Syllabus for ELE 530
Theory of Detection and Estimation
Spring 2009

Instructor: Prof. Fernando Pérez-Cruz

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Class Meets: Room Friend 112 MW 3:00-4:20

Course Description

The subject of signal detection and estimation is concerned with the processing of information-bearing signals for the purpose of making inferences about the information that they contain. The purpose of this course is to provide an introduction to the fundamental theoretical principles underlying the development and analysis of techniques for such processing. The level of this course is suitable for research students in communications, control, signal processing, computer science, and related areas.

Textbook:

- *An Introduction to Signal Detection and Estimation,* Second Edition, H. Vincent Poor

Additional Reading:

- *Linear Estimation*, Kailath, Sayed, Hassibi
- *All of Statistics*, L. Wasserman
- *Learning With Kernels*, B. Schölkopf and A. Smola.
- *Graphical Models for Digital Communications and Image Processing*, B. Frey.

Course Web Page and Announcements

http://www.princeton.edu/∼fp/ELE530.html

Tentative Course Schedule

Date	Topics
2-Feb	Course overview and introduction. Introduction to hypothesis testing.
4-Feb	Bayesian hypothesis testing.
9-Feb	Minimax hypothesis testing.
11-Feb	Neyman-Pearson and composite hypothesis testing.
16-Feb	Detection of deterministic signals.
18-Feb	Detection of signals with random parameters and stochastic signals.
23-Feb	Performance evaluation of signal detection procedures.
25-Feb	Sequential detection.
2-Mar	Non-parametric and robust detection.
4-Mar	TBD
23-Mar	Introduction to parameter estimation. Bayesian parameter estimation.
25-Mar	Nonrandom parameter estimation.
30-Mar	Maximum likelihood estimation.
1-Apr	Further aspects of maximum likelihood estimation.
6-Apr	Signal estimation: Kalman-Bucy filtering.
8-Apr	Linear estimation.
13-Apr	Wiener-Kolmogorov filtering.
15-Apr	Signal detection in continuous time.
20-Apr	Signal detection in continuous time.
22-Apr	TBD
27-Apr	TBD
29-Apr	TBD

Grading Policy

Grading for the course is on a 1000-point scale, with the points distributed as follows:

Homework assignments (8 worth 50 points each))	400
Project (due Monday Apr 27)	300
Midterm Exam	300
Total	1000

Homework assignments are intended to reinforce the material covered in the previous lecture and to motivate a reading of the assigned material in the course textbook. The homework assignments are primarily analytical but students are encouraged to use simulation techniques to verify their answers where appropriate.

As an advanced-level graduate course, ELE 530 requires each student to complete two design projects designed to reinforce the major concepts learned in lecture through implementation and testing of the various algorithms and communication systems. There will be a midterm exam, but not a final exam.

In each of the design projects, the students are required to use both analysis and simulation techniques to demonstrate their results. Comparisons between the analytical and simulated results, with a discussion of any discrepancies, should be presented whenever possible. The students are also encouraged to suggest new directions for research on the topic and to provide preliminary results on the suggested approach.

Projects: These projects will be assigned by the instructor to allow an in-depth exploration of selected topics. Each project requires a written report that clearly describes the problem statement, the methodology, the results, as well as any conclusions and suggestions for future research.

The second project is designed to be an independent research project, selected by the student and approved by the instructor. Ideas for the final project may be obtained from the textbook, the "Additional Reading" books, journals such as *IEEE Transactions on Communications*, *Information Theory*, *Vehicular Technology*, *Journal on Selected Areas in Communications*, or papers from relevant conference proceedings.

The second project may require an oral presentation in the last lecture period.

Late Policy

Homework assignments are due *at the end of lecture* on the assigned days. Submission of late homework is discouraged. 7 points will be deducted per day for late homework submissions.

Project assignments are due via email on the assigned days and should be emailed to the instructor at `fp@princeton.edu`. In addition to the project report, well-commented Matlab code and a "readme.txt" file should also be provided describing the functions of each submitted Matlab .m file and its usage. Late project submissions accrue a penalty of 20 points per day.

End of Syllabus