USN

10ES43

Fourth Semester B.E. Degree Examination, Aug./Sept.2020
Control Systems

Time: 3 hrs. Max. Marks:100

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

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.

PART – A

1 a. With the help of block diagram, explain open loop and closed loop control system with one example each. **(06 Marks)**

b. Define : (i) Linear and nonlinear control system.
(ii) Time invariant and Time varying control system
(iii) Continuous time and Discrete time control system
(iv) Deterministic and stochastic control system **(04 Marks)**

c. For the mechanical system shown in Fig.Q1(c), write the differential equations and hence obtain FV and FI analogous circuits.

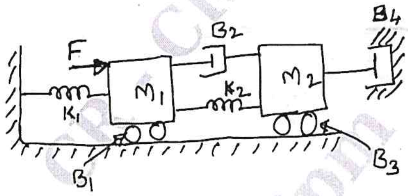

Fig.Q1(c) **(10 Marks)**

2 a. Draw the signal flow graph for the following set of algebraic equations:

$x_2 = a_1x_1 + a_2x_2 + a_3x_3$

$x_3 = a_4x_2 + a_5x_4$

$x_4 = a_6x_1 + a_7x_2 + a_8x_3$

$x_5 = x_4$ **(04 Marks)**

b. Find the transfer function $\frac{C(s)}{R(s)}$ for the block diagram shown in Fig.Q2(b) using block diagram reduction technique.

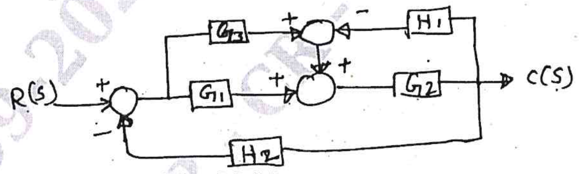

Fig.Q2(b) **(06 Marks)**

c. Draw the signal flow graph for the block diagram shown in Fig.Q2(c) and hence find $\frac{C}{R}$ using Mason's gain formula.

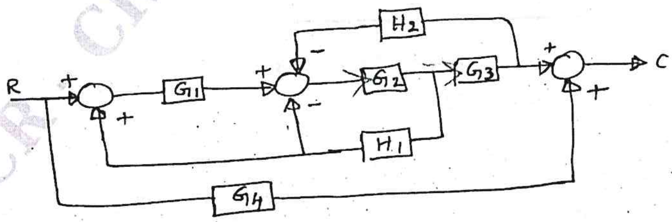

Fig.Q2(c) **(10 Marks)**

3 a. Define the following time domain specifications :
(i) Rise time (ii) Peak time (iii) Maximum overshoot (iv) Settling time **(04 Marks)**

b. For the system shown in Fig.Q3(b) :
(i) What type of system does $\frac{C(s)}{E(s)}$ represent?
(ii) Find the static error coefficients k_p, k_v and k_a
(iii) Find the steady state value of c(t), if r(t) = 10u(t)

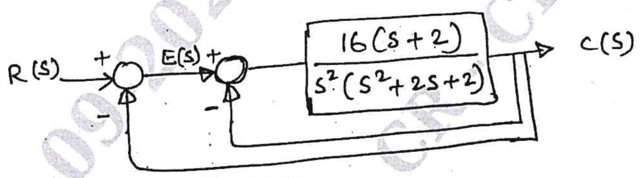

Fig.Q3(b) **(08 Marks)**

c. For the system shown in Fig.Q3(c), find A for maximum overshoot $M_p \le 2\%$.
Given T = 0.4 sec, J = 1600 kg.m^2.

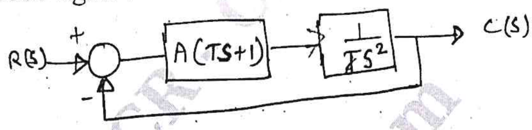

Fig.Q3(c) **(08 Marks)**

4 a. Define stability of a system. With the help of pole location and unit step response state the stability of a system when
(i) $0 < \xi < 1$, ξ = damping ratio.
(ii) $\xi = 1$
(iii) $\xi > 1$
(iv) $\xi = 0$
(v) $0 < \xi < -1$ **(12 Marks)**

b. The characteristic equation of a system is
$s^4 + 22s^3 + 10s^2 + 2s + k = 0$
Using Routh-Hurwitz criteria, find the range of k for which the system is stable. **(08 Marks)**

PART – B

5 a. Define root locus. Show that root loci starts from poles and ends at zeros. **(06 Marks)**

b. Draw the root locus for the system having
$$G(s)H(s) = \frac{k}{s(s+2)(s+3)}$$
Mention the range of k for stability. **(14 Marks)**

6 a. Discuss the assessment of relative stability using Nyquist criteria. **(10 Marks)**

b. Draw the Nyquist contour and Nyquist plot for the system having
$$G(s)H(s) = \frac{5}{s(1-s)}$$
and find the stability using Nyquist stability criteria. **(10 Marks)**

7 a. The open loop transfer function of a unity feedback system is given by

$$G(s) = \frac{K}{s(1+0.1s)(1+s)}$$

(i) Draw the Bode plots and find the gain margin and phase margin.

(ii) Determine the value of K so that the gain margin of the system is 30 dB. **(15 Marks)**

b. Determine the transfer function of the system represented by the Bode magnitude plot shown in Fig.Q7(b).

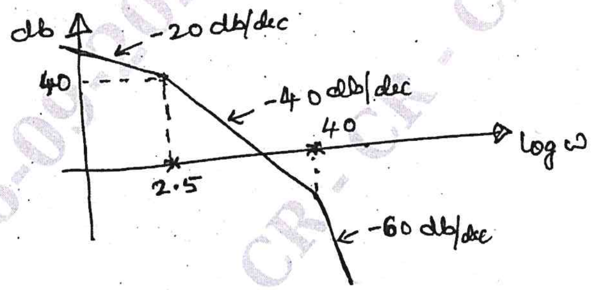

Fig.Q7(b) **(05 Marks)**

8 a. Obtain the state model of the electrical system shown in Fig.Q8(a), assuming current through inductance and voltage across capacitance as state variables and also voltage across capacitance as output.

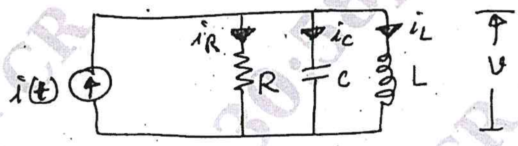

Fig.Q8(a) **(05 Marks)**

b. Mention the properties of state transition matrix e^{AT}. **(05 Marks)**

c. Find the state transition matrix $\phi(t)$, $\phi^{-1}(t)$ and x(t) for the system

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X \quad \text{and} \quad x(0) = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$ **(10 Marks)**

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