Control of Mechanical Engineering Systems
EML 4312   Section 421D
Fall 2022
MWF, Period 9, 4:05 – 4:55 pm
MCCB G086

Modifications to this syllabus may be required during the semester. Any changes will be posted on Canvas.

Instructor:
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Office Hours: MW 5 – 6 pm, MAE-B 224; or via confirmed written appointment

Teaching Assistant:
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Course Description
Theory, analysis and design of control systems, including mechanical, electromechanical, hydraulic, pneumatic, and thermal components and systems. (Credit: 3)

Course Pre-Requisites / Co-Requisites
EGM 3401 (Engineering Mechanics –Dynamics), EGM 3344 (Introduction to Numerical Methods of Engineering Analysis), and MAP 2302 (Elementary Differential Equations) with minimum grades of C.

Course Objectives
By the end of this course, you should be able to do the following:
- Write differential equations describing the behavior of engineering systems.
- Use the Laplace transform to describe the transfer function of engineering systems and determine the time domain response to a wide range of inputs.
- Use state-variable equations to model engineering systems and determine their time response to a wide range of inputs.
- Describe the advantages of feedback control.
- Analyze the performance of control systems.
- Determine the stability of control systems using root locus and Bode methods.
- Design feedback control systems using frequency domain, root locus and state-variable methods.

Materials and Supply Fees
None.

Textbooks and Software
- *No textbook is required.* A couple of optional textbooks are listed below. No reading or problems will be assigned from these optional textbooks.
- (Required) MATLAB, any release since 2014 with Control System Toolbox.
- (Optional) Richard C. Dorf and Robert H. Bishop, "Modern Control Systems," Pearson.
- (Optional) Gene F. Franklin, et. al., "Feedback Control of Dynamic Systems," Pearson
- (Optional) Karl Johan Åström and Richard M. Murray, "Feedback Systems: An Introduction for Scientists and Engineers Book," Princeton University Press

Important Dates
- Prelim 1: Thursday, October 6th (Online Exam)
- Prelim 2: Friday, November 4th (Online Exam)
- Project Submission Due: Wednesday, December 7th (via Canvas)
- Final Exam: TBD

Course Schedule, Approximately by Lecture Number

No.	Topics	Dorf&Bishop
1	Introduction to Systems	Ch. 1, 2.1, 2.2
2	Linearity, Linearization, Linear Systems	Ch. 2.3
3	Laplace Transforms	Ch. 2.4
4-5	Transfer Functions and Block Diagrams	Ch. 2.5, 2.6
	Approximate End of Coverage for Homework #1 (Due Wednesday, Sep. 7)	
6	Impulse Response	Ch. 5.1, 5.2
7	First-order Systems	Ch. 2.8
8-9	Second-order Systems	Ch. 5.3
	Approximate End of Coverage for Homework #2 (Due Wednesday, Sep. 21)	
10-11	Stability	Ch. 2.4, 2.9
12	Transient Analysis	Ch. 2.4, 5.3, 5.5
	Approximate End of Coverage for Homework #3 (Due Wednesday, Sep. 28)	
13-14	Reference Tracking	Ch. 5.6
15-16	PID Control	Ch. 7.6
17	Routh-Hurwitz Stability Criterion	Ch. 6.1, 6.2
	Approximate End of Coverage for Homework #4 (Due Wednesday, Oct. 5)	
	Approximate End of Coverage for Prelim 1 *Prelim 1 is on Thursday, October 6th (Online Exam)*	
18-20	Root Locus Introduction and Rules	Ch. 7.1-4, 7.6, 7.11
21-22	Introduction to Bode Plots and Rules for Drawing	Ch. 8.1, 8.2
	Approximate End of Coverage for Homework #5 (Due Wednesday, Oct. 26)	
23-24	More Bode Plots	Ch. 8.2
25	Converting Bode Plots to Transfer Functions	Ch. 8.3, 8.9
26-27	Gain and Phase Margin	Ch. 8.6, 8.7
	Approximate End of Coverage for Homework #6 (Due Wednesday, Nov. 2)	
	Approximate End of Coverage for Prelim 2 *Prelim 2 is on Friday, November 4th (Online Exam)*	
28-29	Nyquist Plot Criterion	Ch. 9.3
30	Introduction to State Space	Ch. 9.1-4
31	Review of Linear Algebra	App. E, Ch. 3.6, 3.7, 3.9
32	Stability in State Space	Ch. 6.4
33	Controllability	Ch. 11.1, 11.2
	Approximate End of Coverage for Homework #7 (Due Wednesday, Nov. 30)	
34	Solutions in State Space	Ch. 11.2
35	State Space Motor Control	
36	State Space Robot Control	
37	Review for Final Exam	Ch. 11.4

