KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
ELECTRICAL ENGINEERING DEPARTMENT
First Semester (071)

EE 574 Detection and Estimation

- **Prerequisites:** EE 570.
- **Instructor:** Dr. Salam A. Zummo, Office: 59-1071, Phone: 1634
  E-mail: zummo@kfupm.edu.sa
  Web Site: http://faculty.kfupm.edu.sa/ee/zummo/courses.htm or WebCT
- **Course Objectives:**
  - Understand basics of detection and estimation theory.
  - Design and analyze optimum detection schemes.
  - Study different estimation schemes such as ML and MMSE estimators.
  - Understand the basics of linear filtering.
- **Course Description:** Binary and M-hypotheses Detection techniques: Maximum likelihood, Newman Pearson, Minimum probability of error, Maximum a posteriori probability, Bayes decision and minimax detection. Parameter estimation: weighted least squares, BLUE, Maximum likelihood, Mean square estimation. Signal estimation and filtering: Wiener filtering, Kalman filtering and estimation. Simultaneous detection and estimation. Application to system identification and communication systems.
- **Course Outline:** (Time and emphasis may be adjusted as needed)
  - **Review:** (2 Weeks)
    Random variables and stochastic processes, overview on detection and estimation.
  - **Binary Hypothesis Testing:** (1 Week)
    Binary hypothesis testing problem, MAP, ML, Neyman-Pearson, Bayes and Minimax criteria, receiver operating characteristic (ROC).
  - **Multiple Hypothesis Testing:** (2 Weeks)
    Multiple hypothesis testing problem, multiple observations, signal space, the Gaussian channel, sufficient statistics, independent and correlated channels, coordinate transformation.
  - **Waveform Detection:** (2 Week)
    Time sampling, series representation of random process, orthonormal function sampling, detection of signals in noise, signal spaces.
  - **Estimation Theory - Random Parameter:** (2 Week)
    ML estimation, linear minimum-variance estimator, BLUE.
  - **Estimation Theory - Non-random Parameter:** (2 Week)
    Random parameter, Bayes estimation, MSE, absolute-error, uniform-error, least-square estimation.

- **Properties of Estimators:** (1 Week)
  Unbiasedness, efficiency, C-R bound, asymptotic properties.
- **State Estimation:** (1 Week)
  Wiener filter, Kalman filter.
- **Projects' Presentations:** (1 Week)

• Textbook:

- H. Van Trees, Detection, Estimation and Modulation Theory, John Wiley & Sons, 2001.
- Lecture notes.

• References:

1. A. Papoulis, Probability, Random Variables, and Stochastic Processes, McGraw-Hill, 1965.
2. J. Mendel, Lessons in Digital Estimation Theory, Prentice-Hall, 1987.
3. L. Scharf, Statistical Signal Processing - Detection, Estimation and Time Series Analysis, Addison-Wesley, 1991.
4. Srinath, Rajesekaran and Viswanathan, Introduction to Statistical Signal Processing, Prentice-Hall, 1996.

• Homework Assignements:

Homeworks will be issued about once every two weeks. Collaborative work and discussion is encouraged between students. However, solutions are to be worked out and submitted individually.

• Grading Policy:

- Homeworks 20%
- Exam I 20% Tuesday of Week 6 (Class time)
- Exam II 20% Sunday of Week 12 (Class time)
- Final Exam 30%
- Projects 10%