			Marks		PO	CO	PSO
OR	iii	What is a lag compensator? Describe its characteristics and applications in control systems.	6	03	01, 02	01, 04	01, 02

Q.6 Attempt any two:

i Discuss the concepts of controllability and observability in state-space systems. **5** 02 | 01, 02 | 01, 02 | 01, 02

ii Given the state-space representation of a system: **5** 03 | 01, 02 | 01, 03 | 01, 02

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -5 & -4 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

Determine the State Transition Matrix Φ(t) for this system.

iii Given the state-space representation: **5** 03 | 01, 02 | 01, 03 | 01, 02

$$A = \begin{bmatrix} 0 & 1 \\ -4 & -5 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

a) Compute the controllability matrix C= [B, AB].

Determine whether the system is controllable based on the rank of the controllability matrix.

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Total No. of Questions: 6 *Total No. of Printed Pages:4*

Enrollment No......................................

Faculty of Engineering

End Sem Examination Dec 2024

EE3CO34 Control Systems

Programme: B.Tech. Branch/Specialisation: EE

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. Assume suitable data if necessary. Notations and symbols have their usual meaning.

			Marks		PO	CO	PSO
Q.1	i.	The transfer function has how many poles- $G(s)H(s) = \frac{2}{s^2 + 2s + 5}$ (a) 1 (b) 2 (c) 3 (d) 0	1	01	01	01	01
	ii.	What is the main characteristic that differentiates open-loop systems from closed-loop systems? (a) Feedback (b) Input signal (c) Transfer function (d) Output signal	1	01	01	01	01
	iii	For a second-order system with a damping ratio of 0.5, what is the overshoot percentage? (a) 10% (b) 20% (c) 25% (d) 35%	1	02	01, 02	01, 02	01
	iv.	The root locus of a system shows that the poles move from the open-loop poles to which point- (a) Zero (b) Infinity (c) The real axis (d) The imaginary axis	1	01	01	01	01
	v.	For a transfer function given below, what will be the phase- $G(s)H(s) = \frac{2}{s^3}$ (a) 0° (b) -90° (c) -180° (d) -270°	1	02	01, 02	01, 02	01

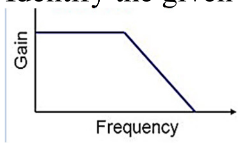
vi. For a stable system - **1** 01 01 01 01

(a) GM & PM both are negative.
(b) GM and PM both are positive.
(c) GM is +Ve and PM -Ve
(d) GM is negative and PM is Positive

vii The transfer function $G_c(s) = \frac{(1+0.5s)}{(1+s)}$ represents- **1** 02 01, 02 01, 02 01

(a) lag network
(b) lead network
(c) lag-lead network
(d) Proportional controller

vii Identify the given characteristic is suitable for - **1** 02 01, 02 01, 02 01



(a) Lead compensator
(b) Lag compensator
(c) Lead lag compensator
(d) RC feedback network

ix. Which property must be satisfied for a system to be controllable? **1** 01 01 01 01

(a) All poles on the right half of the plane
(b) The ability to reach any desired state
(c) Minimal phase shift
(d) No steady-state error

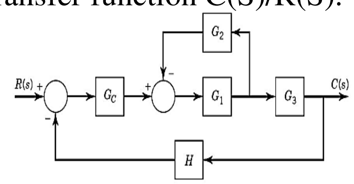
x. Which of the following properties ensures a system can be brought to any desired state using an input? **1** 01 01 01 01

(a) Observability (b) Stability
(c) Controllability (d) Diagonalization

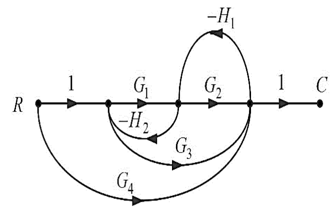
Q.2 i. Define the transfer function of a linear system. **2** 01 01 01 01

ii. Explain the differences between open-loop and closed-loop systems. **3** 02 01, 02 01, 02 01

iii For the system represented in the given figure, determine transfer function C(S)/R(S). **5** 03 01, 02, 03 01, 02 01, 02



OR iv. Using Mason's gain formula calculate the transfer function of the given diagram **5** 03 01, 02, 03 01, 02 01, 02



Q.3 i. What is stable and marginally stable system? **2** 01 01 01 01

ii. With the help of Routh's stability criterion find the stability of the following systems represented by the characteristic equations- **3** 02 01, 02 01, 02 01

$s^5 + 2s^4 + 3s^3 + 4s^2 + 5s + 6 = 0$

iii Given a second-order system with the transfer function: **5** 03 01, 02, 03 01, 02 01, 02

$$H(s) = \frac{25}{s^2 + 10s + 25}$$

Find the natural frequency ω_n and damping ratio ζ

OR iv. Explain the various rules to sketch the root locus. **5** 03 01, 02 01, 02 01, 02

Q.4 i. What is the nyquist stability criterion? Explain how it is used to determine the stability of a control system. **4** 02 01, 02 01, 02 01

ii. Construct the Bode plot and determine the gain margin and phase margin. **6** 03 01, 02, 05 01, 03 01, 02

$$G(s) = \frac{10}{s^2 + 4s + 8}$$

OR iii For a given transfer function; **6** 03 01, 02, 05 01, 03 01, 02

$$G(s)H(s) = \frac{12}{s\,(s+1)(s+2)}$$

Draw the polar plot and find the system's stability.