Attendance Policy
Regular class attendance (In-person or Zoom) is expected although not explicitly included in the grade evaluation.

Exam Make-Up Policy
Instructor notifications are required. See https://care.dso.ufl.edu/instructor-notifications. Note that, "Professors have the right to accept or reject the notification."

Exam Policy
All exams are closed-book, closed-notes, closed-electronic devices. A cheat sheet (one page, two sided) will be allowed during exams. *Students must complete the exam independently; working together on exams is forbidden and considered cheating.* Posting any portion of an exam online is also forbidden and considered cheating.

Honorlock
Consistent with UF policy, Honorlock may be used for course assessments and will be confirmed by the instructor in advance. Please see https://distance.ufl.edu/proctoring/ for more information.

Cheating
All instances of cheating will be referred to Honor Court. Anyone found to have cheated will receive an E grade for the course.

Evaluation of Grades

Assignment	Percentage of Final Grade
Homework	30%
Project	20%
Prelim 1	15%
Prelim 2	15%
Final Exam	20%

Grading Policy

Homework
> Homework submissions must only be submitted through Canvas. The lowest score in homework will be dropped in the final grade. Since the homework solutions are released right after the submission deadline, late homework are NOT accepted under any circumstances.

Project
> Project report must only be submitted through Canvas. Late submissions are accepted up to 24 hours after the due date with a maximum-grade penalty of 20 points.

Exams
> All students are expected to take all exams. If a student is unable to take an exam for unforeseeable reasons, then the instructor will schedule an alternative option if an appropriate instructor notification is accepted.

Grade Corrections
> Corrections of grades should be submitted promptly within 3 business days of the grade posting in writing with a concise statement of why you believe there has been an error. Note that the instructor has the final determination in the grade assigned.

Final Grade
> Students are guaranteed to earn the grade point shown in the table based on their percent earned grade. For example, if a student earns 88.60% (Percent Grade Earned %GE = 88.60) then their grade point will be 3.33 (B+). %GE are rounded to the hundredths

decimal place. For example, if a student earns 79.995% (Percent Grade Earned %GE = 79.995) it will be rounded up to 80.00%, and their grade will be 2.67 (B-). Higher grades can be assigned if the class is curved.

Percent Range	Grade	Grade Points
$93.33 \leq \%GE < 100.00$	A	4.00
$90.00 \leq \%GE < 93.33$	A-	3.67
$86.67 \leq \%GE < 90.00$	B+	3.33
$83.33 \leq \%GE < 86.67$	B	3.00
$80.00 \leq \%GE < 83.33$	B-	2.67
$76.67 \leq \%GE < 80.00$	C+	2.33
$73.33 \leq \%GE < 76.67$	C	2.00
$70.00 \leq \%GE < 73.33$	C-	1.67
$66.67 \leq \%GE < 70.00$	D+	1.33
$63.33 \leq \%GE < 66.67$	D	1.00
$60.00 \leq \%GE < 63.33$	D-	0.67
$0.00 \leq \%GE < 60.00$	E	0.00

More information on UF grading policy may be found at:
http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades

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.

Use of Live Zoom
In light of the challenge of the pandemic, the instructor may live stream to those who are sick or just quarantining. Associated recordings may be made. Regarding associated details, the instructor will update the class throughout the semester.

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 Conduct 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. If you have any questions or concerns, please consult with the instructor or TAs in this class.

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/.

COVID-19
- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.

- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the [UF Health Screen, Test & Protect website](#) for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

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 Resource 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: http://www.distance.ufl.edu/student-complaint-process.