MODERN CONTROL THEORY
(ELECTIVE-I)

Course Code: 15EE2208

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Pre requisites: Control Systems, Basic Mathematics

Course Outcomes: At the end of the course, the student will be able to
CO1: Develop mathematical models of dynamic system in state space.
CO2: Understand non linear systems & their characteristics.
CO3: Analyze control system behavior with controllability & observability.
CO4: Analyze stability of non linear systems using Lyapunov method.

UNIT-I (10-Lectures)

STATE VARIABLE ANALYSIS AND LTI SYSTEMS:

Fields, Vectors and Vector Spaces– Linear combinations and Bases– Linear Transformations and Matrices– Scalar Product and Norms– Eigenvalues, Eigen Vectors and a Canonical form representation of Linear operators– The concept of state –State Equations for Dynamic systems–Time invariance and Linearity–Non-uniqueness of state model– State diagrams for Continuous–Time state models. Linear Continuous time model for physical systems–Existence and Uniqueness of Solutions to Continuous – Time State Equations – Solutions– Linear Time Invariant Continuous–Time State Equations–State transition matrix and its properties.

UNIT-II (10-Lectures)

CONTROLLABILITY AND OBSERVABILITY:

General concept of Controllability- General concept of Observability, Controllability tests for Continuous – Time Invariant systems-Observability tests for Continuous-Time Invariant systems-Controllability and Observability of state model in Jordan Canonical form-Controllability and Observability Canonical forms of State model.

State Feedback Controller design through Pole Assignment–state observers: Full order and Reduced order.

UNIT-III (10-Lectures)

NON LINEAR SYSTEMS:

Introduction– Non Linear Systems– Types of Non– Linearities– Saturation– Dead–Zone– Backlash– Jump Phenomenon etc;- Singular Points– Introduction to Linearization of nonlinear systems, properties of Non Linear Systems– Describing function– describing function analysis of nonlinear systems- Stability analysis of Non– Linear systems through describing functions. Introduction to phase–plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase–plane analysis of nonlinear control systems.

UNIT-IV (10-Lectures)

STABILITYANALYSIS:

Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems–Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

UNIT-V (10-Lectures)

OPTIMALCONTROL:

Introduction to optimal control - Formulation of optimal control problems – calculus of variations –fundamental concepts, functionals, variation of functionals– fundamental theorem of Calculus of variations– boundary conditions–constrained minimization formulation using Hamiltonian method–Linear Quadratic regulator.

TEXT BOOKS:

1. M. Gopal, "*Modern Control System Theory*", New- Age International, 1984.
2. Ogata. K, "*Modern Control Engineering*", Prentice Hall, 1997.

REFERENCES:

1. Donald K. Kirk, "*Optimal Control Theory - An Introduction*", Dover Publications, 2004