DIGITAL CONTROL SYSTEM

ENEE 304

Lecture : 3 **Year : III**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objectives:
The objective is to impart knowledge and understanding of digital control systems, emphasizing the differences between analog and digital control, the role of sampling and data conversion, and the modeling of dynamic systems using difference equations and Z-transform techniques. By the end of the course, students will be able to apply stability analysis methods such as Jury's test and root locus for discrete-time systems and design digital PID controllers for discrete-time control applications.

1 Introduction to Discrete Time Control System (7 hours)

1.1 Advantages of digital control system over analog
1.2 Applications of digital control system
1.3 Types of signals
1.4 Sampling processes
1.5 Principle features of discrete time control system
1.6 Types of sampling operations
1.7 Signal sampling, quantizing and coding
1.8 Data acquisition and data distribution system
1.9 Sample and hold circuit
1.10 Quantizing and quantization error

2 The Z Transform (8 hours)

2.1 Discrete-time signals
2.2 Fundamental of the Z-transforms
2.3 Region of convergence
2.4 Z-transforms of some elementary functions
2.5 Important properties and theorems of the Z-transform
2.6 The inverse Z-transform
2.7 Z-transform method for solving difference equations

3 Z-plane Analysis of Discrete –Time Control Systems (8 hours)

3.1 Impulse sampling and data hold circuit
3.2 Z-transform by the convolution integral
3.3 Reconstructing original signals from sampled signals
3.4 Pulse transfer function

3.5 Starred Laplace transform of the signal involving both ordinary and starred Laplace transforms
3.6 Discrete time equivalents of continuous time system
3.7 Discrete time equivalents of analog controllers
3.8 Realization of digital controllers and digital filters

4 Stability, Design and Compensation of Discrete Time Control System (13 hours)

4.1 Mapping between the S-plane and the Z-Plane
4.2 Stability analysis of closed- loop systems in the Z-plane
4.3 Methods for testing absolute stability
4.4 Transient response analysis
4.5 Steady state response analysis
4.6 Use of root locus and frequency domain concepts
4.7 Compensator design based on the root locus and bode plot method
4.8 PID controller design and selection of parameters for discrete time system
4.9 Phase lead and phase lag compensator design for discrete time system

5 Site Space Analysis` (9 hours)

5.1 Concept of the state space method
5.2 State-space representations of discrete-time systems
5.3 State transition matrix
5.4 Pulse transfer function matrix
5.5 Discretization of continuous time state space equations
5.6 Stability assessment from the discretized state space equations

Tutorial (15 hours)

1. Problems involving Z-transforms of some elementary functions, important properties and theorems of the Z-transform, the inverse Z-transform, Z-transform method for solving difference equations
2. Problems on Z-transform by the convolution integral, realization of digital controllers and digital filters, discrete time equivalents of continuous time system and digital controllers and digital filters
3. Problems related to stability and design and compensation of discrete time control system
4. Problems related to state space analysis

Practical (22.5 hours)

1. Temperature Study of relay type “ON-OFF” control system
2. Z - transform using Software tools
3. Stability analysis of closed-loop system in z-plane using software tools
4. Simulation study of closed loop control system using software tools
5. Position control system through analog interfacing

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	7	8
2	8	12
3	8	12
4	13	16
5	9	12
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Ogata, K. (1995). Discrete-time control systems (Latest Edition). Prentice Hall.
2. Phillips, C. L. (1984). Digital control system: Analysis and design (Latest Edition). Prentice Hall.
3. Phillips, C. L., Nagle, H. T., Chakrabortty, A. (2014). Digital control system analysis and design. Pearson.
4. Vashisth, R., Singh, K. (2012). Digital control system. Galgotia Publications.
5. Fadali, M. S., Visioli, A. (2012). Digital control engineering: Analysis and design. Academic Press.