OR iii. Find the polar plot of following: **7**

(a) $G(s) = \frac{14}{[s(s+1)(s+2)]}$

(b) $G(s) = \frac{sa}{[(1+sa)]}$

Q.5 Attempt any two

i. What do you mean by compensator? Classify it and explain each classification with suitable diagram. **5**

ii. Discuss lag compensator. Sketch the Bode plot of a lag compensator. Give the design steps of a lag compensator. **5**

iii. Sketch the Bode plot and pole-zero plot of a lag-lead compensator. **5**

Q.6 Attempt any two:

i. Write the properties of state transition matrix. (at least 4) **2**

ii. Find the controllability of the system described by the state equation- **3**

$$\begin{bmatrix} \dot{x}1 \\ \dot{x}2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & 0 \end{bmatrix} \begin{bmatrix} x1 \\ x2 \end{bmatrix} + 3 \begin{bmatrix} 0 \\ 3 \end{bmatrix} u$$

iii. Find the transfer function when- **5**

$$A = \begin{bmatrix} -2 & 1 \\ 0 & -3 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \text{ and } C = [1 \quad 1]$$

OR iv. Express the following transfer function in **5**

(a) CCF Forms

(b) OCF Forms

$$\frac{Y(s)}{U(s)} = \frac{[5\,s^2 + 2\,s + 6]}{[s^3 + 7\,s^2 + 11\,s + 8]}$$

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

**Enrollment No.....**

# Faculty of Engineering
## End Sem Examination May-2024
## EC3CO09 Control Systems

Programme: B.Tech. Branch/Specialisation: EC

**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.

Q.1 i. In a control system the output of the controller is given to- **1**

(a) Amplifier (b) Sensor

(c) Final control element (d) Comparator

ii. What is the effect of feedback in the overall gain of the system? **1**

(a) Increases (b) Decreases

(c) Zero (d) No change

iii. First order system is defined as: **1**

(a) Number of poles at origin

(b) Order of the differential equation

(c) Total number of poles of equation

(d) Total number of poles and order of equation

iv. Which of the following quantities give a measure of the transient characteristics of a control system, when subjected to unit step excitation. **1**

I. Maximum overshoot

II. Maximum undershoot

III. Overall gain

IV. Delay time

V. Rise time

VI. Fall time

(a) I, III and V (b) II, IV and V

(c) II, IV and VI (d) I, IV and V

v. The critical value of gain for the system is 40. The system is operating at a gain of 20. The gain margin of the system is: **1**

(a) 2 Db (b) 3 Db (c) 6 dB (d) 4 dB

vi. The phase angle of the system G(s) =s+5/$s^2$+4s+9;varies between **1**
(a) 0° and 90° (b) 0° and -90°
(c) 0° and -180° (d) -90° and -180°

vii. The input of a controller is- **1**
(a) Sensed signal
(b) Error signal
(c) Desired variable value
(d) Signal of fixed amplitude not dependent on desired variable value

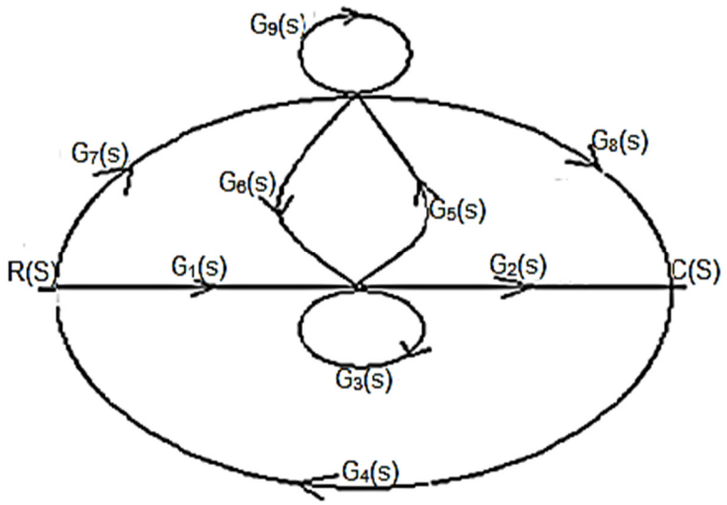
viii. Lead compensation leads to: **1**
(a) Increases bandwidth (b) Attenuation
(c) Increases damping factor (d) Second order

ix. The transfer function for the state representation of the continuous time LTI system: **1**
dq(t)/dt=Aq(t)+Bx(t)
Y(t)=Cq(t)+Dx(t)
is given by:
(a) $C(sI-A)^{-1}B+D$ (b) $B(sI-A)^{-1}B+D$
(c) $C(sI-A)^{-1}B+A$ (d) $D(sI-A)^{-1}B+C$

x. The values of the characteristic equation is given by: **1**
(a) Eigen values (b) State matrix
(c) Eigen vector (d) None of these

