Syllabus for ECE531
Principles of Detection and Estimation Theory
Spring 2011

Instructor: D. Richard Brown III

- Office: Atwater Kent 313
- Office Hours: Tuesdays 3-5pm (or send email).
- email: `drb@ece.wpi.edu`

Class Meetings

AK233, Wednesdays 6:00pm-8:50pm, Jan 19 – Apr 27 (not March 9 – Spring Break).

Examination Schedule:

- Midterm: Wednesday, March 2, 6:00pm
- Final: Wednesday, April 27, 6:00pm

Recommended Background:

Students taking ECE531 should have a solid background in probability and random processes (ECE502 or equivalent) and a familiarity with dynamic systems (ECE504 or equivalent; may be taken concurrently). Some familiarity with linear algebra and Matlab may also be useful.

Course Textbooks:

- *Fundamentals of Statistical Signal Processing Volume I: Estimation Theory*, S. Kay
- *Fundamentals of Statistical Signal Processing Volume II: Detection Theory*, S. Kay

Other Potentially Useful References:

There are many potentially useful textbooks on detection and estimation theory. Here are some that I have found helpful.

- *An Introduction to Signal Detection and Estimation*, Second Edition, by H. Vincent Poor
- *Detection of Signals in Noise*, Whalen.
- *Random Signals: Detection, Estimation, and Data Analysis*, Shanmugen.
- *Introduction to Nonparametric Detection with Applications*, Gibson and Melsa.

- *Testings Statistical Hypotheses*, Lehmann.
- *Theory of Point Estimation*, Lehmann.
- *Linear Estimation*, Kailath, Sayed, Hassibi
- *Quickest Detection*, Poor and Hadjiliadis.

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, and related areas.

Course Web Page and Announcements

The official web page for this course is:

`http://spinlab.wpi.edu/courses/ece531/`

All handouts, including assignments, exams, and their solutions, will be available here. Course announcements will be sent via the course email distribution list: `ece531@ece.wpi.edu`

Grading, Exams, and Homework Policy

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

Homework assignments (10 worth 25 points each, drop two lowest)	200
Midterm Exam	300
Comprehensive Final Exam	500
Total	1000

Exams are closed-book and closed-notes. If you wish, you may bring one sheet of paper with notes (in your own handwriting — no photocopies or printouts) on one or both sides to the midterm examination. Two sheets of paper with notes may be brought to the final examination. Use of calculators is permitted during examinations.

Homework assignments are due by the end of lecture (8:50pm). A 20% late penalty will be deducted from a homework assignment turned in after class on the Wednesday it is due but before 5:00pm on the subsequent Friday. A 40% late penalty will be deducted from a homework assignment turned in after class on the Wednesday it is due but before noon on the following Monday. Since homework solutions will be posted on Mondays, no homework assignments will be accepted after noon on Mondays following the homework due date.

Tentative Course Schedule

Date	Topic	Reading
Jan 19	Course introduction, notation, review of joint and conditional probability concepts, review of random variables	Kay II:1
Jan 26	A mathematical model for hypothesis testing, Neyman-Pearson hypothesis testing	Kay II:3.1-3.6
Feb 2	Bayesian and Minimax hypothesis testing	Kay II:3.7-3.8
Feb 9	Detection of deterministic signals in noise, Composite hypothesis testing	Kay II:4, II:6
Feb 16	Detection of deterministic signals with unknown parameters in noise	Kay II:7
Feb 23	Sequential detection	handout
Mar 2	Midterm exam.	Kay II:1,3-4,6-7
Mar 9	Spring Break.	Kay I:1
Mar 16	Bayesian estimation and introduction to nonrandom parameter estimation	Kay I:10-11, I:2.1-2.4
Mar 23	Nonrandom parameter estimation	Kay I:2.5-2.7, I:5
Mar 30	The Fisher Information matrix and the Cramer-Rao lower bound	Kay I:3
Apr 6	Maximum likelihood estimation	Kay I:7
Apr 20	Linear estimation	Kay I:4, I:6, I:12
Apr 13	Dynamic parameter estimation and the Kalman-Bucy filter	Kay I:13
Apr 27	Comprehensive final exam	Kay I:1-7,10-13, II:1,3-4,6-7

End of Syllabus