

Syllabus: EE 211 (Real-time Control Systems)

Instructor: Professor Hamid Ossareh
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Overview: This course is a continuation of EE210: Control Systems, and aims to teach real-time digital control of dynamic systems. Also covered in this course are advanced analysis and design concepts that are commonly used in the field of controls. There will be an emphasis on design.

Required Textbook(s): Bruce Francis (University of Toronto). *Real-time Computer Control*, Available free online.

Recommended good references to have/be aware of*:

- *Digital Control of Dynamic Systems*. Franklin, et. al.
- *Digital Control Systems*, Kuo

Grading Scheme:

- Homework [20%]
- Labs [15%]
- Project [15%]
- 1 Midterm [25%]
- 1 Final Exam [25%]

Assignments for graduate students: Homework assignments will contain additional problems for graduate students (optional/bonus for undergraduates). These problems will typically involve reading an article/paper and writing a brief essay or solving an additional, more difficult problem.

Topics Covered:

- Digital control systems analysis and design
- The Z-transforms and discrete-time transfer functions
- Discrete-time state space models

*These references should be on hold and available for 2-hour loans in the UVM main library.

- Discretization of continuous-time systems
- Sampled-data systems, effects of sampling, processor scheduling
- Implementation issues
- Predictive control design

Pre-requisites: You are required to have taken an undergraduate Control Systems course or an equivalent as a prerequisite.

Learning Objectives: Upon successful completion of this course, the student should be able to:

- Identify open and closed loop systems and understand the role of feedback
- Understand and calculate key concepts such as stability, tracking, and performance measures for discrete-time systems
- Know the role of sampling, aliasing, and sampled-data systems
- Know how to convert continuous time systems to discrete-time systems and vice-versa
- Design feedback control laws for single input, single output discrete-time systems
- Know how to implement control algorithms to run on embedded processors
- Use mathematical models to describe dynamic processes
- Understand tradeoffs and limitations in feedback control design

Expectations: You are expected to know how to program in Matlab and the basics of linear systems analysis. In addition, I expect you to know how to solve integrals and ordinary differential equations; to know complex numbers, Laplace transforms, LTI systems, and continuous-time transfer functions; to know how to multiply and invert matrices and compute eigenvalues; to know block diagrams, signal flow, basics of feedback systems, and stability; to know Bode, Nyquist, and Root Locus plots; to know PID controllers; and to know basic controller design in continuous-time.

Additionally, here are my expectations of you:

- You will attend all lectures and, if you miss some, you will get the notes from your classmates (*you* are responsible for knowing what was covered and what was discussed in class).
- You will review your notes from the previous lecture *before* coming to class.
- You will show up for class *on time*.
- You will read relevant sections of the textbook on your own.

Academic Integrity: It is expected that everything that you submit with your name on is your own work. Anything that is not 100% your own work should be clearly labeled as such (credit your sources, group members, etc.). Students who submit others' work as their own will not pass the course and will be referred to the Center for Student Ethics and Standards for further discipline. The UVM policy on academic integrity is a useful guide:
<https://www.uvm.edu/policies/student/acadintegrity.pdf>.

University Attendance Policy: The lecture notes will form the bulk of materials, so attendance is important. Please refer to the most recent UVM Catalogue: *"Students are expected to attend all regularly scheduled classes. The instructor has the final authority to excuse absences."*

Student Learning Accommodations: In keeping with University policy, any student with a documented disability interested in utilizing accommodations should contact ACCESS, the office of Disability Services on campus. ACCESS works with students to create reasonable and appropriate accommodations *via an accommodation letter to their professors as early as possible each semester*. Contact ACCESS: A170 Living/Learning Center - 802-656-7753 - access@uvm.edu.

Religious Holidays: Students have the right to practice the religion of their choice. If you need to miss class to observe a religious holiday, *please submit the dates of your absence to me in writing by the end of the second full week of classes*. You will be permitted to make up work within a mutually agreed-upon time.

Extra Help: Do not hesitate to come to my office during office hours or by appointment to discuss a homework problem or any aspect of the course. Blackboard discussion boards are also available if you want to discuss course content with me and your peers.