EC4570 - Detection and estimation theory

Instructor: Monique P. Fargues, Span 456, fargues@nps.edu, *2859, office hours: posted or by appointment

Text & References:

Detection and Estimation Theory, T. Schonhoff & A. Giordano, Prentice Hall, 2006.

Detection Theory, R. Hippenstiel, CRC Press, 2001.
Detection Theory, D. Johnson, class notes, Rice University, dated 2005.
Fundamentals of Statistical Signal Processing: Detection theory, S. Kay, Prentice Hall, 1998
Introduction to Statistical Signal Processing with Applications, M. Srinath et. al., Prentice Hall, 1996.
Detection of Signals in Noise, 2nd ed. R. McDonough and A. Whalen, Academic Press, 1995.

Course outline:

I - Review of basic probability concepts - RV, CDF, PDF, moments, conditional probability, Bayes' theorem, statistical independence between RVs, functions and transformations of RVs, useful pdf types.
II - Review of Random Processes - RP Definition, RP stationarity characteristics, Correlation & cross-correlation, Covariance and cross-covariance, WSS property, RP time average and ergodicity, Periodic RP properties, Power Spectral Density, Linear transformations of RPs, Bandpass/lowpass (complex envelope) representations, Linear systems and bandpass/lowpass representations, Noise process: bandpass & lowpass (complex envelope), Envelope statistics and use in signal detection, Monte Carlo performance evaluation and use in detection.
III.A - Detection Part A: MAP criterion, Maximum likelihood criterion, Bayes criterion, MiniMax criterion, Neyman-Pearson criterion, Multiple sample detection: Real signal case, Complex signal case, Complex signal detector, Performance analysis (white noise case).
III.B – Detection Part B - Sequential detection, Multiple hypotheses detection, Receiver Operator Characteristic (ROC) curves, Model consistency testing.
III.C – Detection Part C - Composite hypothesis testing, Definitions, Applications to communication signals: unknown phase, unknown amplitude, unknown frequency cases.
III.D – Detection Part D - Non parametric detection.
IV – Estimation - Basic estimation schemes: MAP, ML, Bayes estimation, Wiener filter.
V – Applications – as time allows, topics selected among: Direct sequence spread-spectrum signals, Multiuser detection, Spectrum estimation, Adaptive Wiener filter.

Grades: 2 tests, each worth 30%, Assignments: worth 40% , No final

HWs: A few problems will be assigned on a regular basis to apply the various concepts covered in the classroom. Hws will not be collected; however they constitute an essential part of the learning process for the course. You are responsible for working on the problems as they get assigned to facilitate the understanding of the concepts covered in class. Solutions will be made available on the SAKAI course management site.

Assignments: 1) Some assignments may require the use of MATLAB. You should be familiar with the MATLAB software before you take this course or are expected to learn the software on your own. MATLAB tutorials can be found online at www.mathworks.com. A good MATLAB tutorial book is "Mastering MATLAB 7," by D. Hanselman & B. Littlefield. 2) You are allowed and encouraged to discuss assignments with fellow students in the course. However, the work turned in (write-ups and software implementation if required) should be your own work only. Data and code from other students are not to be used in assignments. Work turned in which is found to violate these guidelines will be considered a violation of the academic honor code (See Section 218 of the student handbook for further details). Assignments will be discussed in class, thus late assignments will not be accepted unless pre-approved by the instructor for special circumstances only and limited to a few days past the due date only.

Exams: Tests will be closed books/notes, and time limited. You will be allowed to use two one-sided (8.5*11") sheets on which you may write whatever you feel may be useful to you. Tables if needed will be provided.

Exam schedule: early February and March. Specific dates TBD.

Notes: Electronic copies of the classnotes will be posted or e-mailed prior to class; you will need to print them up BEFORE the associated lectures. Notes are partially filled in, and will be completed during lectures.

Academic Honor Code: Students must follow the academic honor code at all times. Work turned in (tests, assignments, and all software implementations) should be your own work only.