Code: 20A04501

R20

B.Tech III Year I Semester (R20) Regular & Supplementary Examinations January 2024

CONTROL SYSTEMS ENGINEERING

(Electronics & Communication Engineering)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

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1 Answer the following: (10 X 02 = 20 Marks)

(a) What is the use of Mason's gain formula? 2M

(b) Explain how feedback effects sensitivity of the system. 2M

(c) Draw the speed-torque characteristics of AC servomotor. 2M

(d) What does term 'type' of a system indicate? What is its significance? 2M

(e) Define relative stability and mention the techniques which will be used for the measurement of relative stability. 2M

(f) State limitations of Routh's stability. 2M

(g) What is the effect on polar plot if a non-zero pole is added to the transfer function? 2M

(h) Why Bode plots are commonly used in the frequency domain design? 2M

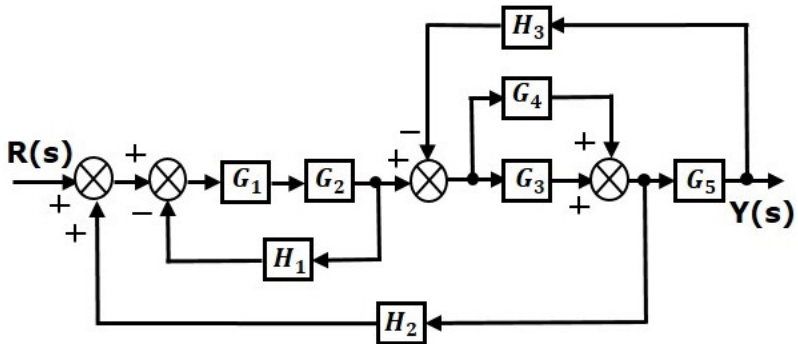
(i) What is meant by state, state variable and state model? 2M

(j) What are the advantages of state space analysis over transfer function analysis? 2M

PART – B

(Answer all the questions: 05 X 10 = 50 Marks)

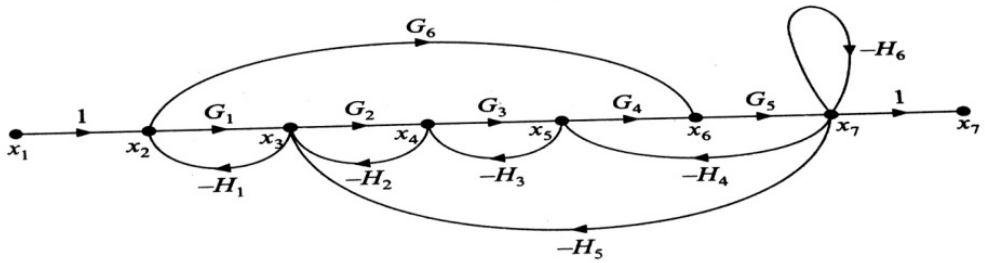
2 (a) Obtain the transfer function of block diagram in figure below. 5M



(b) Write the force balance and torque balance equations for basic elements in mechanical systems. 5M

OR

3 (a) Obtain the transfer function of signal flow graph shown in figure below using Mason's gain formula. 5M



(b) Distinguish between open loop control system and closed loop control system. 5M

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4 For unity feedback control system, the open loop transfer function, $G(s) = \frac{10(s+2)}{s^2(s+4)}$. Find the e_{ss}, when the input is $r(t) = 3 - 2t + 3t^2$. Find K_p, K_v and K_a. 10M

OR

5 (a) Derive the expression for peak time and rise time in terms of ξ and ω_n for a second order system. 5M

(b) Derive the transfer function and develop the block diagram of Armature controlled DC servo motor. 5M

6 With the help of Routh's stability criterion, find the stability of the following systems represented by the characteristic equations: 10M

(i) $s^4 + 8s^3 + 18s^2 + 16s + 5 = 0$.

(ii) $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$.

(iii) $s^5 + s^4 + 2s^3 + 2s^2 + 3s + 5 = 0$.

