ENG ME 404: Dynamics and Control of Mechanical Systems, Fall 2016

INSTRUCTOR

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Office hours: Tuesdays, 12-1, and Thursdays, 12-1 (immediately following class)

MEETING TIME AND PLACE

Tuesday and Thursday, 10-12, in Room 202, 110 Cummington Mall.

INTRODUCTION AND COURSE GOALS

Systems and control theory plays a vital role across most aspects of modern life. Control systems are found in your car, in your appliances, in your cell phone, in your computer, 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 classical control. 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.

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. You are encouraged to install the student version of Matlab on your personal computer; this should come with the control systems toolbox. Information on obtaining/running Matlab 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. To that end I would like to try at least partially "flipping" this course. While I am not a big fan of the buzzword, I do like the concept. Here it means that prior to class you need to read the assigned material and organize your thoughts and questions. As in indication of the importance of properly preparing for lecture, there will be short "did you read" quizzes at the start of each topic. 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 and to think about what might be easy and with might be hard.

While I will do a small bit of lecturing, 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. As usual, you are welcome to discuss the homework with others but each student must perform and submit their own work. Submitted work should be neat, organized, and legible and is to be turned by the start of class on the due date. For problems requiring Matlab, your m-file should also be submitted electronically (by posting it to the Piazza site).

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 and implementation will be in Matlab (hey, my piezos are not cheap and I don't want to risk them!), the models you use will be based on the physical system.

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

Prep quizzes (10%), Homework (10%), Exams (40%), Lab (15%), Project (25%)

COURSE WEBSITE

A website has been set up on Piazza and you should have already received an invite. All course materials will be disseminated there. Note that Piazza has a nice social networking feature allowing questions to be asked and answered among yourselves; I highly encourage you to make use of it!

DROP AND WITHDRAWAL DATES

The last day to **drop** the class (without a W appearing on your transcript) is 10.12.2016.

The last day to **withdraw** from the class (with a W appearing on your transcript) is 11.10.2016.

TEXTBOOK AND REFERENCES

N. Nise, *Control Systems Engineering*, 7th Edtion, Wiley, 2015.

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. G. F. Franklin, J. D. Powell, and A. Emami-Naeini, *Feedback Control of Dynamic Systems*, 7th Edition, Prentice Hall, 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.