ECE 580 Optimization by Vector Space Methods Spring, 2008

Prof. Sean Meyn, meyn@uiuc.edu Mon. & Weds., 11-12:30, 106B6 Engg. Hall

This is an introductory course in functional analysis and infinite dimensional optimization, with applications in least-squares estimation, nonlinear programming in Banach spaces, optimal and robust control of lumped and distributed parameter systems, and differential games.

Office hours Held at Giuliani's Coffee Shop, 608 E. Green St. — Hours to be announced.

Exams, homework, and grading
Homework is available at http://black.csl.uiuc.edu/~meyn/pages/ECE 580/580hw.html

Homework problems will be assigned on a weekly basis, to be handed in at the beginning of class on the date due. They will be graded and returned the following week. *Late homework cannot be accepted.*

There will be one evening midterm on March 5, 7-8:30 p.m., a final project, and a final exam.

References: The following textbooks are on reserve in the Engineering Library. Luenberger's excellent monograph is the course text.

512.523L96o Luenberger, David G.; Optimization by Vector Space Methods

515.7t21i Taylor, Angus; Introduction to Functional Analysis

510m435v.132 Curtain/ Pritchard; Functional Analysis in Modern Appled Mathematics

515.7b18a Balakrishnan, A.V.; Applied Functional Analysis

515.7246d91l v.1 c.4 Dunford, Nelson; Linear Operators

515.7l74e:e c.3 Liusternik/ Sobolev; Elements of Functional Analysis

Course Outline

1. An introduction to functional analytic approach to optimization; Finite- versus infinite-dimensional spaces; Application examples
2. Normed linear spaces
3. Optimization of functionals – General results on existence and uniqueness of an optimum
4. Fixed points of transformations on Banach Spaces – Applications to solutions of differential
5. Hilbert Spaces – The Projection Theorem; Minimum distance to a convex set
6. Examples of complete orthonormal sequences; Wavelets
7. Hilbert Spaces of random variables and stochastic processes; Least-squares estimation
8. Dual Spaces. The Hahn-Banach Theorem, with applications to minimum norm problems
9. Linear operators and adjoints
10. Calculus in Banach Spaces; Gateaux and Frechet derivatives. Local theory of unconstrained optimization; Euler-Lagrange equations
11. Global theory of unconstrained optimization; Fenchel duality theory
12. Constrained optimization of functionals; Local and global theory. Nonlinear programming and the Kuhn-Tucker Theorem in infinite dimensions
13. Optimal control and Pontryagin's Minimum Principle
14. Other related topics of interest from computer science, control, or statistics as time and interest permits.