

Control of Mechanical Engineering Systems

EML 4312 Section 8C52

Class Periods: MWF 3 (11:00am-12:15pm)

Location: Your Favorite Internet-Accessible Location

Academic Term: Summer C 2023

Instructor:

Jonathan Brooks

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(352) 294-0472

Office Hours: TBD

Student Assistants: TBA

Course Description

Theory, analysis, and design of control systems, including mechanical, electromechanical, hydraulic, pneumatic, and thermal components and systems. Credits: 3

Course Pre-Requisites / Co-Requisites

Pre-requisites: MAP 2302

EGM 3344

EGM 3401

Elementary Differential Equations

Introduction to Numerical Methods of Engineering Analysis

Engineering Mechanics – Dynamics

Course Objectives

This course is intended to instruct engineering students on fundamental aspects of feedback control. The focus will be on classical control design and analysis techniques. Numerical simulation of feedback control systems using mathematical software will be stressed. The course is not intended to teach students topics such as programming industrial controllers.

By the end of this course, you should be able to:

- Recognize feedback when you see it.
- Describe what feedback control is, and its pros and cons, to a layperson.
- Use the Laplace transform to describe the transfer function of engineering systems and determine the time domain response to a wide range of inputs.
- Determine transfer function and state-space description of a linear dynamical system from its governing differential equations.
- Visualize feedback interconnections through block diagrams.
- Analyze stability of such a system and determine its frequency response.
- Design controllers for a class of systems arising in mechanical and aerospace engineering systems to meet stability and performance requirements.
- Perform numerical simulation of feedback control systems using MATLAB/Simulink.

Materials and Supply Fees

None

Relation to Program Outcomes (ABET):

This course contributes to enhancing the students' knowledge of advanced mathematics through multivariable calculus, differential equations, and linear algebra. This course also contributes to the students' ability to work professionally in mechanical and aerospace systems areas including design and analysis of such systems. The course supports several program outcomes in the Mission Statement of the Department of Mechanical and Aerospace Engineering. Specific ME and AE program outcomes supported by this course include:

(1) Using knowledge of advanced mathematics through multivariate calculus and differential equations (ME and AE Program Outcomes M2 and A2);

(2) Be familiar with linear algebra (ME and AE Program Outcome M3 and A3);

(3) Possess knowledge of stability and controls (AE Program Outcome A5).

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Low
3. An ability to communicate effectively with a range of audiences	Low
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	High

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbooks and Software

- **Title:** *Control Systems Engineering (8e) with zyLabs*
- **Author:** Norman S. Nise
- Instructions for accessing this e-book will be given on Canvas
- Software: MATLAB Student Version (**any recent version** should be fine)
We will be using MATLAB's Controls Systems Toolbox and Simulink
 You may consider using UFApps to access a number of popular software applications for "free" including MATLAB at: <http://info.apps.ufl.edu/>
MATLAB is also available for purchase and download at
http://www.mathworks.com/academia/student_version/index.html

Recommended Textbooks

- **Title:** *An Introduction to Feedback Control*
- **Author:** Prabir Barooah
- **ISBN:** 978-1542497923

Tentative Course Schedule

Week	Topics	Estimated Assignments
1	Feedback; mathematical preliminaries	

2	Linear systems; linearization of nonlinear systems; Laplace transforms	HW1
3	Transfer functions	HW2
4	Stability	HW3
5	Impulse response; step response	Exam 1
6	Second-order systems	HW4
7	Block diagrams; PID control design	Exam 2
8	Root locus	HW5
9	Root locus; frequency domain	Exam 3
10	Bode plots	HW6
11	Frequency-domain controller design	HW7
12	Frequency-domain controller design; state-space systems	Exam 4

Pre-Recorded Lectures (No Live Class):

Wednesday, May 31st

Friday, June 2nd

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance

- Regular class attendance is expected although not explicitly included in the grade evaluation.
- The course will be delivered online. A Zoom conference will be created for each lecture for students to attend synchronously. Lectures will be recorded and posted online for asynchronous attendance.

Homework

- HW will be posted on Canvas along with its due date.
- HW will be turned in on Canvas.
- Some or all assigned problems will be graded for each assignment. You are required to complete all assigned problems.
- Late HW will be accepted up to 24 hours after the due date with a maximum-grade penalty of 20 points. If you have an absolute doomsday of a week, this is your safety valve. Hardship cases will be considered on an individual basis and only if the instructor has been contacted before the due date of the assignment. Students with hardship cases (e.g., due to medical problems) will be referred to the Dean of Students office, which will perform a background investigation to determine if the hardship is legitimate.
- If you do not agree with the grading of a HW problem, you will have one week from the date the HW is returned to submit a written argument of why you think the grade should be higher. However, the final decision will remain the instructor's.

Exams

- Exams will be open-book and open-notes.
- Exams will be conducted online via Honorlock. A webcam is required for Honorlock.
- An Honorlock calculator will be provided. No other calculators are allowed during exams.
- Exam problems may be taken directly from the homework problems or from lecture discussions with some modifications. Thus, in addition to the weight placed on homework in the final grade, it is to your advantage to understand as many of the homework problems as possible. The emphasis of the exams will be to test your understanding, not on formulaic repetition, so expect the exam problems to be challenging and to test your grasp of the methods taught in the class.
- Makeup exams are only allowed for students with extreme, documented circumstances. Students must contact the instructor as soon as possible to provide documentation and request a make-up exam. Excused absences must be consistent with university policies in the undergraduate catalog and require appropriate documentation.

- If you do not agree with the grading of a particular exam problem, you will have one week from the date the exam is returned to submit a written argument of why you think the grade should be higher. However, the final decision will remain the instructor's.

E-learning course web site (Canvas)

- Students are expected to check Canvas on a regular basis for up-to-date course information. This may include changes to the syllabus, homework assignment due dates, and exam schedules.

Syllabus

- Any changes to the syllabus (e.g., tentative exam dates) will be announced to the class.

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies:

<https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

Evaluation of Grades

Assignment	Percentage of Final Grade
Homework	20%
Project	10%
Lowest Exam	15%
2 nd Lowest Exam	15%
2 nd Highest Exam	20%
Highest Exam	20%
	100%

Your grade will be calculated according to the above weights. The grade shown on Canvas is likely different from your actual grade.

Tentative Exam Dates (all times eastern US)

Thursday, June 8th, 8:00pm-9:30pm

Thursday, July 6th, 8:00pm-9:30pm

Thursday, July 20th, 8:00pm-9:30pm

Thursday, August 10th, 8:00pm-9:30pm

Grading Policy

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Cheating at the University of Florida is unacceptable and will not be tolerated. While learning together and collaboration in the interest of learning are welcome, cheating and plagiarism are not. You are welcome to work with others to learn, but your work must be your own. If you need help with a problem, do not search for someone else’s solution online. Using solutions such as those on Chegg is an Honor Code violation in this class. Instead, **come to office hours to get help from the SAs or myself!** We are the most direct and Honor Code-approved method of getting help in the class. *Use us!*

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <https://distance.ufl.edu/state-authorization-status/#student-complaint>.