APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY

08 PALAKKAD CLUSTER

Q.P. Code: IAR0822252-I **(Pages: 2)**

Name: .....

Reg. No: .....

SECOND SEMESTER M.TECH. DEGREE EXAMINATION JULY 2022

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

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

Time: 3 Hours **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	The response of a system is $y = ax + b\,dx/dt$. Test whether the system is linear or nonlinear.	3
	Answer b or c	
b	Derive the describing function of dead zone Non-Linearity.	6
c	Explain the design of nonlinear system using describing function method.	6

Q. No.	Module 2	Marks
2. a	Explain different types of singular points.	3
	Answer b or c	
b	Explain the concept of Phase plane analysis. How it can be used for stability analysis.	6
c	A linear second order servo is described by the equation $\ddot{e} + 2\zeta\omega_n\dot{e} + \omega_n^2 e = 0$, Where $\zeta = 0.15$, $\omega_n = 1$ rad/sec, e (0) = 1.5 and e (0) = 0. Determine the singular point. Construct the phase trajectory, using the method of Isoclines. Choose slope as -2.0, -0.5, 0, 0.5 and 2.0.	6

Q. No.	Module 3	Marks
3. a	Explain construction of Lyapunov function by variable gradient method.	3
	Answer b or c	
b	Check the stability of the system by using Lyapunov second method. The system is described by: $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -1 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$	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	Discuss circle criterion in detail.	3

Answer b or c

b	Find the sector [0,k] for which the given transfer function is absolutely stable using Popov criteria. $$G(s) = \frac{1}{(s+2)(s+3)}$$	6
c	With relevant block diagram explain sliding mode controller.	6

Q. No.	Module 5	Marks
5. a	What is the need for adaptive control?	4

Answer b or c

b	Gain Scheduling adapts quickly to changing conditions-Justify.	8
c	Explain the design procedure for developing an MRAC using MIT rule with necessary diagram.	8

Q. No.	Module 6	Marks
6. a	What are the classifications of self-tuning regulators?	4

Answer b or c

b	Explain Adaptive control scheme in detail with diagram.	8
c	How to perform stability analysis of a controller which designed by integrator backstepping controller?	8