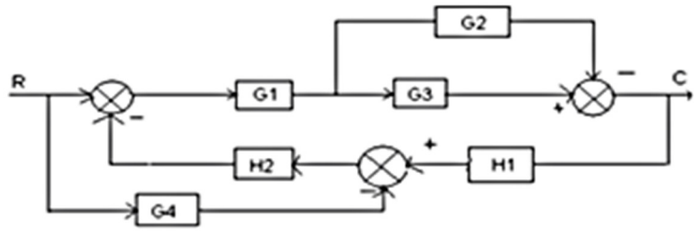
Q.2 i. Define open-loop and closed-loop control systems with their applications. **2**

ii. Find C(s)/R(s) for the following system using Mason's gain formula: **3**






iii. Derive the transfer function of the system shown in fig. using block Diagram reduction techniques- **5**




OR iv. Determine the transfer function of a system represented by the differential equation- **5**

(a) $\frac{d^3y}{dt^3} + 3\frac{d^2y}{dt^2} + 2\frac{dy}{dt} + y = \frac{d^2x}{dt^2} + 2\frac{dx}{dt} + 3x$

(b) $\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 4y = 2\frac{d^2x}{dt^2} + 6x$

Q.3 i. States the effects of adding of poles and zeros in root-locus. (At least 4 effects for each) **2**

ii. Find type, error coefficient and steady-state error of the system having unity feedback and open-loop transfer function- **3**

$G(s) = \frac{k(s+4)}{[s^2(s^3+8s^2+4)]}$

When input is $\frac{A}{2}t^2$ . .

iii. Define the following with suitable diagram: **5**
(a) Transient Response
(b) Peak time
(c) Rise Time
(d) Settling Time
(e) % Overshoot

OR iv. The open-loop transfer function of a unity feedback control system is **5**

$$G(s) = \frac{k}{[s(s+4)(s+6)]}$$

Draw the root locus of the system.

Q.4 i. Find frequency domain specification for a second-order system with unity feedback and $G(s) = \frac{169}{[s(s+7)]}$. **3**

ii. A unity feedback control system has- **7**

$$G(s) = \frac{k}{[s(s+4)(s+10)]}$$

Draw the bode plot. Find K when the system is marginally stable.

# Marking Scheme
# Control Systems (T) - EC3CO09 (T)

| | | | | |
|---|---|---|---|---|
| Q.1 | i) | c | | **1** |
| | ii) | b | | **1** |
| | iii) | d | | **1** |
| | iv) | d | | **1** |
| | v) | c | | **1** |
| | vi) | b | | **1** |
| | vii) | b | | **1** |
| | viii) | a | | **1** |
| | ix) | a | | **1** |
| | x) | a | | **1** |

| | | | | |
|---|---|---|---|---|
| Q.2 | i. | Each difference | 1 Mark | **2** |
| | ii. | Correct calculation | 2 Marks | **3** |
| | | Formula | 1 Mark | |
| | iii. | Each correct steps | 1 Mark (1*4) | **5** |
| | | Answer | 1 Marks | |
| OR | iv. | Correct steps | 1.5 Marks | **5** |
| | | Answer(for both) | 1 Marks | |

| | | | | |
|---|---|---|---|---|
| Q.3 | i. | Statements | 0.5 Marks each | **2** |
| | ii. | Each value | 1 Mark (1*3) | **3** |
| | iii. | 1 Marks each | (1*5) 5 Marks | **5** |
| OR | iv. | Each step | 1 Mark(1*4) | **5** |
| | | Diagram | 1 Marks | |

| | | | | |
|---|---|---|---|---|
| Q.4 | i. | Each Step | (1*2) 2 Marks | **3** |
| | | Diagram | 1 Mark | |
| | ii. | Step marks | 4 Marks | **7** |
| | | Diagram | 2 Marks | |
| | | K | 1 Mark | |
| OR | iii. | Correct steps | 1 Mark (1*5) | **7** |
| | | Diagram | 2 Marks | |

| | | | | |
|---|---|---|---|---|
| Q.5 | i. | Definition | 2 Marks | **5** |
| | | Classification | 3 Marks | |
| | ii. | Definition | 1 Mark | **5** |
| | | Steps | 3 Marks | |
| | | Plot | 1 Mark | |
| OR | iii. | Correct steps for both plots | 1 Mark each | **5** |
| | | Correct steps for both plots | 1 Mark each | |

| | | | | |
|---|---|---|---|---|
| Q.6 | | | | |
| | i. | Each 2 properties | 1 Mark (1*2) | **2** |
| | ii. | Formula | 1 Mark | **3** |
| | | Calculation steps | 2 Marks | |
| | iii. | Formula | 1 Mark | **5** |
| | | Calculation steps | 4 Marks | |
| | iv. | 2.5 Marks each | 5 Marks (2.5*2) | **5** |

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