

ECE 722: Detection and Estimation Theory

Text books

- 1- H. L. Van Trees, “**Detection, Estimation, and Modulation Theory, Part I,**” John Wiley and Sons, 2004
- 2- Mourad Barkat, “**Signal Detection and Estimation,**” Second Edition, Artech House, Inc. 2005
- 3- Steven M. Kay, “**Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory,**” New Jersey: Prentice Hall, 1993

Course Outline

Part I: Detection Theory

- 1) Contents
- 2) Classical Detection Theory
 - A. Introduction
 - B. Simple Binary Hypothesis Tests
 - i. Decision Criteria
 1. Bayes Criterion
 2. Neyman-Pearson Criterion and tests
 3. Performance: Receiver Operating Characteristics
 - C. M Hypotheses Tests

Part II: Estimation Theory

- 1) Introduction
 - A. Estimation Theory: Scope and Applications
- 2) Minimum Variance Unbiased Estimation
 - A. Unbiased Estimators

- B. Minimum Variance Criterion
- C. Existence of the Minimum Variance Unbiased Estimator

3) Cramer-Rao Lower Bound

- A. Cramer-Rao Lower Bound (CRLB) Theorem
- B. Derivation of Scalar Parameter CRLB
- C. General CRLB for Signals in White Gaussian Noise
- D. Transformation of Parameters
- E. Asymptotic CRLB and Efficient Estimators
- F. Extension to Vector Parameters
- G. Fisher Information Matrix
- H. Signal Processing Examples

4) Linear Models

- A. Definition and Properties
- B. Linear Model Examples

5) Best Linear Unbiased Estimators

- A. BLUE Definition
- B. BLUE Derivation
- C. Extension to Vector Parameters

6) Maximum Likelihood Estimation

- A. MLE definition
- B. MLE Derivation
- C. Properties of the MLE
- D. MLE for Transformed Parameters
- E. Extension to Vector Parameters
- F. Signal Processing Examples

7) Least Squares Estimation

- A. The Least Squares Approach
- B. Linear Least Squares

- C. Geometrical Interpretations
- D. Constrained Least Squares
- E. Signal Processing Examples

8) Bayesian Estimation

- A. Prior Knowledge and Estimation
- B. Choosing Prior PDF
- C. Properties of the Gaussian PDF
- D. Bayesian Linear Model
- E. Bayesian Estimation for Deterministic Parameters

9) General Bayesian Estimation

- A. Risk Functions
- B. Minimum Mean Square Error Estimators
- C. Maximum A Posteriori Estimators

10) Linear Bayesian Estimation

- A. Linear MMSE Estimation
- B. Geometrical Interpretations
- C. Vector LMMSE Estimators
- D. Signal Processing Examples – Wiener Filtering