B.Tech III Year I Semester

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

19AEE54b- ADVANCED CONTROL SYSTEMS

(Professional Elective-I)

L	T	P	C
3	0	0	3

Course Objectives:

- To give an overview of system analysis and design based on state space.
- Design of state feedback control and observer.
- The properties of Nonlinearities. Stability analysis for linear and nonlinear systems.
- Design of optimal control problem.

UNIT – I: STATE VARIABLE DESCRIPTION **10 Hrs**

State space representation of systems – State diagrams for continuous time state models – Solution of state equations – State transmission matrix. Controllability and observability for continuous time systems, Principle of Duality, Controllability and observability of state models in Jordan canonical form and other canonical forms – Numerical problems Learning Outcomes: At the end of the unit the student will be able to: Obtain the State Space Modelling for linear time-invariant systems. Know about controllability of a system Know about observability of a system To understand tests for controllability and observability of a given system.

Learning Outcomes:

At the end of this unit, the student will be able to

- Obtain the State Space Modelling for linear time-invariant systems. **L1**
- To understand tests for controllability and observability of a given system. **L2**

UNIT – II: POLE PLACEMENT OBSER **10 Hrs**

Fundamental theorem of feedback control - Pole assignment by state feedback using Ackermann's formula – Eigen structure assignment problem-Design of full order observer using Ackermann's formula. - Full order Observer based controller design. Reduced order observer design - Numerical problems

Learning Outcomes:

At the end of this unit, the student will be able to

- To know about design of pole assignment **L1**
- To know about full order based controller design aspects **L2**

UNIT – III: DESCRIBING FUNCTION AND PHASE-PLANE ANALYSIS **10 Hrs**

Introduction to nonlinear systems, Types of nonlinearities, Concepts of describing functions, describing functions for Dead zone, Saturation, backlash, relay with dead zone and Hysteresis - Jump Resonance. Introduction to phaseplane analysis, Method of Isoclines for Constructing Trajectories, Singular points, Phase-plane analysis of nonlinear control systems – Numerical problems

Learning Outcomes:

At the end of this unit, the student will be able to

- Develop the describing function for the nonlinearity present to assess the stability of the system **L1**
- To understand about classification of describing functions **L2**

UNIT – IV: STABILITY ANALYSIS **10 Hrs**

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 – Numerical problems.

Learning Outcomes:

At the end of this unit, the student will be able to

- Develop Lyapunov function for the stability analysis of nonlinear systems **L1**
- To understand and solve direct method of Lyapunov with numerical examples **L2**

UNIT – V: OPTIMAL CONTROL **10 Hrs**

Discrete time linear state regulator – Algorithm for the solution, Use of observer in implementing the control law. Continuous time linear state regulator – Matrix Riccati equation. Time invariant linear state regulator – the reduced matrix Riccati equation - An iterative method to solve the reduced matrix Riccati equation – Numerical problems

Learning Outcomes:

At the end of this unit, the student will be able to

- Introduction to optimal control **L1**
- To know about discrete and continuous time linear state regulators **L2**

Text Books:

1. M. Gopal, "Modern Control System Theory" 2nd edition, New Age International Publishers, 1996
2. K. Ogata, "Modern Control Engineering" 3rd edition, Prentice Hall of India, 1998

Reference Books:

1. M. Gopal, "Digital Control and State Variable Methods" Tata Mc Graw-Hill, 1997.
2. Gene F. Franklin, "Feedback Control of Dynamic Systems", 6th Edition, J.D. Powell, Pearson, 2010.
3. Stainslaw H. Zak , "Systems and Control", Oxford Press, 2003
4. N. K. Sinha, "Control Systems", 3rd Edition, New Age International, 2005.
5. Graham C. Goodwin, "Control System Design", Stefan F. Graebe and Mario E. Salgado, Pearson, 2000

Course Outcomes:

At the end of this Course the student will be able to

- To develop state variable models and its solution for various systems **L1**
- To understand and develop models for full order and reduced order based observers **L2**
- To know about describing function and analyse systems **L3**
- To understand about phase plane analysis of non-linear control systems **L4**
- To understand and develop models for Lyapunov's stability criterion **L5**