

## UEIXXX: ADVANCED CONTROL SYSTEMS

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>1</b>	<b>0</b>	<b>3.5</b>

**Course objective:** To learn the methods for analyzing the behavior of nonlinear control systems and the designing of control systems.

**Nonlinear Control Systems:** Introduction to Nonlinear systems and their properties, Common Non-linearities, Describing functions, Phase plane method, Lyapounov's method for stability study, concept of Limit Cycle.

**Optimal Control Theory:** Introduction, Optimal control problems, Mathematical procedures for optimal control design: Calculus of variations, Pontryagin's optimum policy, Bang-Bang Control, Hamilton-Jacobi Principle

**z-Plane Analysis of Discrete-Time Control Systems:** Introduction, Impulse sampling and data hold, Reconstructing original signal from sampled signals, concept of pulse transfer function, Realization of digital controllers.

**Design of Discrete-time Control Systems:** Introduction, Stability analysis of closed-loop systems in the z-plane, Transient and steady state response analysis, Design based on the root-locus method, Design based on the frequency-response method.

**State-Space Analysis:** Introduction, State-space representations of discrete-time systems, Solving discrete-time state-space equations, Pulse transfer function matrix, Discretization of continuous time state space equations, Lyapunov stability analysis, Controllability and Observability, Design via pole placement, State observer design.

### **Course Learning Outcomes (CLO):**

After the successful completion of the course the students will be able to:

1. demonstrate non-linear system behavior by phase plane and describing function methods and the
2. perform the stability analysis nonlinear systems by Lyapunov method develop design skills in optimal control problems
3. derive discrete-time mathematical models in both time domain (difference equations, state equations) and z-domain (transfer function using z-transform).
4. predict and analyze transient and steady-state responses and stability and sensitivity of both open-loop and closed-loop linear, time-invariant, discrete-time control systems.
5. acquire knowledge of state space and state feedback in modern control systems, pole placement, design of state observers and output feedback controllers

### **Text Books:**

1. Slotine & Li, *Applied Non-Linear Control*, Englewood Cliffs, NJ: Prentice-Hall, (1991).
2. Bandyopadhyay, M.N., *Control Engineering: Theory and Practice*, Prentice-Hall of India Private Limited (2003).
3. Ogata, K., *Discrete-time Control Systems*, Pearson Education (2005).

### **Evaluation Scheme:**

S.NO.	Evaluation Elements	Weightage
1	MST	30
2	EST	45
3	Sessional (May include Assignments//Quizzes/Lab Evaluations)	25