DIGITAL CONTROL SYSTEMS

Course Code:13EE2204 **L P C**
4 0 3

Pre requisites: Control Systems

Course Educational Objectives:

1. To equip the students with the basic knowledge of A/D and D/A conversion
2. To understand the basics of Z- Transform
3. To study the stability analysis of digital control system
4. To gain the basic Knowledge of the design of digital control systems for different engineering models
5. To gain the basic knowledge of digital simulation and DSP Processors.

Course Outcomes:

1. This course provides a foundation in discrete-time linear control system theory.
2. Analyze, design, and synthesize digital control systems using transform techniques (root locus and frequency response) and state-space methods (pole-assignment and state estimation).
3. Analyzing and understanding the challenges to interface digital computing devices with the Analog dynamics of most real-world systems.
4. Evaluating and setting the necessary specifications for analog systems that are to be controlled by digital computing devices.
5. Designing digital devices to satisfy given specifications and to achieve desired system-behavior.
6. Understanding the Basic Concepts of Microprocessor control of control systems and custom designed chips like Galil DMC-105.

UNIT-I

SIGNAL CONVERSION AND PROCESSING

Introduction, Digital Signals and coding, Data Conversion and Quantization, Sample and Hold Devices, Sampling Period

Considerations, Mathematical Modeling of the Sampling Process, Sampling Theorem, Mathematical Modeling of Sampling by Convolution Integral, Flat-Top Approximation of Finite Pulse width Sampling, Data Reconstruction and Filtering of Sampling Signals, Zero-Order Hold, First Order Hold, Polygonal Hold and Slewer Order Hold.

Z – TRANSFORMS, TRANSFER FUNCTIONS AND BLOCK DIAGRAMS

Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, the inverse Z – transforms, Modified Z- Transforms. Introduction, The Pulse Transfer Function and the Z-Transfer Function, Pulse Transfer Function of the Zero- Order Hold and the Relation between G(s) and G(z), Closed loop systems-characteristic Equation, Causality and Physical Realizability, Sampled Signal Flow Graph.

UNIT-II

STATE SPACE ANALYSIS

State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations.

CONTROLLABILITY AND OBSERVABILITY

Concepts of Controllability and Observability, Tests for controllability and Observability. Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function.

UNIT-III

STABILITY ANALYSIS

Stability Analysis of closed loop systems in the Z-Plane. Jury stability test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion. Stability analysis using Liapunov theorems.

UNIT-IV
DESIGN OF DISCRETE-DATA CONTROL SYSTEMS

Introduction, Cascade Compensation by Continuous-Data Controllers, Design of Continuous-Data Controllers with Equivalent Digital Controllers, Digital Controllers, Design of Digital Control Systems with Digital Controllers through bilinear transformation.

UNIT- V
DIGITAL SIMULATION

Introduction, Digital Simulation- Digital Modeling with Sample and Hold Devices, State Variable Formulation, Numerical Integration, Rectangular Integration, Frequency Domain Characteristics- Frequency Warping, Frequency Prewarping.

MICROPROCESSOR AND DSP CONTROL

Introduction, Microprocessor Control of Control Systems, Single- Board Controllers with Custom-Designed Chips, The Galil DMC-105 Board, Digital Signal Processors- The Texas Instruments TMS320 DSP's, Development Systems and Support Tools.

TEXT BOOKS:

1. Kuo, "*Digital Control Systems*", 2nd Edition, Oxford University Press, 2003.

2. K.Ogata, "*Discrete-Time Control systems*", 2nd Edition, Pearson Education/PHI, 2002.

REFERENCE BOOKS:

1. M.Gopal, "*Digital Control and State Variable Methods by conventional and intelligent control system*", third edition, TMH, 2009.

2. M. Gopal,"*Modern Control Systems Theory*", Wiley Eastern,1984.

3. M. Gopal, "*Digital control engineering*" , New Age International Publications,2003