Electrical and Computer Engineering
Northeastern University
Fall 2025

EECE 5610 Digital Control Systems

Objective: In this course we will develop an understanding of the basic principles of *classical digital control theory*, with emphasis on frequency domain methods. This theory will be applied to case–studies from several engineering disciplines. If time permits we will have an overview of some current issues such as *robust control, control oriented identification using generative AI,* and *using digital control techniques to analyze structured state space models Gen AI architectures.*

Prerequisites: EECE 5580 or equivalent.

By Topic: You should have an understanding of basic *continuous and discrete system theory,* including ordinary differential equations, convolution, Laplace transform; difference equations and z–transform; and of *classical control theory,* including stability analysis and frequency domain design methods.

Class Schedule: Tuesdays and Fridays 1:35 pm- 3:15 pm, Snell Library 017

Instructor: Professor Mario Sznaier, Room 414, Dana Bldg., 373–5364, email: msznaier@coe.neu.edu. Office Hours: Tu and Fr. W: 10:00-11:00 or by appointment.

Grading: Homework: 20 %; Final Project: (optional) extra 5%; 2 Exams: 40 % each. The exams are scheduled as follows:

- Exam 1, one $8\frac{1}{2}$ by 11 cheat sheet, 10/21/25
- Midterm 2, two $8\frac{1}{2}$ by 11 cheat sheets,12/5/25

Exams: All exams are closed book, but calculators and cheat sheets are permitted as noted above.

Homework: Homework assignments will be handed out weekly and they will be normally due one week after assignment. Late homework **will not** be accepted unless you have a very good reason and you get my permission. You are encouraged to work the homework problems using *Matlab*.

Collaboration policy: Students are encouraged to get together to discuss the homework. Keep in mind, however, that for the problem sets the solutions you hand in should reflect your own understanding of the class material, and should be written solely by you. It is not acceptable to copy a solution that somebody else has written or to copy a solution provided by AI (such a s ChatGPT, Grok, etc).

Project: Each student has the option of turning in a final project (for up to 5 % additional credit). This project consists of designing a digital controller for an active vision system and includes modeling of the digital effects (the continuous time plant will be given), controller design, closed loop simulation, and analysis of the effects of parameter variations.

Textbook: C.L. Phillips, H.T. Nagle Jr., and A. Chakrabortty, Digital Control Systems Analysis and Design, 4 th edition, Pearson, 2015, Chapters 1–8.

References:

Control: ◦ C. L. Philli R. D. Harbor, *Feedback Control Systems,* 4^{th} Ed., Prentice Hall, (TJ216.P45).
◦ R. Dorf, *Modern Control Syst.,* 7^{th} ed., Addison Wesley, (TJ216.D67).
◦ G. F. Franklin, J. D. Powell and M. L. Workman, *Digital Control of Dynamic Systems,* Addison Wesley, 3^{rd} Ed. (TJ223.M53F73).
◦ K. Ogata, *Discrete–Time Control Systems,* 2^{nd} ed., Prentice–Hall, 1995 (QA402.04).

Software: ◦ Leonard and Levine, *Using Matlab to Analyze and Design Control Systems,* Benjamin Cummings, 1995 (TJ213.L368)
◦ J. Moscinski, *Advance Control with Matlab and Simulink,* Horwood, 1995 (QA 402.3.A33)

z–Trans.: ◦ B. P. Lathi, *Signal Processing & Linear Systems,* 1998, (TK5102.9.L38).
◦ A.V. Oppenheim and A.S. Willsky, *Signals and Systems,* 1983 (QA402.O63).
◦ R.D. Strum and D.E. Kirk, *Discrete Systems and Digital Signal Processing,* Addison Wesley, 1988, (TK5102.5.S774)

Syllabus

1. Course Overview, Introduction to Digital Control.
2. Discrete Time Systems and the z –Transform.
3. Sampling and Reconstruction.
4. Open Loop Discrete–Time Systems.
5. Closed–Loop Discrete–Time Systems
6. Time–Response Characteristics
7. Stability Analysis of Discrete Linear Systems
8. Digital Controller Design
9. Introduction to State–Space Methods
10. Current topics: Data Driven Control, Systems Identification using GenAI, using Digital Control methods to analyze recently proposed GenAI architectures (e.g. Mamba)

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