

NIRMA UNIVERSITY

Institute:	Institute of Technology, School of Technology
Name of Programme:	BTech in Electronics and Instrumentation Engineering
Semester :	VII
Course Code:	4EI101ME25
Course Title:	Nonlinear and Digital Control
Course Type:	Department Elective-III
Year of Introduction:	2024-2025

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Course Learning Outcomes (CLOs):

At the end of the course, the students will be able to –

1. understand the basics of Nonlinear and digital control system (BL2)
2. analyze nonlinear system (BL3)
3. perform the analysis of discrete time control system (BL3)
4. design controller for discrete time system. (BL5)

Unit	Contents	Teaching hours (Total 45)
Unit-I	Introduction to Nonlinear Control System Nonlinear system elements, Continuous and discontinuous nonlinearities, Behavior of nonlinear control systems	03
Unit-II	Describing function-based Method for Nonlinear system analysis Derivation of describing functions of nonlinear elements, Overview of Nyquist criteria for the stability analysis, Stability Analysis of Nonlinear system using the Describing functions	08
Unit-III	Stability Analysis of Nonlinear System Introduction to Phase plane analysis, concept of equilibrium point and related stability, Linearization techniques, Stability using Lyapunov method, Input-output stability, L stability, L stability of state models, L_2 gain, related examples.	14
Unit-IV	Digital Control System: Mathematical Modeling Introduction to Digital control of continuous time system, Overview of sampled data control system. Discrete-time system and Z-Transformation, properties of Z- transform, Modified z-transform, Mapping of s-plane to z-plane, State space description of dynamic system, related examples.	10
Unit-V	Digital Control System: Analysis Computation of the solution of discrete time state equations, state space-based time response analysis for various inputs, Jury's stability test for the sampled data control system, stability analysis of discrete time system	05

Discrete time observer and controller, related examples,
Separation Principle for discrete time state model-based system

Self Study:

The self -study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:

This shall consist of at least 10 practicals based on the above syllabus.

Suggested Reading:

1. Hasan Khalil, *Nonlinear Control*, Pearson Education
2. Hasan Khalil, *Nonlinear Systems*, Pearson Education
3. I.J. Nagrath and M. Gopal, *Control System Engineering*, New Age International Publication
4. M. Gopal, *Digital control and state variable methods*, New Age International Publication

Suggested List of Experiments:

Sr. No.	Name of Experiments/Exercises	Hours
1	Study of various nonlinear system	02
2	Analyze the behavior of the nonlinear system in presence of time varying input	02
3	Analysis of nonlinear system using Describing function based method	02
4	Analysis of nonlinear system using linearization techniques	02
5	Analysis of nonlinear system using Lyapunov's method	02
6	Develop the mathematical modeling of the discrete time system in the state space domain	02
7	Analyze sampled data control system	02
8	Perform the stability analysis of the sampled data system	02
9	Analyze the discrete time control system	02
10	Perform stability analysis of discrete time control system	02
11	Design a state feedback controller for the discrete time system	02
12	Design a state observer for the discrete time system	02