

NIRMA UNIVERSITY

| | |
|------------------------------|---|
| Institute: | Institute of Technology |
| Name of Programme: | M.Tech. in Electronics & Instrumentation Engineering (Robotics and Artificial Intelligence) |
| Semester: | II |
| Course Code: | 6EI861ME25 |
| Course Title: | Nonlinear and Digital Control |
| Course Type: | Elective |
| Year of introduction: | 2025 - 26 |

| L | T | Practical component | | | | C |
|---|---|---------------------|----|---|---|---|
| | | LPW | PW | W | S | |
| 2 | 1 | - | - | - | - | 3 |

Course Learning Outcomes (CLOs):

After successful completion of the course, student will be able to –

1. explain the basics of nonlinear and digital control systems (BL2)
2. analyse nonlinear systems (BL4)
3. evaluate the performance of discrete time control systems (BL5)
4. design controller for discrete time systems. (BL6)

| Unit | Contents | Teaching Hours (Total 30) |
|----------|---|------------------------------|
| Unit I | Introduction to Nonlinear Control System Nonlinear system elements, Continuous and discontinuous nonlinearities, behaviour of nonlinear control systems | 02 |
| Unit II | 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. | 08 |
| Unit III | Digital Control System: Mathematical Modelling 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 IV | 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 |

Unit V **Digital Control System: Design**

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.

Suggested
Readings/References:

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

Suggested List of
Tutorials:

1. Study of various nonlinear system
2. Analyze the behavior of the nonlinear system in presence of time varying input
3. Analysis of nonlinear system using Describing function based method
4. Analysis of nonlinear system using linearization techniques
5. Analysis of nonlinear system using Lyapunov's method
6. Develop the mathematical modeling of the discrete time system in the state space domain
7. Analyze sampled data control system
8. Perform the stability analysis of the sampled data system
9. Analyze the discrete time control system
10. Perform stability analysis of discrete time control system
11. Design a state feedback controller for the discrete time system
12. Design a state observer for the discrete time system

L = Lecture, T = Tutorial, P = Practical, C = Credit

w.e.f. the academic year 2025 - 26 and onwards