

**ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES
(AUTONOMOUS)
M.Tech II-Semester Regular Examinations, May 2016
NON LINEAR CONTROL SYSTEMS
(Control Systems Engineering)**

Date:

Time: 3 hours

Max Marks: 60

Answer ONE Question from each unit

All questions carry equal marks

All parts of the question must be answered at one place only

UNIT-I

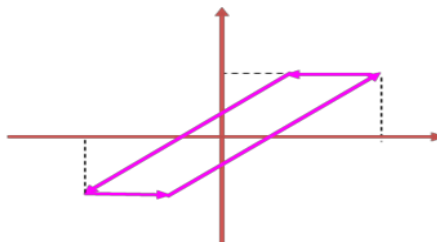
1. a Explain the different types of Non-linearities in physical system with suitable examples. 6M
 b Explain the following terms in detail 6M
 (i) Jump phenomena (ii) Limit cycles
- (OR)**
2. a Describe singular point? How they are classified? Draw the phase trajectories of commonly found singular points. 6M
 b Explain in detail the various properties exhibited by Non linear systems. 6M

UNIT-II

3. a Describe the construction of phase trajectories using Delta method. 4M
 b A linear second order servo is described by the equation $\ddot{e} + 2\zeta\omega_n\dot{e} + \omega_n^2 e = 0$ 8M
 where $e = 0.15$, $\omega_n = 1$, $e(0) = 1.5$, $\dot{e}(0) = 0$. Determine the singular point. Develop the phase trajectory, using the method of isoclines.
- (OR)**
4. a Sketch the state trajectory for the following system 6M
 $\dot{x}_1 = x_1 + x_2$
 $\dot{x}_2 = -x_1 + x_1^2 x_2$
 with the initial condition $x(0) = (0, 2)$. Analyze and Comment on the nature of the equilibrium point.
 b. Describe the construction of phase trajectories using Pell's method with an example. 6M

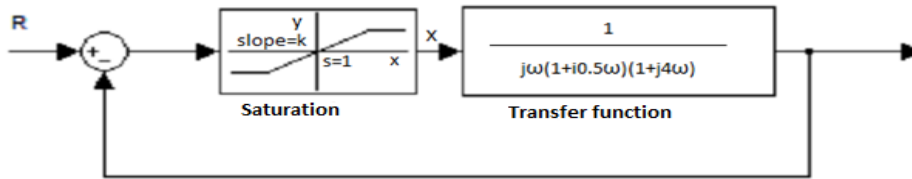
UNIT-III

5. a Analyze existence and stability of periodic solutions by describing function analysis. 4M
 b. Design the describing function of the element whose input-output characteristics is shown below. 8M



(OR)

- 6 a Formulate the Describing function of dead zone and saturation nonlinearity. 5M
 b Consider a unity feedback system shown in the figure having a saturating amplifier with gain K. Determine the maximum value of K for the system to stay stable. What would be the frequency and nature of limit cycle for a gain K=2.5? 7M



UNIT-IV

7. a Describe the basic concepts and theorems involved in Lyapunov stability analysis for a nonlinear systems. 6M
 b Analyze the state of the system described by 6M

where $\dot{X} = AX$ where $A = \begin{bmatrix} -1 & -2 \\ 1 & 4 \end{bmatrix}$

Using Lyapunov stability analysis.

(OR)

8. a A non linear system is described by 8M
 $\dot{x}_1 = -3x_1 + x_2$
 $\dot{x}_2 = x_1 - x_2 - x_2^3$
 Using the krasovokii's method for constructing the Lyapunov function. Describe the stability of the equilibrium state.
 b. Analyze the local and global stability of an equilibrium point using Lyapunov Method. 4M

UNIT-V

9. a Describe the basic concept of feedback linearization with an example 6M
 b Explain the process of linearization of non linear systems about equilibrium point 6M
- (OR)
10. a Describe about the Mathematical tools for feedback linearization and also the Feedback linearization of MIMO systems 6M
 b Discuss the details of input output linearization of 6M
 a) Single input single output non linear system
 b) Multi input multi output non linear system
