III Year B.Tech, EEE, II-Semester

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DIGITAL CONTROL SYSTEMS
(Professional Elective-II)

Prerequisites: Control systems

Course Objectives:

1. To understand the concepts of Discrete Data System in comparison with continuous Data system.
2. To introduce the mathematical tool –z transform for solving linear difference equation.
3. To understand the extent concepts of state space representation to discrete time system
4. To become familiar with the design concepts of discrete time system.

UNIT 1: (~ 10 Lecture Hours)

Introduction: Introduction, Examples of Digital control systems- Digital to analog conversion and Analog to Digital conversion, Sample and Hold Devices, Mathematical Modeling of the Sampling process, Sampling theorem, Data reconstruction, Zero order Hold, First order hold, Polygonal and Slewer Hold.

z-Transform: Introduction, z-Transforms, Properties, Theorems and Limitations of z-Transform, Inverse z-Transform, Modified z-Transform, z-Transform method for solving difference equations.

UNIT 2: (~ 8 Lecture Hours)

Pulse Transfer Function: pulse Transfer function for closed loop system, mapping between s-plane and z-plane – primary strip and complementary strip, constant Frequency Loci, constant damping ratio loci.

State Space Analysis: State Space representation of discrete time systems, Pulse Transfer Matrix, solving discrete time state space equations, State transition matrix and its properties, Methods of computing the State Transition Matrix, Discretization of continuous time state space equations.

UNIT 3: (~ 12 Lecture Hours)

Controllability and Observability: Definition and Theorems of controllability and Observability, Tests of controllability and Observability, duality between controllability and Observability, Relationship between controllability, Observability and transfer function, Effect of pole zero cancellation on controllability and Observability.

Stability Analysis: Stability analysis of closed loop systems in the Z-plane, transient and steady state response analysis, Jury Stability Test- Stability Analysis using Bilinear Transformation and Routh- Hurwitz Criterion, Design of digital control system with dead beat response.

UNIT 4: (~ 6 Lecture Hours)

Design of Discrete Time Control System: Design based on frequency response method- Bilinear Transformation, Design procedure in the w-plane, Lead, Lag and Lead-Lag compensators and Digital PID controllers.

UNIT 5: (~ 8 Lecture Hours)

State Feedback Controllers & Observers: Design of State feedback controller through pole placement –Necessary and sufficient conditions, Ackerman's formula.

State Observers-Full order and Reduced order Observers

TEXT BOOKS:

1. B.C Kuo, "Digital Control Systems", Oxford University Press, 2nd Edition, 2012.
2. K. Ogata, "Discrete Time control systems", Pearson Education, PHI, 2nd Edition, 2015.
3. M. Gopal, "Digital Control Engineering", New Age International, 2nd Edition, 2014.

REFERENCE BOOKS:

1. C. P Kurian, V. I. George, "Digital Control System" , Cengage Learning India, 2012
2. M. Sami Fadali, Antonio Visioli, "Digital Control Engineering Analysis and Design", Academic Press, 2nd Edition, 2012.
3. M. Gopal, "Digital Control & State Variable Methods", Tata McGraw Hill, 4th Edition, 2012.

Course Outcomes:

Subsequent to completion of the course, the students will be able to:

1. Distinguish between analog control systems and digital control systems by acquiring the knowledge on z-transforms and sampling for basic analysis of digital control system.
2. Develop and analyze pulse transfer function for discrete time system.
3. Analyze the performance of digital control systems using state space representation.
4. Analyze the performance and Stability of digital control systems through various classical and other methods.
5. Design Discrete-time control systems based on frequency response method i.e. lag, lead and lag-lead compensators etc.
6. Design State feedback controllers and observers using various techniques.