Course Syllabi: UEI841 Advanced Control Systems (L : T : P :: 3 : 1 : 0)

1. **Course number and name:** UEI841; Advanced Control Systems

2. **Credits and contact hours:** Credits: 3.5; Hours: 4

3. **Text book, title, author, and year**

   - *Bandyopadhyay, M.N., Control Engineering: Theory and Practice, Prentice–Hall of India Private Limited (2003).*
   - *Ogata, K., Discrete–time Control Systems, Pearson Education (2005).*

   a. Other supplemental materials
      - Nil

4. **Specific course information**

   a. Brief description of the content of the course (catalog description)

   Nonlinear Control Systems: Introduction to Nonlinear systems, Liapounov's method for stability study, Phase plane method, Describing functions.

   Optimal Control Theory: Introduction, Optimization by steepest decent method, Optimization with constraint gradient method, Minimization of functions by numerical methods: Fletcher–Powell method, Newton–Raphson method; Optimal control problem: Characteristics of the plant, Requirements of the plant, Plant data supplied to the Controller; Mathematical procedures for optimal control design: Calculas of variations, Pontryagin's optimum policy, Bang–Bang Control, Hamilton–Jacobi Principle, Dynamic Programming; State regulator problem, Parameter optimization.

   z–Plane Analysis of Discrete–Time Control Systems: Introduction, Impulse sampling and data hold, Obtaining the z–transform by the convolution integral method, Reconstructing original signal from sampled signals, The pulse transfer function, Realization of digital controllers and digital filters.

   Design of Discrete–time Control Systems by Convolution Methods: 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, Analytical design 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, Liapunov stability analysis, Controllability, Useful transformations in state–space analysis and design, Design via pole placement, State observer, Servo systems.

   Quadratic Optimal Control Systems: Introduction, Quadratic optimal control, Steady–state quadratic optimal control, Quadratic optimal control of a servo system.

5. **Specific goals for the course**

   After the completion of the course, the students will be able to:
   - Study the non-linear system behavior by phase plane and describing function methods and learn about the stability of linear and nonlinear systems by Lyapunov method
   - Develop analysis and design skills in optimal control and robust control

- Assure knowledge of state space and state feedback in modern control systems, pole placement, design of state observers and output feedback controllers
- Design and fine tune PID controllers and understand the roles of P, I and D in feedback control
- Familiarize themselves with the scholarly literature in modern control systems

6. **Brief list of topics to be covered**
    - Nonlinear Control Systems
    - Optimal Control Theory
    - z–Plane Analysis of Discrete–Time Control Systems
    - Design of Discrete–time Control Systems by Convolution Methods
    - State–Space Analysis