TEL 603 Detection & Estimation

Fall 2011

ECE Department, Technical Univ. of Crete

Instructor: Dr. Aggelos Bletsas (aggelos at telecom teleia tuc teleia gr)

Lectures: Wednesday, Friday, $16.00 - 17.30$, HMMY Conf. Room.

Class web site: courses.ece.tuc.gr ($\rightarrow$ Select "TEL 603" from course list)

Office Hours: Thursday $14.00 - 16.00$. Please RSVP.

Welcome to grad course TEL 603! This is a core graduate course, useful for people specializing in various aspects of engineering. Throughout the semester, we derive and discuss basic theoretical tools and provide concrete examples. Even though practical engineering problems will be analyzed, the course aims to develop solid problem solving skills applicable to more general settings.

Grading

1) Mid-term and Final written exam.
2) 5-6 Problem Sets.
3) Class participation, effort, as well as instructor's subjective assessment on how well the material has been grasped by the student.
4) Class project/paper (for bonus credit). You will be asked to present a research paper and reproduce its results; Talk to the instructor for valid topics on gossiping algorithms, compressive sensing and factor graphs!

Important Notes

A. Written exams are open-book. You can bring whatever (non-electronic) material you want.

B. Cooperation in groups of $2-3$ students is permitted during problem sets preparation. However,

$$\texttt{cooperation} \neq \texttt{copying}.$$

You are responsible to provide your own report, indicating with whom you cooperated.

C. Problem sets are due in class. You are allowed to hand-write the answers, provided that your notes are crystal clear and easy to read (no deciphering is needed). Please, do not spend time on latexing your answers.

D. Class starts exactly at the advertised time; there is NO "academic quarter" or any other type of (Greek) delay. Please try to come on time.

Indicative Syllabus

(Tentative)

Week 1: Revision of Linear Algebra and Probability, Bayesian Binary Hypothesis Testing and Sufficient Statistics.

Week 2: Receiver Operating Characteristic (ROC), Neyman-Pearson Tests and Minimax Hypothesis Testing.

Week 3: M-ary Hypothesis Testing and Performance Analysis Bounds.

Week 4: Bayesian Estimation, Mean Squared Error and Linear Least Squares Estimators.

Week 5-6: Estimation of Non-random parameters, Cramer-Rao Bound, Uniform Minimum Variance Unbiased (UMVU) Estimators, BLUE Estimators.

Week 7: Parameter Estimation of Sinusoidal Signals (e.g. Periodogram), Performance Bounds and Applications.

Midterm!

Week 8: Asymptotic Behavior of Maximum Likelihood (ML) Estimators.

Week 9: Composite Hypothesis Testing: UMP Tests, GLR Tests and Asymptotic Optimality of GLRT.

Week 10: Karhunen-Loeve Expansion of Gaussian Processes.

Week 11: Standard Kalman/Wiener Filtering.

Week 12: Additional Examples: Detection of Signals with Unknown Parameters and Applications to Digital Communication and Radar Signals.

Week 13: Introduction to Detection of Memory-based Signals with Unknown Parameters (Markov Chains).

Week 14: Project Presentations.

Bibliography

1. Bernard C. Levy, Principles of Signal Detection and Parameter Estimation, Springer 2008.
2. Steven M. Kay, Fundamentals of Statistical Signal Processing, Volumes I (Estimation) and II (Detection), Prentice Hall, 1993.
3. Harry L. Van Trees, Detection, Estimation, and Modulation Theory, Part I, John Wiley & Sons, 2001.
4. H. Vincent Poor, An Introduction to Signal Detection and Estimation, 2nd edition, Springer, 1994.
5. Athanasios Papoulis, Probability, Random Variables and Stochastic Processes, McGraw-Hill.
6. Lecture Notes.