Colorado State University, Ft. Collins, Spring Semester 2013

ECE652: Estimation and Filtering Theory, 3cr

Time & Location: TR 8:00am-9:15am, Engr E206

Instructor: Ali Pezeshki

Contact Info: Engr C103J, Tel. 970-491-3242, pezeshki@engr.colostate.edu

Office Hours: 1 hour after each lecture, or by appointment

Course Description:

Detection, estimation, and time series analysis are the main branches of statistical signal processing. Estimation theory is perhaps the most fundamental of these three, as it plays an important role in the other two. Our objective is to lay the foundations for estimation theory and to develop its main lines, from parameter estimation to Wiener and Kalman filtering. We will then cover examples in modal analysis, linear prediction, sensor array processing, and radar, sonar, and optical imaging.

Note: The couse is very mathematical. Command of linear algebra, matrix analysis, and probablity and random processes is required and assumed.

Suggested Textbook:

L. L. Scharf, *Statistical Signal Processing: Detection, Estimation, and Time Series Analysis,* Addison Wesley, 1991.

Additional Reading:

H. L. Van Trees, *Detection, Estimation, and Modulation Theory: Part I,* Wiley-Interscience, 2001.

S. M. Kay, *Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory,* Prentice Hall, 1993.

H. V. Poor, *An Introduction to Signal Detection and Estimation,* Springer, 2010.

T. Kailath, A. H. Sayed, and B. Hassibi, *Linear Estimation,* Prentice Hall, 2000.

G. Golub and C. Van Loan, *Matrix Computations,* The Johns Hopkins University Press, 1989.

R. A. Horn and C. R. Johnson, *Matrix Analysis,* Cambridge University Press; 2nd ed., 2012.

J. A. Gubner, *Probability and Random Processes for Electrical and Computer Engineers,* Cambridge University Press, 2006.

T. W. Anderson, *An Introduction to Multivariate Statistical Analysis,* Wiley-Interscience; 3rd ed., 2003.

Course Topics:

- Sufficient Statistics and Minimum Variance Unbiased Estimators
- Maximum Likelihood Estimators, Fisher Information, Cramer-Rao Bounds, and Subspace Estimation
- Bayes Estimators, Minimax Estimator, Maximum A Posteriori Estimate, and Kalman Filters
- Minimum Mean-Squared Error Estimators, Linear MMSE, Rank Reduction, and Rate Distortion
- Least Squares Methods
- Modal Analysis, Linear Prediction, Prony Methods, and MUSIC

- Compressed Sensing and Sparse Approximations

Evaluation and Grading:

Homework	50%
Project	50%

Expository papers, within the scope of the course, will be assigned to students in the first third of the semester and will be discussed during office hours. These papers will form the basis for course projects. Each student will extend his/her expository paper in a new direction for his/her project. Each project requires the delivery of an oral presentation and a written report.

Regular attendance in class is required.

Working Together:

Working together on general study is encouraged. Of course, any assignment, exam, or project you turn in must be solely your own work. Academic dishonesty has serious consequences (see below).

Academic Integrity:

The ECE faculty expects every member of the CSU community to practice honorable and ethical behavior both inside and outside the classroom. Any actions that might unfairly improve a student's score on homework, quizzes, or examinations will be considered cheating and will not be tolerated. Examples of cheating include (but are not limited to): Sharing results or other information during an examination; Bringing forbidden material or devices to an examination; Working on an exam before or after the official time allowed; Requesting a regrade of answers or work that has been altered. Submitting homework that is not your own work or engaging in forbidden homework collaborations; Representing as your own work anything that is the result of the work of someone else.

At the professor's discretion, cheating on an assignment, examination, or project will result in a reduced score, a zero score, or a failing grade for the course. All occurrences of academic dishonesty will be reported to the Vice President for Student Affairs and copied to the ECE Head. If there is any question as to whether a given action might be construed as cheating, please see the professor before you engage in any such action.

Please see CSU's pages on Practicing Academic Integrity (http://learning.colostate.edu/integrity/) and the Honor Pledge (http://tilt.colostate.edu/integrity/honorpledge/) for more information.