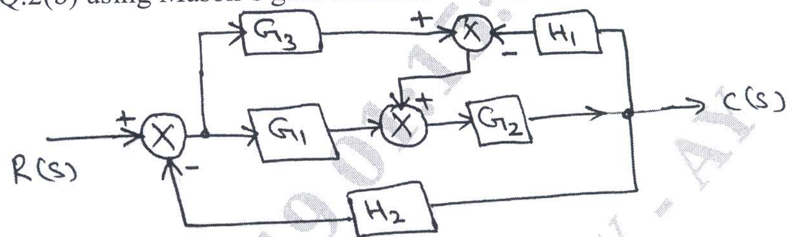

Fig.Q.2(b)

3 a. Derive the expression for peak overshoot in terms of ξ and W_n for second order control systems. **(04 Marks)**

b. A unity feed back system has $G(s) = \dfrac{K}{s(s+2)(s^2+2s+s)}$

i) For a unit ramp input, it is desired $e_{ss} \le 0.2$ find K.

ii) Determine e_{ss} if input $r(t) = 2 + 4t + \dfrac{t^2}{2}$. **(08 Marks)**

c. A system has 30% overshoot and settling time of 5 seconds for unit step input. Determine:
i) The transfer function ii) Peak time iii) Output response. **(08 Marks)**

4 a. Define the following terms:
i) Conditionally stable system
ii) Marginally stable system
iii) Relative stable system. **(06 Marks)**

b. The open loop transfer function of a unity feedback 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 (1) verify whether the closed loop system is stable or not. **(06 Marks)**

c. The block diagram of a feedback control system is shown in Fig.Q.4(c). Apply RH-criterion to determine the range of 'K' for stability if $G(s) = \dfrac{K}{(s+4)(s+5)}$. **(08 Marks)**

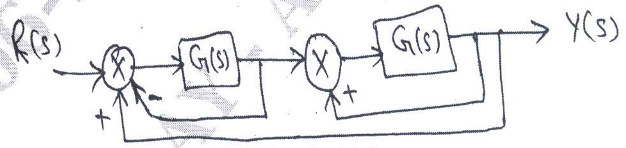

Fig.Q.4(c)

PART – B

5 a. The characteristic equation of a single loop unity feedbacks control system is given by $F(s) = s^3 + 8s^2 + 20s + k = 0$ sketch the complete root locus diagram. **(10 Marks)**

b. Prove that a combination of two poles $s = -a_1$ and $s = -a_2$, one zero is $s = -b$ to the left of both of them on the real axis results in a root locus whose complex root branches from a circle centered at the zero with radius given by $\sqrt{(b-a_1)(b-a_2)}$, the root locus gain varying from 0 to ∞. **(10 Marks)**

6 a. What are the limitations of frequency domain approach? **(04 Marks)**

b. List the effect of lead compensation and lag compensation. **(04 Marks)**

c. Determine the transfer function of a system whose asymptotic gain plot is shown in Fig.Q.6(c) **(12 Marks)**

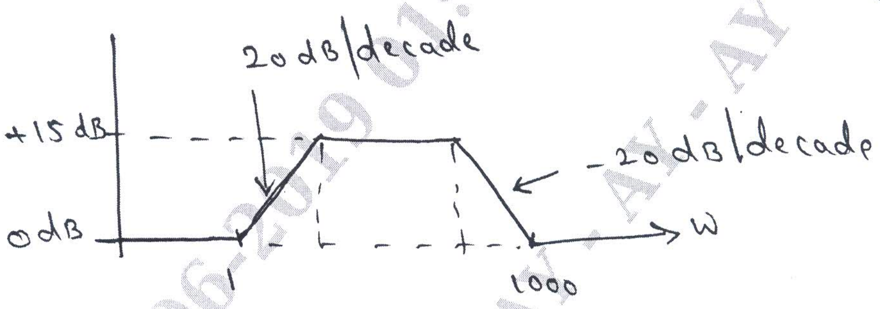

Fig.Q.6(c)

7 a. Draw the exact polar plot of

$$GH(s) = \frac{12}{s(s+1)(s+2)}.$$ **(05 Marks)**

b. Explain Nyquist stability criterion. **(05 Marks)**

c. A –ve feed back control system is characterized by an open loop transfer function $G(s)H(s) = \frac{5}{s(s+1)}$. Investigate the closed loop stability of the system using Nyquist stability criterion. **(10 Marks)**

8 a. Define state variable and state vector. List the properties of state transition matrix. **(08 Marks)**

b. For a certain system, when

$$X(0) = \begin{bmatrix} 1 \\ -3 \end{bmatrix} \text{ then } X(t) = \begin{bmatrix} e^{-3t} \\ -3e^{-3t} \end{bmatrix}$$

While $X(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$ then $X(t) = \begin{bmatrix} e^{t} \\ e^{t} \end{bmatrix}$

Determine the system matrix 'A' also find the state transition matrix. **(12 Marks)**

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