

APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY

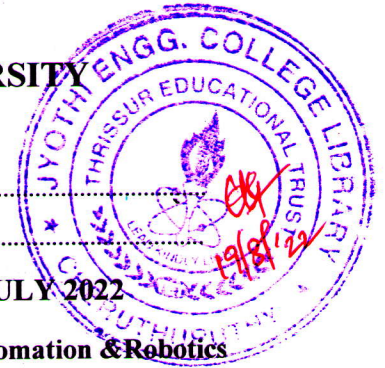
08 PALAKKAD CLUSTER

Q.P. Code: IAR0822252-I

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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 $\dot{e}(0) = 0$. 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:	6
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$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

- 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. 6

$$G(s) = \frac{1}{(s+2)(s+3)}$$

- 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