COURSE GOALS

This course is aimed at an introduction (with rigorous treatment) to the fundamentals of optimal and robust control. It will be divided roughly into two parts. The first will cover spects of robust control including model reduction, H_2 and H_∞ control, and feedback control of uncertain systems. The second will delve into optimal control including topics such as the linear quadratic regulator, the calculus of variations, and the maximum principle.

MEETING TIME AND PLACE

Monday and Wednesday from 2-4 in PSY B36.

INSTRUCTOR

Prof. Sean Andersson

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COURSE PREREQUISITES

ENG ME 501 or a similar course on linear system theory is a pre-requisite as is some exposure to frequency-domain control. Knowledge of nonlinear control at the level of ENG ME 762 would be useful but is not required. I also assume you have the standard mathematical background (linear algebra, ODEs, some exposure to PDEs, Laplace transforms, etc.).

HOMEWORK, EXAMS AND GRADING

Homework will be assigned semi-weekly with a target of 6-10 sets for the semester. There will be two in-class exams at dates yet to be determined. You will also present one paper (to be selected from a list provided by me) and complete a final project. You will propose a final project approximately halfway through the semester. At the end of the semester you will submit a final report (in the form of a short conference paper) and make a presentation.

The breakdown in weighting for the final grade is: homework (25%), exams (20% each), paper presentation (10%), and project (25%).

CORE TOPICS

1. **Model realizations and reduction**: Balanced realizations, model reduction
2. **$\mathbf{H_2}$ and $\mathbf{H_\infty}$ control**
3. **Feedback control of uncertain systems**
4. **Linear quadratic optimal control**: fixed and free end point, finite and infinite time horizon
5. **The calculus of variations**: Euler-Lagrange in finite and infinite dimensions
6. **Pontryagin's maximum principle:** linear and nonlinear dynamics, fixed and free end time, minimum time
7. **Dynamic programming:** Discrete and continuous time (Hamilton-Jacobi-Bellman equation)

TEXTBOOK AND REFERENCES

There is no required textbook for this course. A (very short) list of references is:

1. R.W. Brockett, *Finite Dimensional Linear Systems*, Wiley (1970) [Out of print]
2. L.S. Pontryagin, V.G. Boltyansky, R.V. Gamkrelidze, and E.F. Mishchenko, *The Mathematical Theory of Optimal Processes*, Interscience, 1962.
3. J. Macki and A. Strauss, *An Introduction to Optimal Control Theory*, Springer-Verlag, 1982.
4. B.D.O. Anderson and J.B. Moore, *Optimal Control: Linear Quadratic Methods*, Prentice-Hall, 1990.
5. G.E. Dullerud and F. Paganini, *A Course in Robust Control Theory: A Convex Approach*, Springer, 2000.
6. K. Zhou and J.C. Doyle, *Essentials of Robust Control*, Prentice-Hall, 1998.
7. K. Zhou, J.C. Doyle, and K. Glover, *Robust and Optimal Control*, Prentice-Hall, 1996.
8. Skogestad and Postlethwaite, *Multivariable Feedback Control*, Wiley, 1996.
9. Green and Limebeer, *Linear Robust Control*,Prentice-Hall, 1995.