

Control of Mechanical Engineering Systems

EML 4312

Class Periods: MWF, period 6, 3:30pm to 4:35pm

Location: Yo' Place

Academic Term: Summer C 2020

Instructor:

Jonathan Brooks

brooks666@ufl.edu

Office Hours: 5pm-6pm Sunday, 9pm-10pm Monday, 6pm-7pm Wednesday, 10am-11am Friday

Teaching Assistants:

- Alex Benvenuti, abenvenuti@ufl.edu, 12am-1am Monday, 2pm-3pm Friday
- Damon Ghetmiri, s.ghetmiri@ufl.edu, 1pm-2pm Tuesday, 12pm-1pm Thursday
- Jhon Ibanez, jibanez@ufl.edu, 6pm-7pm Friday, 6pm-7pm Saturday
- Andrew Ouellette, andrew.ouellette@ufl.edu, 5:30pm-6:30pm Tuesday, 5:30pm-6:30pm Thursday
- Andrew Tumlin, a.tumlin@ufl.edu, 2pm-3pm Monday, 2pm-3pm Wednesday

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.

Upon completion of the 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

Professional Component (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 enumerated 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 Program Outcomes M2); (2) Be familiar with linear algebra (ME Program Outcome M3); (3) Possess knowledge of stability and controls (AE Program Outcome A5). The content of the course is 30% engineering design, 30% mathematics, and 40% engineering science.

Relation to Program Outcomes (ABET):

Outcome	Coverage*
a. Apply knowledge of mathematics, science, and engineering	High
b. Design and conduct experiments, as well as analyze and interpret data	
c. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	High
d. Function on multidisciplinary teams	
e. Identify, formulate, and solve engineering problems	High
f. Understand professional and ethical responsibilities	
g. Communicate effectively	Low
h. Understand the impact of engineering solutions in a global, economic, environmental, and societal context	
i. Recognize the need for and be able to engage in lifelong learning	Low
j. Understand contemporary issues	
k. Use the techniques, skills, and modern engineering tools necessary for engineering practice	High

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

Required Textbooks and Software

- Title: *An Introduction to Feedback Control*
- Author: Prabir Barooah
- ISBN: 978-1542497923
- Software: MATLAB Student Version (**any recent version** should be fine)
We will be using MATLAB's Controls Systems Toolbox
 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

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance

- Regular class attendance is expected although not explicitly included in the grade evaluation.

Homework

- Homework will be posted on Canvas along with its due date.
- Homework will be graded on completion. Completion means an honest effort. If you are unsure if you have done enough to constitute an honest effort, that means you have not.
- Due dates for homework assignments will be provided on the assignment files.
- Homework will be turned in on Canvas.
- You may submit your homework up to 24 hours after the due date, but your grade will be truncated down to 80.
- Hardship cases for late homework 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 homework problem, you will have one week from the date the homework 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

- There will be four exams: one at the end of May, one before summer break, one toward the end of July, and one at the end of the semester.
- Exams will be closed-book and closed-notes. The instructor will announce, in class, any allowed formula sheets at least one week before the exam.
- No cell phones or programmable calculators (or anything that can store formulae) are allowed during exams with (potentially) the exception of scientific calculators (such as TI-30, Casio,...).
- 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. 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 concepts 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 (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>).
- 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.

Evaluation of Grades

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

Base 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

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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 requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

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://www.dso.ufl.edu/sccr/process/student-conduct-honor-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.

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: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.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: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

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 Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.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://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.