IV Year II Semester	L	T	P	C
17EE837	3	1	0	3

ADVANCED CONTROL SYSTEMS
(Professional Elective-IV)

Preamble:

This subject aims to study state space, describing function, phase plane and stability analysis including controllability and observability. It also deals with modern control and optimal control systems.

Learning objectives:

1. Review of the state space representation of a control system: Formulation of different models from the signal flow graph, diagonalization.
2. To introduce the concept of controllability and observability. Design by pole placement technique.
3. Analysis of a nonlinear system using Describing function approach and Phase plane analysis.
4. The Lypanov's method of stability analysis of a system.
5. Formulation of Euler Lagrange equation for the optimization of typical functional and solutions.
6. Formulation of linear quadratic optimal regulator (LQR) problem by parameter adjustment and solving riccatti equation.

Unit – I

State space analysis: State Space Representation – Solution of state equation – State transition matrix, –Canonical forms – Controllable canonical form – Observable canonical form, Jordan Canonical Form.

Unit – II

Controllability, observability and design of pole placement: Tests for controllability and observability for continuous time systems – Time varying case – Minimum energy control – Time invariant case – Principle of duality Controllability and observability form Jordan canonical form and other canonical forms – Effect of state feedback on controllability and observability – Design of state feedback control through pole placement.

Unit – III

Describing function analysis: Introduction to nonlinear systems, Types of nonlinearities, describing functions, Introduction to phase–plane analysis.

Unit – IV

Stability analysis: Stability in the sense of Lyapunov – Lyapunov's stability and Lypanov's instability theorems – Direct method of Lypanov for the linear and nonlinear continuous time autonomous systems.

Unit – V

Calculus of variations: Minimization of functional of single function – Constrained minimization – Minimum principle – Control variable inequality constraints – Control and state variable inequality constraints – Euler lagrangine equation.

Unit – VI

Optimal control: Linear quadratic optimal regulator (LQR) problem formulation – Optimal regulator design by parameter adjustment (Lyapunov method) – Optimal regulator design by continuous time algebraic riccatti equation (CARE) – Optimal controller design using LQG framework.

Learning Outcomes

1. State space representation of control system and formulation of different state models are reviewed.
2. Able to design of control system using the pole placement technique is given after introducing the concept of controllability and observability.
3. Able to analyse of nonlinear system using the describing function technique and phase plane analysis.
4. Able to analyse the stability analysis using lypnov method.
5. Minimization of functional using calculus of variation studied.
6. Able to formulate and solve the LQR problem and riccatti equation.

Text books:

1. Modern Control Engineering – by K. Ogata, Prentice Hall of India, 3rd edition, 1998
2. Automatic Control Systems by B.C. Kuo, Prentice Hall Publication

Reference books:

1. Modern Control System Theory – by M. Gopal, New Age International Publishers, 2nd edition, 1996
2. Control Systems Engineering by I.J. Nagarath and M.Gopal, New Age International (P) Ltd.
3. Digital Control and State Variable Methods – by M. Gopal, Tata Mc Graw– Hill Companies, 1997.
4. Systems and Control by Stainslaw H. Zak , Oxford Press, 2003. Optimal control theory: an Introduction by Donald E.Kirk by Dover publications.