GEORGIA INSTITUTE OF TECHNOLOGY

ECE 3550
Fall Semester 2026

Feedback Control Systems

Instructor: Professor Erik I. Verriest

Class Hours:
MW 17:00-18:15, Boggs 89.

Prerequisites: ECE 2040 "Circuit Analysis" (minimum grade C).

Course Objective: To introduce the basic underlying principles in the study of the analysis and design of linear time-invariant dynamical systems: LTI-ODE, Laplace transform, transfer function representations. Introduction to feedback control theory. Graphical analysis and design methods.

Course Outcomes: Upon successful completion of this course, students should be able to:

1. Demonstrate thorough knowledge of the concept of system dynamics.
2. Demonstrate an understanding of the concept of feedback and its application to control systems.
3. Analyze signals commonly arising in control applications and derive their Laplace transforms.
4. Apply the concepts of system response (including transients and steady-state) and of system stability.
5. Apply the principles of feedback control in a broad context of engineering systems.
6. Design control systems for steady-state tracking of reference inputs, disturbance rejection, and sensitivity reduction.
7. Apply graphical design techniques (root locus plots, Bode plots, Nyquist plots) to control system analysis and design.

Grading:		
	Two tests:	25 % each.
	Homework :	10 %
	Final:	40 %.

All tests are **closed book** except for one (predetermined) formula sheet.
Failure to show up for a test without valid reason results in a **zero**.
The final exam MUST be taken at its scheduled time.

https://registrar.gatech.edu/current-students/exams
If you need to schedule travel, please do so accordingly.

I use the **full scale** (0 to 100) for grading. That means that if you know half of the material, you will score around 50%.
Knowing half of the material is sufficient for a *passing grade* (C and above).
That being said, it is unusual, but not impossible, for students to get over 90 %. $A > 78$; $B > 64$; $C > 50$; $D > 45$.

Make-ups: Permitted *only* if either you have a legitimate excuse and I am notified in advance, or you are physically incapable of being in class due to an emergency.
At the discretion of the instructor, make-up tests may either be oral or written, and may be given on the week before finals.

Honesty: In order to maintain academic honesty, all instances of academic misconduct will be reported to the Dean of Students. After that, it is out of my hands. If unsure about the Georgia Tech honor code, please consult:
https://policylibrary.gatech/student-affairs/acdemic-honor-code

Disability and Athletic absences:
Special services are available through the Office of Disability Services. https://disabilityservices.gatech.edu. Please let the instructor know at the beginning of the course but not after the second week if you will take advantage of this. Verification of eligibility is required. Please review the ODS Intake Process document to learn more:
https://disabilityservices.gatech.edu/node/50

Computer Usage: Individual computer experimentation (Matlab, Mathematica or MAPLE) is strongly recommended, but not required.

Text book: Franklin, Powell & Emami-Naeini, *Feedback Control of Dynamic Systems (8-th edition)*, Prentice Hall, 2018.
My class notes will be posted on Canvas.

Attendance: This will be an active classroom, where you will be expected to participate. I see a drastic difference in test performance between students who regularly attend class and those who don't. Borderline grade cases may be finalized based on class attendance and course participation.

Acceptable Student Conduct
Students should familiarize themselves with the acceptable student conduct.
https://www.policylibrary.gatech.edu/student-life/student-code-conduct.

Homework: There will be an assignment approximately every week (except on the test weeks), due the following week. Carefully prepared and detailed solutions will be posted on Canvas. **Expect to work at least another three hours *outside* the class for each class hour.**

The test problems will be similar in nature, but not identical to homework problems. Late homework will *not* be accepted.

Homework and tests will have:

- *Exercises*, involving direct application of concepts discussed in class. These have no 'surprises' in store and can be solved comfortably by routine or familiar procedures (no matter how difficult)!
- *Creative Problems*: Here you need to pull things together as typically you don't know directly how to go about solving these, and a deeper insight may be needed.

Because of this, **limited cooperation** (in pairs) will be allowed. It is also my belief that you learn by discussing and explaining concepts.

Emphasis: Will be on the *basic underlying methods* in the study of systems and control. All derivations will start from "first principles".

As appropriate, a full understanding of these principles will be aimed for. Mathematical rigor will be strived for. It is this instructor's firm belief and experience that a good theoretical background provides a better mobility than training in a specific art of technique. *Nothing is more practical than a good theory!* However, let this not intimidate you. No prior knowledge of advanced or higher mathematics besides the cited prerequisites will be assumed. New concepts (complex analysis and operator theory) will be introduced as the course evolves. Familiarity with complex arithmetic, and LTI-ODE's is expected. Now is the time to review this!

ECE 3550 Topical Outline - (tentative, Fall 2026)

1. Signal Operations - System Properties
   (a) Elementary Operations on Signals
   (b) Systems as Operators
   (c) Time Invariance, Linearity, Causality, Memorylessness, Finite-Dimensionality
2. Linear Time Invariant Ordinary Differential Equations
   (a) Differential Operators
   (b) Homogenous equations
   (c) Driven Equations and Convolution Representation
3. Laplace Transform
   (a) Definition and Relation to Fourier Transform
   (b) Properties and Inverse Laplace Transform
   (c) Transient Response
4. Transfer Function and Stability
   (a) Transfer Function Representation of Systems
   (b) Frequency Response and Bode Plots
   (c) Stability and Routh-Hurwitz Criterion
5. Connection Algebra
   (a) Interconnections: Series, Parallel and Feedback
   (b) Systems Modeling from Physical Principles
   (c) Similarity and Analog Simulation
6. Feedback Control
   (a) Modal Control and Stabilization
   (b) Tracking and Steady State Error
   (c) Sensitivity Reduction
   (d) Disturbance Rejection
7. Root Locus Method
   (a) Complex Maps and Parameterized Representations
   (b) Analysis of Closed Loop Pole Locations

(c) Root Locus Meta-rules

(d) Application to Control System Design

8. Nyquist Plot and Criterion

   (a) Notions from Analytic Function Theory
   (b) Principle of the Argument
   (c) Nyquist Criterion
   (d) Rouché's Theorem and Compensator Design

9. Topics to be selected from (time permitting)

   (a) Systems with Delays
   (b) Discrete-time Systems and Discretization
   (c) Identification from Input-output Data