Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE(MINOR)- SEMESTER–VI EXAMINATION – SUMMER 2025

Subject Code:116AO01 Date:10-06-2025

Subject Name:Control of Robotic Systems

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Define transfer function and its significance in control systems.	**03**
	(b)	Describe the purpose of Bode plots in frequency response analysis.	**04**
	(c)	A unity feedback control system has an open-loop transfer function: $G(s)=K / s(s+2)(s+4)$ Determine the value of gain K at which the system just becomes marginally stable.	**07**
Q.2	**(a)**	Explain the Routh-Hurwitz criterion for stability.	**03**
	(b)	Define controllability and observability.	**04**
	(c)	Illustrate the control law partitioning approach in robotic systems.	**07**
		OR	
	(c)	Design a PID controller for a robotic joint and explain its tuning process.	**07**
Q.3	**(a)**	What is a phase-plane method in non-linear control?	**03**
	(b)	Use the describing function method to analyze a simple nonlinear system.	**04**
	(c)	Analyze a manipulator control problem using non-linear stability techniques.	**07**
		OR	
Q.3	**(a)**	Define Lyapunov's stability criterion.	**03**
	(b)	Explain the role of Liapunov's function in assessing system stability.	**04**
	(c)	Evaluate system stability through phase plane trajectories with graphical illustration.	**07**
Q.4	**(a)**	Differentiate between Point-to-Point and Continuous Path Control.	**03**
	(b)	Explain hybrid position/force control with an example.	**04**
	(c)	Examine the stability of the system whose characteristic equation is: $S^4 + 2S^3 + 3S^2 + 4S + 5 = 0$ (a) Construct the Routh array. (b) Determine the number of roots lying in the right-half of the s-plane. (c) Comment on system stability based on your findings.	**07**
		OR	
Q.4	**(a)**	Define Cartesian control in robotic systems.	**03**
	(b)	Explain system analysis by phase plane method.	**04**
	(c)	Derive the state-space model for a single joint robotic arm and discuss its control implementation.	**07**

Q.5	**(a)**	Explain pole placement by state feedback.	**03**
	(b)	Describe any two physical non-linear systems and their characteristics.	**04**
	(c)	Explain phase plane method for non-linear control system.	**07**

OR

Q.5	**(a)**	Explain the difference between P, PI, and PID controllers.	**03**
	(b)	Explain Lag – Lead Compensation of Time response.	**04**
	(c)	With neat sketch explain the working of Hydraulic PI controller and derive the transfer function.	**07**

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