

DETECTION AND ESTIMATION THEORY**22ECMC2T2****Credits: 4****Lecture: 4 periods/week****Internal Assessment: 40 marks****Semester end examination: 60 marks**

Prerequisites: Linear Algebra, Random Process

Course Outcomes:**At the end of the course student will be able to:**

- Understand fundamentals of signal/ parameter detection and estimation principles (L2)
- Apply suitable detection and estimation techniques to solve the problems of different systems (L3)
- Analyse the signal and parameter estimation problems to make inferences (L4)
- Analyse the signal detection problems to support generalizations (L4)

UNIT I

Fundamentals of Estimation Theory: Role of Estimation in Signal Processing, Unbiased Estimation, Minimum variance unbiased (MVU) estimators, Finding MVU Estimators, Cramer-Rao Lower Bound, Linear Modelling, Sufficient Statistics, Use of Sufficient Statistics to find the MVU Estimator

UNIT II

Deterministic Parameter Estimation: Least Squares Estimation, Best Linear Unbiased Estimation, and Maximum Likelihood Estimation

Random Parameter Estimation: Bayesian Philosophy, Selection of a Prior PDF, Bayesian linear model, Minimum Mean Square Error Estimator, Maximum a Posteriori Estimation

UNIT III

Hypothesis Testing: Bayes' Detection, MAP Detection, ML Detection, Minimum Probability of Error Criterion, Neyman-Pearson Criterion, Multiple Hypothesis, Composite Hypothesis Testing: Generalized likelihood ratio test (GLRT), Receiver Operating Characteristic Curves.

UNIT IV

Detection of Signals in White Gaussian Noise (WGN): Binary Detection of Known Signals in WGN, M-ary Detection of Known Signals in WGN, Matched Filter Approach

Learning Resources

Text Book:

1. S. M. Kay, “Fundamentals of Statistical Signal Processing: Estimation Theory”, Vol I, Prentice-Hall, 1993.
2. S. M. Kay, “Fundamentals of Statistical Signal Processing: Detection Theory”, Vol II, Prentice-Hall, 1998.

References:

1. H. Vincent Poor, An Introduction to Signal Detection and Estimation, 2nd Ed., Springer, 1998
2. Harry L. Van Trees, Detection, Estimation and Modulation Theory, Part- I, II, & III, John Wiley & Sons, 2004
3. Louis L. Scharf, Statistical Signal Processing: Detection, Estimation and Time Series Analysis, Prentice Hall, 1991
4. Carl W. Helstrom, Elements of Signal Detection & Estimation, Prentice Hall, 1994
5. M. D. Srinath, P. K. Rajasekaran and R. Visawanath, Introduction to Statistical Signal Processing with Applications, Prentice Hall, 1995
6. Kung Yao, Flavio Lorenzelli, and Chiao-En Chen, Detection and Estimation for Communication and Radar Systems, Cambridge University Press, 2013

Web Resources:

1. <https://nptel.ac.in/courses/117/103/117103018/>
2. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-432-stochastic-processes-detection-and-estimation-spring-2004/>