

# Faculty of Engineering

## End Semester Examination May 2025

### EC3CO09 Control Systems

<b>Programme</b>	:	B.Tech.	<b>Branch/Specialisation</b>	:	EC
<b>Duration</b>	:	3 hours	<b>Maximum Marks</b>	:	60

**Note:** All questions are compulsory. Internal choices, if any, are indicated. Assume suitable data if necessary.  
 Notations and symbols have their usual meaning.

<b>Section 1 (Answer all question(s))</b>				<b>Marks CO BL</b>
<b>Q1.</b> What is a control system?				1    1    1
<input checked="" type="radio"/> Control system is a system in which the output is controlled by varying the input <input type="radio"/> Control system is a feedback system that can be both positive and negative			<input type="radio"/> Control system is a device that will manage or regulate the behaviour of other devices using control loops <input type="radio"/> Control System is a system in which the input is controlled by varying the output	
<b>Q2.</b> The output of the feedback control system must be a function of _____.				1    1    1
<input type="radio"/> Output and feedback signal <input checked="" type="radio"/> Reference input			<input checked="" type="radio"/> Input and feedback signal <input type="radio"/> Reference output	
<b>Q3.</b> Which of the following is a typical characteristic of the second-order system's time response?				1    2    1
<input type="radio"/> It has a single pole at the origin. <input type="radio"/> It has no overshoot.			<input checked="" type="radio"/> It oscillates and decays over time. <input type="radio"/> It reaches a constant value instantly.	
<b>Q4.</b> In a first-order system, what is the time constant ( $\tau$ ) a measure of-				1    2    1
<input type="radio"/> The system's damping ratio <input type="radio"/> The natural frequency of the system			<input checked="" type="radio"/> The speed of the system's response <input type="radio"/> The system's maximum overshoot	
<b>Q5.</b> What is the main purpose of a polar plot in frequency response analysis?				1    3    2
<input type="radio"/> To show the phase versus time <input type="radio"/> To analyze transient behavior			<input checked="" type="radio"/> To plot the system's frequency response in a polar coordinate system <input type="radio"/> To calculate stability margins	
<b>Q6.</b> Which of the following is true about the Nyquist stability criterion?				1    3    1
<input type="radio"/> It is used to analyze the system's time-domain behavior. <input checked="" type="radio"/> It helps determine the number of poles in the right half-plane based on the contour of the Nyquist plot.			<input type="radio"/> It is primarily concerned with damping factors. <input type="radio"/> It is used to calculate the time constant of the system.	
<b>Q7.</b> The PI controller improves the system's performance by-				1    4    1
<input type="radio"/> Increasing bandwidth <input checked="" type="radio"/> Reducing steady-state error			<input type="radio"/> Reducing transient response <input type="radio"/> Reducing overshoot and settling time	
<b>Q8.</b> What is the main purpose of a compensator in control systems?				1    4    1
<input type="radio"/> To reduce the cost of the system <input type="radio"/> To increase the speed of the system			<input checked="" type="radio"/> To improve the transient and steady-state response <input type="radio"/> To stabilize an unstable system	

**Q9.** Which of the following is the correct representation of a state-space model for a system? 1 5 1

- A set of second-order differential equations
- A single algebraic equation
- A transfer function
- A set of first-order differential equations

**Q10.** Which of the following is a property of a system described by a state-space model? 1 5 1

- It requires the system to be time-invariant
- It can only be used for linear systems
- It can represent both continuous and discrete systems
- It only applies to mechanical systems

### **Section 2 (Answer all question(s))**

**Marks CO BL**

**Q11.** Define a transfer function in control systems. Explain its significance. 2 1 1

<b>Rubric</b>	<b>Marks</b>
Definition-1 Significance - 1	2

**Q12.** Define the term "Control System" and explain its basic objectives. 3 1 2

<b>Rubric</b>	<b>Marks</b>
Definition-1 Objective ( At least 2)- 2	3

**Q13. (a)** Explain the concept of block diagram representation in a control system. What are the steps involved in block diagram reduction? 5 1 3

<b>Rubric</b>	<b>Marks</b>
Definition-1 Steps(at least 4 steps) - 4	5

**(OR)**

- (b)** Compare the open-loop and closed-loop systems in terms of definition, diagram, accuracy, stability, and response time.

<b>Rubric</b>	<b>Marks</b>
Each difference ( at least 5) -1	5

### **Section 3 (Answer all question(s))**

**Marks CO BL**

**Q14.** What are the main differences between the transient and steady-state responses of a system? 3 2 3

<b>Rubric</b>	<b>Marks</b>
Explanation main difference	3

**Q15. (a)** What is the root locus method in control systems? Explain the basic guidelines for sketching the root locus of a system.

7 2 3

Rubric	Marks
Definition-2 All steps ( 10 steps , each has 0.5 marks)	7

(OR)

- (b)** Describe the Routh-Hurwitz stability criterion. How is it used to determine the stability of a system? Explain with an example.

Rubric	Marks
Description-2 Determination of stability-2 Example-3	7

#### Section 4 (Answer all question(s))

Marks CO BL

**Q16.** What are stability margins in frequency domain analysis? Discuss the phase margin and gain margin briefly. 4 3 2

Rubric	Marks
stability margins-2 phase margin -1 gain margin -1	4

**Q17. (a)** Define the Nyquist stability criterion. How is it used for determining the stability of a system in the frequency domain? 6 3 3

Rubric	Marks
Definition-2 for determining the stability-4	6

(OR)

- (b)** Explain the different types of frequency response plots commonly used in control systems, including polar plots and Bode plots. How are they used to analyze system performance?

Rubric	Marks
different types of frequency response plots-4 How are they used to analyze system performance?- 2	6

#### Section 5 (Answer all question(s))

Marks CO BL

**Q18.** What are the advantages will get when adding a PI controller in cascade with the plant? 2 4 1

Rubric	Marks
Advantages ( At-least 2)	2

**Q19.** Explain the role of compensators in improving system performance. 3 4 2

Rubric	Marks
Explanation	3

**Q20. (a)** Explain the design of a PID controller. How do P, PD, PI, and PID controllers differ in terms of their effect on the system's error, transient response, and steady-state performance?

Rubric	Marks
design of a PID controller-2 Differences-3	5

(OR)

- (b)** Compare the phase-lag and phase-lead compensators in terms of their effects on stability, phase margin, bandwidth and transient response. When would you choose one over the other?

Rubric	Marks
Differences ( At least 4 )-4 Choosing criteria-1	5

### Section 6 (Answer all question(s))

**Marks CO BL**

**Q21.** Explain the concept of controllability and observability, in the context of state-space representation.

Rubric	Marks
concept of controllability -2 concept of Observability - 2	4

**Q22. (a)** Explain the significance of the state transition matrix in the solution of state-space equations. What role does it play in the time response of the system?

6 5 3

Rubric	Marks
the significance of the state transition matrix-3 role does it play in the time response of the system - 3	6

(OR)

- (b)** Explain the concept of state-space canonical forms. How do they simplify the process of finding the state-space representation of a system?

Rubric	Marks
the concept of state-space canonical forms- 2 the process of finding the state-space representation - 4	6

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