OR

7 Sketch the root locus of the system whose open loop transfer function is $G(s) = \frac{K}{s(s+2)(s+4)}$. Find the value of K so that the damping ratio of the closed loop system is 0.5. 10M

8 (a) State and explain the Nyquist stability criterion. 5M

(b) Sketch the Bode plot and hence find the gain cross over frequency, phase cross over frequency $G(s) = \frac{0.75(1+0.2s)}{s(1+0.5s)(1+0.1s)}$. 5M

OR

9 The open loop transfer function of a unit feedback system is given by $G(s) = \frac{1}{s(1+s)(1+2s)}$. Sketch the polar plot and determine the gain margin and phase margin. 10M

10 Consider a system with state model given $\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -1 \end{bmatrix} X + \begin{bmatrix} 0 \\ 5 \\ -24 \end{bmatrix} u$; $y = [1 \quad 0 \quad 0]x + [0]u$. Verify the system is observable and controllable. 10M

OR

11 (a) Obtain the state model of the system described by $\frac{Y(s)}{U(s)} = \frac{5}{s^2+6s+7}$. 5M

(b) Explain about diagonalization. 5M

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(Electronics & Communication Engineering)

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PART – A

(Compulsory Question)

*****

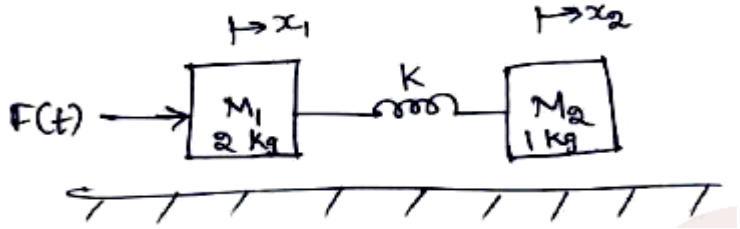
1 Answer the following: (10 X 02 = 20 Marks)

(a)	What is control system?	2M
(b)	List the advantages of feedback system.	2M
(c)	What is the need for controller?	2M
(d)	What are the steady state errors?	2M
(e)	List the necessary conditions for stability.	2M
(f)	What are break away points and break in points?	2M
(g)	What is frequency response?	2M
(h)	List the advantages of Bode plot.	2M
(i)	Define state variable.	2M
(j)	What is controllability?	2M

PART – B

(Answer all the questions: 05 X 10 = 50 Marks)

2 Determine the transfer function of the following mechanical system. 10M



OR

3 Draw the signal flow graph for the following system and find the transfer function using Mason's gain formula. 10M

$x_2 = a_{12}x_1 + a_{22}x_2 + a_{32}x_3$

$x_3 = a_{23}x_2 + a_{43}x_4$

$x_4 = a_{24}x_2 + a_{34}x_3 + a_{44}x_4$

$x_5 = a_{25}x_2 + a_{45}x_4$

4 Find the transfer function for AC servo motor with supporting diagram and suitable equations. 10M

OR

5 What are the various standard test signals? Draw the characteristics diagram and obtain the mathematical model representation of the all signals. 10M

6 By using Routh criterion, determine the stability of the system represented by the characteristics equation $S^5 + S^4 + 2S^3 + 2S^2 + 11S + 10 = 0$. 10M

OR

7 Sketch the root locus for open loop transfer function in unity feedback system is given below, $G(s) = K/(S^2+4S+13)$. 10M

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8 Sketch the bode plot for the following transfer function and determine the Gain cross over frequency, Gain margin and Phase margin. 10M
G(s) = 20 / S (1+3S) (1+4S).

OR

9 The open loop transfer function of unity feedback system is given by G(S) = $1/S^2(1+S)(1+2S)$. Sketch the polar plot and determine the Gain margin and Phase margin. 10M

10 Find the state model of the system described by the following equation; 10M
(Y(S)/U(S)) = $5/S^3 + 6S + 7$.

OR

11 Consider a system with state space model given below. 10M

$$x = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 5 \\ -24 \end{bmatrix} u;\ y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \end{bmatrix} u.$$

Verify that the system is observable and controllable.

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