Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem (Odd) Examination Dec-2022

EE-EX3CO15 Linear Control System

Programme: B.Tech. Branch/Specialisation: EE/EX

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

Q.1 i. The resolution of a potentiometer depends on- **1**

(a) Type of contact (b) Size and width of the wire

(c) Wire material (d) None of these

ii. The starting point of the description of a linear system may be system's- **1**

(a) Dynamic equations (b) Differential equations

(c) Transfer function (d) None of these

iii. The ratio of settling time to time constant for a tolerance of 2% of a under damped system is approximately- **1**

(a) 6 (b) 1 (c) 12 (d) 8

iv. The characteristics equation of a unity feedback system is described by $0.1s^2 + s + 10 = 0$. The steady state error of the system to unit ramp input will be- **1**

(a) 1 (b) 0.1 (c) 10 (d) 0.2

v. The characteristics equation of a feedback control system is $s^3 + Ks^2 + 5s + 10 = 0$. For the system to be critically stable, the value of K should be- **1**

(a) 1 (b) 2 (c) 3 (d) 4

vi. Intersection of root locus branches with the imaginary axis may be determined using the- **1**

(a) Nyquist criterion (b) Polar plot

(c) Bode plot (d) Routh criterion

vii. The transfer function $(1 + 0.5s)/(1 + s)$ represent a- **1**

(a) Proportional controller (b) Lead network

(c) Lag network (d) Lag-lead controller

viii. To increase the bandwidth of a control system, we may use- **1**

(a) Phase lead compensator (b) Phase lag-lead compensator

(c) Phase lag compensator (d) None of these

P.T.O

ix. State space analysis is applicable even if the initial conditions are- **1**
(a) Zero (b) Nonzero
(c) Equal (d) All of these

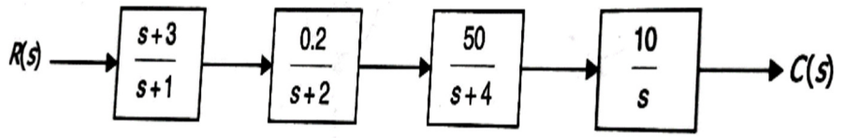
x. The smallest set of variables that determine the state of the system are known as- **1**
(a) State (b) State vector
(c) State space (d) State variables

Q.2 i. Compare open loop and close loop control system based on their block diagram. **2**

ii. Explain the role of techo generators in control system. **3**

iii. Represent the following set of equations by a signal flow graph and determine the overall gain relating x_5 and x_1. **5**
$x_2 = ax_1 + fx_2$; $x_3 = bx_2 + ex_4$;
$x_4 = cx_3 + hx_5$; $x_5 = dx_4 + gx_2$.

OR iv. Determine the ratio *C(s)/R(s)* of the block diagram shown in figure below – **5**



Also define summing point, take off point, and forward path.

Q.3 i. Define the term – delay time, rise time, settling time and steady-state error. **2**

ii. A system has $G(s) = 20/(s^2 + 5x + 5)$ and unity feedback. **8**
Find (i) ω_n, (ii) ξ, (iii) ω_d, (iv) T_d, (v) T_r, (vi) T_p, (vii) M_p (viii) T_s.

OR iii. For a unity feedback system $G(s) = \frac{20(s+2)}{[s^2(s+1)(s+5)]}$. Determine (i) the type of system, (ii) error coefficients, and (iii) steady-state error for input $1 + 3t + \frac{t^2}{2}$. **8**

Q.4 i. Determine whether the following systems are stable, marginally stable, and unstable. **3**
(a) – 2, – 5 (b) – 3, 2 (c) – 2, 0.

ii. For $G(s)H(s) = K/[s(s + 1)(s + 3)]$, determine the coordinates of valid break-away/break-in point(s). **7**

OR iii. A unity feedback control system has $G(s) = 20/[s(s + 2)]$. Draw the Bode plot. **7**

Q.5 i. Explain series and parallel compensation using proper diagram. **4**

ii. Explain design steps of a lead compensator. **6**

OR iii. Explain design steps of a lag compensator. **6**

Q.6 Attempt any two:

i. Find the transfer function when **5**
$A = \begin{bmatrix} -2 & 1 \\ 0 & -3 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, and $C = [1\ 1]$

ii. Check for controllability of a system having following coefficient matrices – **5**
$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} \text{ and } C^T = \begin{bmatrix} 10 \\ 5 \\ 1 \end{bmatrix}$$

iii. Check for observability of a system having following coefficient matrices – **5**
$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} \text{ and } C^T = \begin{bmatrix} 10 \\ 5 \\ 1 \end{bmatrix}$$

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Marking Scheme
EE-EX3CO15 Linear Control System

Q.1	i.	(b) Size and width of the wire	1 Mark	**1**
	ii.	(d) None of these	1 Mark	**1**
	iii.	(a) 6	1 Mark	**1**
	iv.	(b) 0.1	1 Mark	**1**
	v.	(b) 2	1 Mark	**1**
	vi.	(d) Routh criterion	1 Mark	**1**
	vii.	(c) Lag network	1 Mark	**1**
	viii.	(a) Phase lead compensator	1 Mark	**1**
	ix.	(b) Nonzero	1 Mark	**1**
	x.	(d) State variables	1 Mark	**1**
Q.2	i.	Compare open loop and close loop control system	1 Mark each (1 Mark*2)	**2**
	ii.	Diagram	1 Mark	**3**
		Explanation	2 Marks	
	iii.	Signal Flow Graph	2 Marks	**5**
		Overall gain calculation	3 Marks	
OR	iv.	Ratio of $C(s)/R(s)$	2 Marks	**5**
		Definition	1 Mark each (1 Mark*3)	
Q.3	i.	Definition	0.5 Mark each (0.5 Mark*4)	**2**
	ii.	For each parameter	1 Mark each (1 Mark*8)	**8**
OR	iii.	(i) The type of system	2 Marks	**8**
		(ii) Error coefficients	3 Marks	
		(iii) Steady-state error	3 Marks	
Q.4	i.	For each	1 Mark (1 Mark*3)	**3**
	ii.	Diagram of root locus	2 Marks	**7**
		Solution	5 Marks	
OR	iii.	Bode plot	3 Marks	**7**
		Solution	4 Marks	
Q.5	i.	Parallel compensation using proper diagram	2 Marks	**4**
		Parallel compensation using proper diagram	2 Marks	
	ii.	As per the steps		**6**
OR	iii.	As per the steps		**6**
Q.6		Attempt any two:		
	i.	As per the solution(1+2+2)	5 Marks	**5**
	ii.	As per the solution(1+1+3)	5 Marks	**5**
	iii.	As per the solution(1+1+3)	5 Marks	**5**

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