ENG ME/EC/SE 701: Optimal and Robust Control, Fall 2011

INSTRUCTOR

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Office hours: tbd

MEETING TIME AND PLACE

Monday and Wednesday from 2-4 in tbd.

INTRODUCTION AND COURSE GOALS

This course aims to provide a rigorous introduction to the fundamentals of both robust and optimal control. The two topics will be treated essentially independently. As each of those topics often fills (at least) an entire course, coverage will unfortunately be sparse with a greater emphases given on the optimal control portion. Under optimal control, topics will include the linear quadratic regular, the calculus of variations, the Pontryagin Maximum principle, and Hamilton-Jacobi theory. Robust control topics will include μ–synthesis, H_2 control, and H_∞ control.

COURSE PREREQUISITES

Frequency-domain (or classical) control (at the level of ME 404) and linear system theory (at the level of ME 501) is a prerequisite. Knowledge of nonlinear systems (at the level of ME 762) is not required but would be helpful. (Required material from nonlinear system theory will be introduced as needed.) The standard mathematical background is assumed (linear algebra, ODEs, some exposure to PDEs, Laplace transforms, and so on). Prior experience with Matlab is not required but is also helpful.

HOMEWORK, PROJECTS, AND GRADING

Class performance will be evaluated based on homework sets, in-class quizzes, two projects, and the somewhat ephemeral “class participation”. Homeworks will be assigned semi-regularly with the total number depending on the eventual pace of the course. While you are free to discuss your efforts, each student is responsible for submitting their own homework solution, representing their own work.

In-class quizzes will be somewhat random and will take one of two forms. The first is a standard quiz. The second is a two-part quiz. After the first part is taken and submitted, students will be put into small groups to discuss the material on the quiz. After this discussion, students will individually take the second part.

The class-participation component will be judged based on two factors. The first is the response to in-class questions during the lecture. The second is participation in group discussions (such as in the two-part quizzes mentioned above). While somewhat hard to judge, feedback on this component will be provided periodically and will always be available by request.

The projects will be done in teams (with team sizes depending on course enrollment). In the first project, the group will select a paper and supporting topic from a list provided by me. They will then prepare and deliver a presentation on those items. Details will be provided at the appropriate time.

The second project will involve the application of a method (or methods) from the course to a problem of the team’s choice, a written report, and an oral presentation. Some example problems will be provided by me, though teams are encouraged to propose their own (hopefully based on their research). Again, details will be provided at the appropriate time.

The weighting of these components is as follows:

Homework (30%), Quizzes (20%), Project 1 (20%), Project 2 (25%), Participation (5%)

COURSE WEBSITE

A website will be setup on blackboard.bu.edu. All course materials will be disseminated there.

DROP AND WITHDRAWAL DATES

The last day to **drop** the class (without a W appearing on your transcript) is 10.11.2011.

The last day to **withdraw** from the class (with a W appearing on your transcript) is 11.11.2011.

TEXTBOOK AND REFERENCES

No textbook is required. I will be working out of personal notes and some of the references noted below.

For optimal control:

1. L.S. Pontryagin, V.G. Boltyansky, R.V. Gamkrelidze, and E.F. Mishchenko, *The Mathematical Theory of Optimal Processes*, Interscience, 1962.
2. A. E. Bryson and Y. -C. Ho, *Applied Optimal Control: Optimization, Estimation, and Control*, Taylor and Francis, 1975.
3. B.D.O. Anderson and J.B. Moore, *Optimal Control: Linear Quadratic Methods*, Dover Publications, 2007.
4. M. Athans and P. L. Falb, *Optimal Control: An Introduction to the Theory and Its Applications*, Dover Publications, 2006.

For robust control:

1. K. Zhou and J. C. Doyle, *Essentials of Robust Control*, Prentice Hall, 1998.
2. K. Zhou, J. C. Doyle and K. Glover, *Robust and Optimal Control*, Prentice Hall, 1995.
3. G. E. Dullerud and F. Paganini, *A Course in Robust Control Theory: A Convex Approach*, Springer Verlag, 2000.

For linear and nonlinear control systems:

1. G. F. Franklin, J. D. Powell, and A. Emami-Naeini, *Feedback Control of Dynamic Systems*, 6th Edition, Prentice Hall, 2009.
2. K. J. Åström and R. M. Murray, *Feedback Systems: An Introduction for Scientists and Engineers*, Princeton University Press, 2008. [Available also online]
3. R.W. Brockett, *Finite Dimensional Linear Systems*, Wiley (1970) [Out of print]
4. H.K. Khalil, *Nonlinear Systems*, Prentice-Hall, Third Edition, 2002.