

ENG ME 404: Dynamics and Control of Mechanical Systems, Fall 2018

INSTRUCTOR

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Office hours: Tuesdays 2:30-3:30

TEACHING ASSISTANT

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MEETING TIME AND PLACE

Tuesday and Thursday, 1:30 - 3:15 pm, in ME 202.

INTRODUCTION AND COURSE GOALS

Systems and control theory plays a vital role across most aspects of modern life. Control systems are found in cars, appliances, cell phones, airplanes, robots, and just about anywhere you look. The goal of this course is to introduce you to the fundamental concepts in feedback control and provide you a set of tools to analyze and design controllers. The focus will be on what is known as *classical control* and topics will include modeling, feedback, transfer functions, frequency domain analysis and design, and PID control. If we're lucky we'll cover a bit of digital control, which is how it's (nearly) all done nowadays anyway. My goal is to make the class as interactive as possible and to focus on the *application and design* of controllers rather than (just) the theory and mathematics.

COURSE PREREQUISITES

All students should have taken ME 302: Engineering Mechanics II, as well as the standard math sequence. In addition, Matlab (including the Control toolbox) will be used quite heavily. If you haven't done so already, you should download and install Matlab on your computer. Information on obtaining a copy of the software can be found at:

<http://www.bu.edu/tech/support/research/software-and-programming/common-languages/matlab/>

COURSE EXPECTATIONS AND GRADING

It is my firm belief that learning is an *active* experience. While there is some traditional lecture in class, most of our time will be spent working problems. For this to work, it is essential that prior to class you read the assigned material and organize your thoughts and questions. As an indication of the importance of properly preparing for lecture, there will be short "did you read" quizzes at the start of most lectures. You can (and should!) do these simultaneously with your reading. The idea is not for you to closely study all the material prior to class but rather to familiarize yourself with the topics of the day, to think about what might be easy and what might be hard, and to come ready with questions.

As noted, the bulk of lecture will be spent addressing questions (because you should have some after doing the reading!) and doing in-class activities. These will be done in groups but everyone will have to complete them and turn them in with their next homework. Groups will be assigned by me with shuffling done periodically throughout the semester. While these in-class activities will not be graded, a portion of the homework will be based on them.

Speaking of homework- there will be some. As usual, you are welcome to discuss the regular homework with others as well but each student must perform and submit their own work. Submitted work should be neat, organized, and legible and is to be turned in by the start of class on the due date. For problems requiring Matlab, your m-file should also be submitted electronically (by e-mailing it to me).

There will be a few exams, each given at the conclusion of a major collection of topics. These will be in class.

There will be one physical lab- PID control of the flying wing apparatus.

There will be no final exam.

There will be a term project. Working in small teams, you will develop controllers for a piezoactuator in my lab. The project will be run as if you are working at a small company developing a project for me, your customer. While controller design, implementation, and test will be in Matlab, the models you use will be based on the physical system.

The overall grade will be assigned according to the following breakdown.

Prep quizzes (5%), Homework (15%), Exams (40%), Lab (15%), Project (25%)

COURSE WEBSITE

We're going to be using Slack for the course at bume404.slack.com. You should get an invite, if you haven't already.

DROP AND WITHDRAWAL DATES

The last day to **drop** the class (without a W appearing on your transcript) is 10.09.2018.

The last day to **withdraw** from the class (with a W appearing on your transcript) is 11.09.2017.

TEXTBOOK AND REFERENCES

G. F. Franklin, J. D. Powell, and A. Emami-Naeini, *Feedback Control of Dynamic Systems*, 8th Edition, Prentice Hall, 2019. (Earlier editions of the text, at least through the sixth edition, are also fine. You may just need to adjust the assigned reading.)

There are, in fact, many many textbooks on this material. A few other common ones are given below.

For linear and nonlinear control systems:

1. N. Nise, *Control Systems Engineering*, 7th Edition, Wiley, 2015.
2. K. Ogata, *Modern Control Engineering*, 5th Edition, Prentice Hall, 2009.
3. K. J. Åström and R. M. Murray, *Feedback Systems: An Introduction for Scientists and Engineers*, Princeton University Press, 2008. [Available free online at http://www.cds.caltech.edu/~murray/amwiki/index.php/Main_Page]
4. K. J. Åström and T. Hägglund, *PID Controllers: Theory, Design, and Tuning*, 2nd edition, 1995.

For more advanced material (beyond the scope of the course), I recommend the following.

1. R.W. Brockett, *Finite Dimensional Linear Systems*, SIAM, 2015.
2. H.K. Khalil, *Nonlinear Systems*, Prentice-Hall, Third Edition, 2002.

ACADEMIC INTEGRITY

BU takes academic integrity very seriously. Academic misconduct is conduct by which a student misrepresents his or her academic accomplishments, or impedes other students' opportunities of being judged fairly for their academic work. Knowingly allowing others to represent your work as their own is as serious an offense as submitting another's work as your own. More information on BU's Academic Conduct Code, with examples, may be found at <http://www.bu.edu/academics/policies/academic-conduct-code>.

COLLABORATION POLICY

In this class, when completing your homework you may use any textbooks, web sources, as well as human collaborators (from class), subject to the following enforced conditions:

- You must clearly acknowledge all your sources (including human collaborators) at the top of your homework.
- You must write all answers in your own words
- You must be able to fully explain your answers upon demand

Clearly these do not apply to exams; those cannot be done in collaboration with anyone.

Failure to meet any of the above conditions could constitute plagiarism and will be considered cheating in the class. If you are not sure whether something is permitted by the course policy, **please ask one**. It is far more awkward to explain your actions after the fact to the college disciplinary committee.