IN5152 SYSTEM THEORY

DETAILED SYLLABUS

OBJECTIVES:

- To understand the fundamentals of physical systems in terms of its linear and nonlinear models.
- To educate on representing systems in state variable form
- To educate on solving linear and non-linear state equations
- To exploit the properties of linear systems such as controllability and observability
- To educate on stability analysis of systems using Lyapunov's theory
- To educate on modal concepts and design of state and output feedback controllers and estimators

UNIT I STATE VARIABLE REPRESENTATION

Introduction-Concept of State-State equations for Dynamic Systems -Time invariance and linearity- Non uniqueness of state model- Physical Systems and State Assignment – free and forced responses- State Diagrams.

UNIT II SOLUTION OF STATE EQUATIONS

Existence and uniqueness of solutions to Continuous-time state equations - Solution of Nonlinear and Linear Time Varying State equations - State transition matrix and its properties – Evaluation of matrix exponential- System modes- Role of Eigen values and Eigen vectors.

UNIT III STABILITY ANALYSIS OF LINEAR SYSTEMS

Controllability and Observability definitions and Kalman rank conditions -Stabilizability and Detectability-Test for Continuous time Systems- Time varying and Time invariant case- Output Controllability-Reducibility- System Realizations.

UNIT IV STATE FEEDBACK CONTROL AND STATE ESTIMATOR

Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems- The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

UNIT V LYAPUNOV STABILTY ANALYSIS

Introduction-Equilibrium Points- BIBO Stability-Stability of LTI Systems- Stability in the sense of Lyapunov - Equilibrium Stability of Nonlinear Continuous-Time Autonomous Systems-The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems-Finding Lyapunov Functions for Nonlinear Continuous-Time Autonomous Systems – Krasovskil's and Variable-Gradient Method.

TEXT BOOKS:

1. M. Gopal, "Modern Control System Theory", New Age International, 2005.

2. K. Ogatta, "Modern Control Engineering", PHI, 2002.

3. John S. Bay, "Fundamentals of Linear State Space Systems", McGraw-Hill, 1999.

4. D. Roy Choudhury, "Modern Control Systems", New Age International, 2005.

5. John J. D'Azzo, C. H. Houpis and S. N. Sheldon, "Linear Control System Analysis and Design with MATLAB", Taylor Francis, 2003.

6. Z. Bubnicki, "Modern Control Theory", Springer, 2005.

7. C.T. Chen, "Linear Systems Theory and Design'' Oxford University Press, 3rd Edition, 1999.

8. M. Vidyasagar, "Nonlinear Systems Analysis', 2nd edition, Prentice Hall, Englewood Cliffs, New Jersey