APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY

08 PALAKKAD CLUSTER

Q. P. Code : IAR0821252D-I (Pages: 2)

Name: .....

Reg. No: .....

SECOND SEMESTER M.TECH. DEGREE EXAMINATION JULY 2021

Branch: Mechanical Engineering **Specialization: Industrial Automation and Robotics**

08ME6352(D) NON-LINEAR AND ADAPTIVE CONTROL SYSTEMS

(Common to IAR)

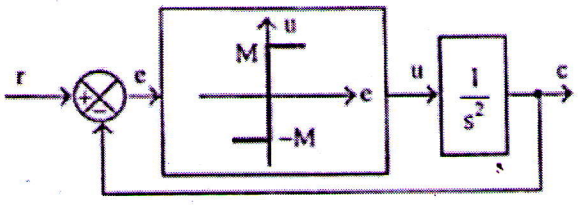
Time: 2 hour 15 minutes **Max. Marks: 60**

Answer all six questions.

Modules 1 to 6: Part 'a' of each question is compulsory and answer either part 'b' or part 'c' of each question.

Q. No.	Module 1	Marks
1. a	Define linear and non-linear control systems and explain their differences.	3
	Answer b or c	
b	Derive the describing function of Ideal Relay Non-Linearity?	6
c	Derive the describing function of Saturation Non-Linearity?	6

Q. No.	Module 2	Marks
2. a	Explain phase plane and phase trajectory with neat sketch?	3
	Answer b or c	
b	Consider a system with an ideal relay as shown in the following figure. Construct phase trajectories, corresponding to initial conditions, c(0), $\dot{c}(0)$=1.Take r=2 volts and M =1.2 volts.	6



c	Construct a phase trajectory by delta method for a nonlinear system represented by the differential equation.$\ddot{X} + 4|\dot{X}|X + 4\dot{X} = 0$.Choose the initial conditions as $X(0)$=1.0 and $\dot{X}(0)$=0.	6

Q. No.	Module 3	Marks
3. a	Explain the terms: (i) Positive definiteness. (ii) Negative definiteness.	3
	Answer b or c	
b	Determine Whether or not following quadratic form is positive definite $$Q(x_1, x_2) = 10x_1^2 + 4x_2^2 + x_3^2 + 2x_1x_2 - 4x_3x_1$$	6
c	Consider the nonlinear system and prove that the equilibrium points at the origin for the system $\dot{x_1} = -6x_1 + 2x_2$, $\dot{x_2} = 2x_1 - 6x_2 - 2x_2^3$ is asymptotically stable.	6

Q. No.	Module 4	Marks
4. a	State and explain Cycle criterion	3
	Answer b or c	
b	Find the sector [0,k] for which the given transfer function is absolutely stable using Popov criteria. $G(s) = \frac{s}{s^2-s+1}$.	6
c	How sliding mode controller is used in automation applications: A Case Study	6

Q. No.	Module 5	Marks
5. a	Explain the importance of Gain scheduling in adaptive control system.	4
	Answer b or c	
b	Differentiate between direct adaptive control system and indirect Adaptive control system.	8
c	Explain the design procedure for developing an MRAC using MIT rule with necessary diagram.	8

Q. No.	Module 6	Marks
6. a	Briefly explain adaptive predictive control scheme.	4
	Answer b or c	
b	Explain Self tuning regulator using Pole placement design in detail.	8
c	Compare the performance of Indirect and Direct Self Tuning Regulator designs in detail.	8