MODERN CONTROL THEORY
(ELECTIVE-I)

Course Code: 13EE2208 **L P C**
4 0 3

Pre requisites: Control Systems, Basic Mathematics

Course Educational Objectives: This Course introduces

1. Mathematical modeling of dynamic systems and development of state space models.
2. Analysis of control systems in state space. Concepts of controllability & observability.
3. Non linear systems and their characteristics
4. Stability analysis techniques
5. Optimal control system

Course Outcomes: At the end of the course, the student will be able to

1. Develop mathematical models of dynamic system in state space.
2. Understand non linear systems & their characteristics.
3. Analyze control system behavior with controllability & observability.
4. Analyze stability of non linear systems using Lyapunov method.

UNIT-I: STATE VARIABLE ANALYSIS AND LTI SYSTEMS

Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen values, 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: 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-III: 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-IV: STABILITY ANALYSIS

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: OPTIMAL CONTROL

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