ME/ECE 360: System Modeling and Control

Fall 2025

Instructor:	Aykut C. Satıcı	**Course Time:**	MW 9:00 – 10:15 a.m.
Email:	aykutsatici@boisestate.edu	**Classroom:**	MEC 106
Room:	RUCH 233	**Office hours:**	MW 10:30 – 11:30 a.m.

Course Page:

- Class website (with Zoom links): https://canvas.boisestate.edu/
- Simulink Tutorial: https://www.mathworks.com/learn/tutorials/simulink-onramp.html
- Control Tutorial: https://ctms.engin.umich.edu/CTMS/index.php?aux=Home

Office Hours: Monday and Wednesday 10:30 – 11:30 a.m. at RUCH 233, or by appointment.

Teaching Assistant and Grader:

- TA 1 name: Ocean Islam | email: oceanislam@u.boisestate.edu |
- TA 2 name: Ethan Cooper | email: ethancooper297@u.boisestate.edu |
- Grader name: Jonathan Wadsworth | email: jonathanwadswort@u.boisestate.edu |
- Office hours: Please see Canvas.

Prerequisites: This class requires an understanding and working knowledge of differential equations (MATH 333), Laplace transforms, and basic physics.

Course Description: This course is designed to equip students with the fundamental theories and methodologies that are used in modeling, simulating, and controlling physical dynamical systems.

Learning Outcomes:

- Model dynamical systems in time and Laplace domains,
- Simulate dynamical systems numerically,
- Understand Laplace transforms and transfer functions,
- Describe dynamical systems with block diagrams,
- Understand and analyze system responses,
- Determine the stability of dynamical systems,
- Design feedback controllers to stabilize dynamical systems,
- Design feedback controllers to meet performance specifications.

Texts and Materials: You can order the book on the Boise State bookstore, on Amazon, or directly from Wiley. Ordering the book through Wiley after getting a student IEEE membership will give you a 35% discount. Please see this link for the discount code. You need to log in with your IEEE credentials first.

- J. Chiasson, *An Introduction to System Modeling and Control*, Wiley, 2022.
- Course Contents: Chapters 1-10 of *An Introduction to System Modeling and Control*.

Grading Policy: Homework (5%), Midterm Exam #1 (30%), Midterm Exam #2 (30%), Final (35%).

- Homework must be submitted on the due date and time on Canvas. Extensions may be granted for special circumstances and only when requested at least one day in advance.
- Two questions will be selected at random from the homework for grading.
- You are responsible for all the information given in class verbally and/or in writing. Any information about the course on the web may be superseded by the information given in the class.

Important Dates:

Midterm Exam #1 ..... October 13, 2025
Midterm Exam #2 ..... November 19, 2025
Final Exam ..... December 17, 2025

Course Policy:

- All exams are comprehensive, closed book, and closed notes.
- Calculators are not allowed in the exams.
- Write legibly and present your work neatly.
- Your solution to the problem must follow a logical progression.
- Staple all the pages of everything you submit as hard copy.
- Requests for regrading must be submitted no later than one week after the exam is returned.

Class Policy:

- Class participation and cooperation among students are highly encouraged.
- Student feedback will be collected throughout the semester and adaptation will be undertaken.
- Extra lectures or problem solving sessions may be scheduled when necessary.

Academic Honesty: Academic dishonesty is **NOT** tolerated. Students are responsible for reading and understanding the student code of conduct. For more information, click here.

Make-up Policy: Students are eligible for a make-up exam if they miss a scheduled exam due to a death in the immediate family, serious illness or military service.

- Students are responsible for informing the instructor of their excused absence as soon as possible and their excused absence must be *officially verified*.
- If your excuse is acceptable, you will be given a single *comprehensive* make-up exam, which will be delivered during the last week of the classes.

Disabilities Policy: Students with disabilities needing accommodations to fully participate in this class should contact the Educational Access Center.

Interesting Control Videos

- Principles of flight: https://youtu.be/5O-j0w-h7v0?si=9x50juEV-yhy2Piw
- Aircraft systems – flight controls: https://youtu.be/WhQ8Ai4fa_Q?si=5djCsejuDfPLlF6c
- Aircraft control surfaces explained: https://youtu.be/XxrdhJanotw?si=6nhlhUsJDhOpx8If
- Aerodynamics: https://youtu.be/edLnZgF9mUg?si=T0lYxaFjtsMs6F5n
- Cyclorotor Pitch Aeronautics:

  - https://youtu.be/aKa7rO4v5L8?si=8-JGTSBnCxTK0xh-
  - https://youtu.be/S9F0jz4eqNY?si=cvlADvdSY2WxLzzs
- Steve Karp animation – flight controls: https://youtu.be/AiTk5r-4coc?si=4-CGtoDhI5Nc8LG8

Tentative Course Outline:

- Week 1: Introduction
  - Aircraft, quadrotors, inverted pendulum, magnetic levitation
  - General control problem
- Week 2: Laplace Transforms
- Week 3 – 4: Differential Equations and Stability
  - Phasor method of solution
  - Final value theorem
  - Stable transfer functions
  - Routh-Hurwitz stability test
- Week 5: Mass-Spring-Damper Systems
- Week 6: Rigid Body Rotational Dynamics
  - Moment of inertia
  - Newton's law of rotational motion
  - Gears
- Week 7: The Physics of the DC Motor
  - Magnetic force
  - Single-loop motor
  - Faraday's law
  - Dynamic equations of the DC motor
  - Optical encoder model
- Week 8: Block Diagrams
- Week 9 and 10: System Responses
  - First-order system response
  - Second-order system response
    - transient response and closed-loop poles
    - peak time t_p and percent overshoot M_p
    - settling time t_s and rise time t_r
    - choosing the gain of a proportional controller
  - Second-order systems with zeros
  - Third-order systems
- Week 11 – 12: Tracking and Disturbance Rejection
  - Servomechanism
  - Control of a DC servo motor
  - Theory of tracking and disturbance rejection
  - Internal model principle
  - Design example: PID control of aircraft pitch
- Week 13 – 14: Pole Placement, 2-DoF Controllers