

BE/ME/MS500 A2/A4: Introduction to Biological Feedback Control
Course Syllabus, Spring 2025

Instructors: Dr. Elise Morgan (efmorgan@bu.edu)
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Course Schedule: M-W 4:30-6:15 pm, ERB 203

Visiting Hours:** Dr. Morgan, Wed 12 pm – 1:00 pm, 44 Cummington Mall, room 601. Dr. Luan, Wed 3:30 - 4:30 pm, 110 Cummington Mall, room 236

Summary. Examination of the basic concepts of feedback control from different perspectives in natural sciences and engineering. Discussion of the fundamentals of current understanding of how biological systems use feedback control, foundational analytical principles of feedback control from mechanical and electrical engineering, and juxtaposition of the biological and engineering bodies of knowledge. Course goals are: 1) to connect each student's prior, discipline-specific understanding of feedback control to a common framework; 2) to expose students to the concept of mathematical modeling of feedback in systems, including biological examples of feedback control; and 3) to provide instruction in and experience working in multi-disciplinary teams.

Course Outcomes. As an outcome of completing this course, students will:

1. Be able to define and apply key terms in feedback control, such as robustness, stability, negative feedback, positive feedback, feed-forward, sensitivity, transfer functions, equilibrium, homeostasis, open- vs. closed-loop systems, linear vs. nonlinear systems, and linearization
2. Understand the principles and consequences of several feedback mechanisms in biological systems and in engineered systems
3. Create mathematical representations of simple mechanical, electrical, and biological systems, and identify stability criteria for each
4. Contribute to class discussions on both quantitative and qualitative topics
5. Describe characteristics of a well-functioning team, and demonstrate an ability to use tools and strategies associated with working successfully on a team

Prerequisites: At least one college-level calculus course. At least one high-school level biology course.

Readings: Distributed on Blackboard

Grading:	25%	Class Participation
	25%	Mini Project
	20%	Homework
	30%	Course Project

Homework: Assignments will be announced in class and posted to Blackboard. Assignments will be

* Visiting hours (also known as office hours) are the times we set aside specifically to be available for students in my courses. During these times, we will be in our offices and ready for students to drop in with questions or topics they want to discuss. We enjoy working with students one-on-one and in small groups, so we encourage you to drop by.

submitted digitally through GradeScope. Late homework will not be accepted except in extreme circumstances, because late submissions delay the release of solutions for everyone. It's the responsibility of the student to confirm they have appropriate access to Blackboard and GradeScope.

Mini-Project and Course Project: These will each be a team project and will involve researching and analyzing a problem in biological feedback control. These projects are meant to help you develop your skills in working on a team and in analyzing cases of feedback control.

Collaboration:

A. Homework: Do it individually. Some group collaboration is permitted, but all work turned in must be in your own words and accurately represent your understanding. Sources (including people) consulted while completing the assignment must be acknowledged.

B. Projects: These are group collaborative projects. It is anticipated there will be some division of labor. For each project, the team will hand in one report and make one presentation.

Accommodations:

Accessibility. If you have or believe you might have a disability that requires accommodations, please contact the Office for Disability Services (ODS) at (617) 353-3658 to coordinate any reasonable accommodation requests. I will make every effort to accommodate such requests. It's the responsibility of the student to notify me of the accommodation at least one week prior to due date in the case of a homework assignment and at least four weeks prior to the due date of a project. For more information: <http://www.bu.edu/disability/accommodations/>

Religious/Cultural Observance. Students who have religious/cultural observances that impede class attendance and/or conflict with due dates should let me know in person and by email by the end of the 2nd week of the semester.

Mental Health and Well-Being. If you or someone you know is feeling anxious, overwhelmed, depressed, or otherwise in need of support, expert resources are available on campus. For help, please see <https://www.bu.edu/shs/behavioral-medicine/behavioral-resources/>

Ethical Responsibilities:

Cheating on homework or any form of assignment is not allowed. Plagiarism and other forms of cheating are a serious academic offense and should not be taken lightly. Understanding and upholding your ethical responsibilities is an integral part of becoming a professional.

Please recall that when you enrolled at Boston University, you agreed to an Academic Honesty Pledge. The Academic Conduct Code details your responsibilities as well as the results of code violations, and is posted at: <https://www.bu.edu/academics/policies/academic-conduct-code/>. If you have questions about whether you should give credit to a source, you may ask me for advice.

Regarding use of generative AI (e.g., ChatGPT): Any use of AI tools should be for enhancing your development as a learner, scientist, writer, communicator, and thinker. When using these tools, there are always two risks. First, that you will be led astray by incorrect information that AI tools sometimes provide, and second, that you will impair further development of your own capabilities. I hope that you are approaching this course as an opportunity to learn rather than a series of assignments you need to complete by any means possible. While you may use AI tools in this course, you are responsible both for the validity of the work you turn in and for how much you learn in this course. This course's policy on acknowledging use of AI tools follows that put forth by Computing and Data Sciences (<https://www.bu.edu/cds-faculty/culture-community/gaia-policy/>), "When using AI tools on assignments, add an appendix showing (a) the entire exchange, highlighting the most relevant sections; (b) a description of precisely which AI tools were used (e.g. ChatGPT private subscription

version or DALL-E free version), (c) an explanation of how the AI tools were used (e.g. to generate ideas, turns of phrase, elements of text, long stretches of text, lines of argument, pieces of evidence, maps of conceptual territory, illustrations of key concepts, etc.); (d) an account of why AI tools were used (e.g. to save time, to surmount writer's block, to stimulate thinking, to handle mounting stress, to clarify prose, to translate text, to experiment for fun, etc.)."

Attendance, Participation, and Climate:

Attendance and participation are very important in this course, and they correlate strongly with student success. Because your success is important to me, I encourage you to come to class prepared and to speak up: ask a question if something isn't clear; let me know if I'm going too fast (or too slow!); volunteer to answer a question even if you aren't sure of the answer.

We all have a shared responsibility to create a positive learning environment in the course. Honest and respectful dialogue, and listening attentively to each other, are important. Expression of different views, and even disagreement, is encouraged, but must be phrased in a respectful way. I will not tolerate hostility, personal attacks, or other forms of exclusionary behavior towards any member of the class. Some of the in-class activities and other assignments in this course involve working in groups, and I expect each person to work towards creating a positive learning environment within their group.