ENG ME 404: Dynamics and Control of Mechanical Systems, Fall 2015

INSTRUCTOR

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Office hours: TBD

MEETING TIME AND PLACE

Tuesday and Thursday, 10-12, in Room 202, 110 Cummington Mall. *Note that it is listed as taking place in Pho 202 but I engineered a room swap.*

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. Elements of both state-space (modern) and frequency (classical) control will be discussed. Topics will include modeling, feedback, transfer functions, frequency domain analysis and design, and PID control.

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. Classtime will then be spent answering questions you may have and working through problems. **I will not be introducing material or giving a lecture on the material during the lecture period!** 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 will also turn in sheets for the in-class work and those will be graded.

It is expected that doing the pre-class work will take a significant amount of time. The (positive) tradeoff, I hope, is better learning and more focused time in class. I also intend to keep the assigned weekly homeworks much lighter than they would otherwise have been since we'll be doing more in the lecture period. 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 (likely by just e-mailing it to me and the GTF).

There will be extended quizzes (or you could call them short exams, take your pick) at the conclusion of each major topic. 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.

Did-you-read quizzes (15%), In-class work (15%), Homework (10%), Extended quizzes (35%), Lab (10%), 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 10.06.2014.

The last day to **withdraw** from the class (with a W appearing on your transcript) is 11.07.2011.

TEXTBOOK AND REFERENCES

G. F. Franklin, J. D. Powell, and A. Emami-Naeini, *Feedback Control of Dynamic Systems*, 7th Edition, Prentice Hall, 2015.

Note that the sixth edition of the text, while slightly different, should also be fine.

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. K. Ogata, *Modern Control Engineering*, 5th Edition, Prentice Hall, 2009.
2. N. Nise, *Control Systems Engineering*, 6th Edtion, Wiley, 2010.
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*, Wiley (1970) [Out of print, try googling it]
2. H.K. Khalil, *Nonlinear Systems*, Prentice-Hall, Third Edition, 2002.