E6203 Computer Control Systems

CONTENT

- Discrete-time system modelling and analysis.
- Cascade compensation.
- State-space design methods.
- Optimal control.
- Design and implementation of digital controllers.

(Full set of lecture notes available only to enrolled students)

SYLLABUS (39 HOURS)

Discrete Time System Modelling and Analysis (6 hours)

Sampling process. Z-transform. Inverse z-transform. Mapping between s and z domains. System stability. Steady-state error analysis for stable systems. Root-Locus analysis. Bilinear transformation. Frequency response.

Cascade Compensation (6 hours)

Digitization technique. Direct technique. Lead compensation. Lag compensation. Lag-lead compensation. Frequency-response characteristics. Deadbeat response.

State-Space Design Methods (9 hours)

State-variable representation. State-feedback using digitization. State-feedback by pole placement. Discrete controllability. State observers. Discrete Observability. Dynamic output feedback. Integral control. Deadbeat control.

Optimal Control (6 hours)

The discrete maximum (minimum) principle.
Linear quadratic control. Dynamic programming.
Solution of the discrete Riccati equation.

Design and Implementation of Digital Controllers (12 hours)

Operational aspects. Principles of structuring.
Design of simple loops.
Designing controllers with predictive first-order hold.
Approximating continuous-time controllers.
Implementation aspects.
Prefiltering and computational delay.
Numerics.
Programming.
Realization.

E6203 Computer Control Systems

Part 1

Lecturer: Professor Minyue FU

- Fundamentals and Sampling process
- z-transform and inverse z-transform
- Analysis Methods
- Design Techniques

Textbook

- Kuo, BC (1992). *Digital Control Systems*, 2nd edition, Saunders College Publishing.

Reference Books

- Houpis, C H and Lamont, G B (1992). *Digital Control Systems: Theory*, *Hardware*, *Software*, 2nd edition, McGraw-Hill.
- Astrom, K J and Wittenmark, B (1990). *Computer Controlled Systems: Theory and Design*, Prentice-Hall.
- Franklin, G F and Powell, J D (1990). *Digital Control of Dynamic Systems*, Addison-Wesley.
- Middleton, R H and Goodwin, G C (1990). *Digital Control and Estimation: A Unified Approach*, Prentice-Hall.

LECTURE 1:
FUNDAMENTALS AND SAMPLING PROCESS

Main topics:

- Basic concepts
- Linear time-invariant systems
- Sampling and signal reconstruction
- z-transform

LECTURE 2:
z-TRANSFORM AND
PLANE TRANSFORMATIONS

Topics:

- z transform properties
- Inverse z transform
- Mapping between s and z domains
- First-backward difference
- Bilinear (Tustin) transformation
- s-plane, z-plane and w-plane

LECTURE 3:
ANALYSIS TECHNIQUES

Topics:

- Transfer Functions of Sampled-data Systems
- Zero-order Hold Function
- Stability Tests
- Steady State Analysis
- Root-locus Technique
- Frequency Response

LECTURE 4:
DESIGN TECHNIQUES

Topics:

- Digital Feedback Design
  - s-plane Method
  - z-plane Method
  - w-plane Method
- Lead-lag Compensation
- PID Control