4/4 B.Tech. SECOND SEMESTER

E85T4C DIGITAL CONTROL SYSTEMS (ELECTIVE-IV) Credits: 4

Lecture: 4 periods/week **Internal assessment: 30 marks**
Tutorial: 1 period /week **Semester end examination: 70 marks**

Objectives:
Understand concepts of digital control system sampling theory .Get an idea of stability analysis and discrete time state equations. Thorough knowledge of design of discrete time control system by conventional methods, state feedback controllers and observers.

Learning Outcomes:

1. Student understands the main difference between continuous time systems (analog) and discrete time systems (digital)
2. Also able to do sampling process which incorporates Z-transform analysis for stability concepts, state estimation (controllability and observability), state feedback controllers also in design of discrete time control systems

Unit I Sampling And Reconstruction
Introduction, Examples of Data control systems – Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.

Unit II The Z – Transforms
Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, the inverse Z – transforms, Modified Z- Transforms

Unit III Z-Plane Analysis Of Discrete-Time Control System
Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems, mapping between s-plane and z-plane.

Unit IV 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

Unit V 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 VI Stability Analysis
Mapping between the S-Plane and the Z-Plane – Primary strips and Complementary Strips – Constant frequency loci, Constant damping ratio loci, Stability Analysis of closed loop systems in the Z-Plane. Jury stablility test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion.

Unit VII Design Of Discrete Time Control System By Conventional Methods

Transient and steady – State response Analysis – Design based on the frequency response method – Bilinear Transformation and Design procedure in the w-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers.

Unit VIII State Feedback Controllers And Observers

Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula. State Observers – Full order and Reduced order observers.

Learning resources

Text books:

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

Reference books:

1. Digital Control Systems, Kuo, Oxford University Press, 2nd Edition, 2003.
2. Digital Control and State Variable Methods by M.Gopal, TMH