Q.5 i. Explain the role of Bode plots in the design and analysis of compensators. **4** 02 01 01, 02 01, 02

ii. Explain the physical realization of a lag-lead compensator and its effect on system performance. **6** 03 01, 02 01, 04 01, 02

[2]

[3]

P.T.O.

Marking Scheme
EE3CO34 (T) Control Systems (T)

Q.1	i)	b) 2	1
	ii)	a) Feedback	1
	iii)	c) 25%	1
	iv)	b) Infinity	1
	v)	(d) -270°	1
	vi)	(b) GM and PM both are Positive	1
	vii)	(b) lead network	1
	viii)	(b) Lag compensator	1
	ix)	b) The ability to reach any desired state	1
	x)	c) Controllability	1

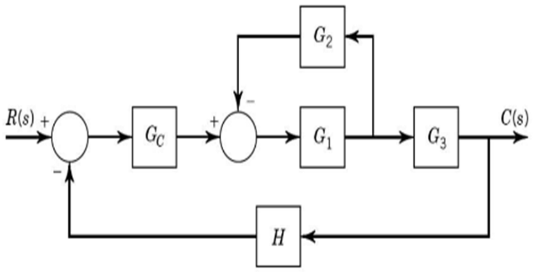
Q.2 i. Define the transfer function of a linear system. **2**

Definition- 2 Marks

ii. Explain the differences between open-loop and closed-loop systems. **3**

Differences- 1 point each

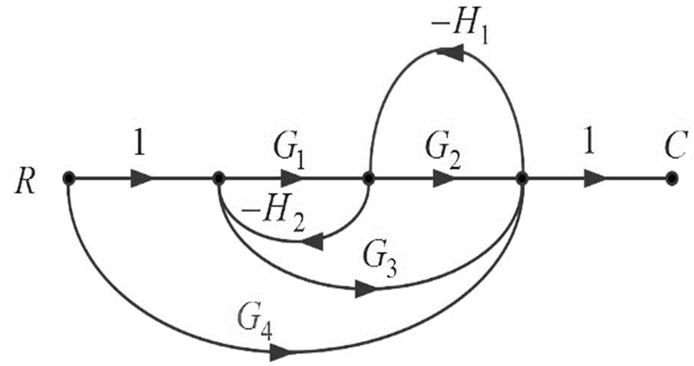
iii. For the system represented in the given figure, determine transfer function C(S)/R(S). **5**



determine transfer function C(S)/R(S)- 5 marks

OR iv. **5**

Using Mason's gain formula calculate the transfer function of the given diagram



Mason's gain formula- 1 Marks

Steps- 2 Marks

Calculation- 2 Marks

Q.3 i. What is stable and marginally stable system? **2**

1 mark each

ii. With the help of Routh's stability criterion find the stability of the following systems represented by the characteristic equations: **3**

$s^5 + 2s^4 + 3s^3 + 4s^2 + 5s + 6 = 0$

Routh's stability criterion solution- 2 marks

Stability – 1 mark

OR iii. Given a second-order system with the transfer function: **5**

$$H(s) = \frac{25}{s^2 + 10s + 25}$$

Find the natural frequency ω_n and damping ratio ζ

the natural frequency ω_n- 3 Marks

damping ratio- 2 Marks

iv. Explain the various rules to sketch the root locus. **5**

Step- 1 mark each

Q.4 i. Nyquist stability criterion – 2 Marks **4**

determine the stability – 2 Marks

ii. Construct the Bode plot and determine the gain margin and phase margin. **6**

$$G(s) = \frac{10}{s^2 + 4s + 8}$$

Bode plot- 4 Marks
Gain Margin- 1 Mark
Phase Margin- 1 Mark

OR iii. For a given transfer function $G(s)H(s) = \frac{12}{s\,(s+1)(s+2)}$, draw the polar plot and find the system's stability. **6**

polar plot- 4 Marks
system's stability -2 Marks

Q.5 i. Explanation – 2 Marks **4**
Analysis - 2 Marks

ii. Explanation – 3 Marks **6**
effect on system performance - 3 Marks

OR iii. lag compensator - 3 Marks **6**
characteristics -2 Marks
Applications - 1 Mark

Q.6

i. Discuss the concepts of controllability and observability in state-space systems. **5**
controllability and observability- 2.5 Marks each

ii. Given the state-space representation of a system: **5**

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -5 & -4 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

Determine the State Transition Matrix Φ(t) for this system.

the State Transition Matrix Φ(t)- 5 Marks

iii. Given the state-space representation: **5**

$$A = \begin{bmatrix} 0 & 1 \\ -4 & -5 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

a) Compute the controllability matrix C=[B,AB].
3 Marks

b) Determine whether the system is controllable based on the rank of the controllability matrix.- 2 Marks

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