SIGNAL DETECTION & ESTIMATION THEORY
(ELECTIVE –I)

Course Code: 13EC2106

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Pre requisites: Linear algebra, Signals and systems, Probability and Random Processes.

Course Educational Objectives:

The objective of this course is to introduce the fundamental concepts of detection and estimation theory that deals with the processing of information-bearing signals for the purpose of extracting information.

1. Understand basics of detection and estimation theory.
2. Design and analyze optimum detection schemes.
3. Study different estimation schemes using estimators.

Course Outcomes:

1. Should be able to cast a generic detection problem into a hypothesis testing framework and to find the optimal test for the given optimization criterion.
2. Should also be capable of finding optimal estimators for various signal parameters, derive their properties and assess their performance.

UNIT-I

REVIEW OF RANDOM VARIABLES:

Review of Gaussian variables and processes; problem formulation and objective of signal detection and signal parameter estimation in discrete-time domain.

STATISTICAL DECISION THEORY:

Bayesian, minimax, and Neyman-Pearson decision rules, likelihood ratio, receiver operating characteristics, composite hypothesis testing, locally optimum tests, detector comparison techniques, asymptotic relative efficiency.

UNIT – II

DETECTION OF DETERMINISTIC SIGNALS:

Matched filter detector and its performance; generalized matched filter; detection of sinusoid with unknown amplitude, phase, frequency and arrival time, linear model.

DETECTION OF RANDOM SIGNALS:

Estimator-correlator, linear model, general Gaussian detection, detection of Gaussian random signal with unknown parameters, weak signal detection.

UNIT – III

NONPARAMETRIC DETECTION:

Detection in the absence of complete statistical description of observations, sign detector, Wilcoxon detector, detectors based on quantized observations, robustness of detectors.

UNIT – IV

ESTIMATION OF SIGNAL PARAMETERS:

Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, Sufficientstatistics, minimum statistics, complete statistics; linear models; best linear unbiased estimation; maximumlikelihood estimation, invariance principle; estimation efficiency; Bayesian Estimation: philosophy, nuisanceparameters, risk functions, minimum mean square error estimation, maximum a posteriori estimation.

UNIT – V

SIGNAL ESTIMATION IN DISCRETE-TIME:

Linear Bayesian estimation, Weiner filtering, dynamicalsignal model, discrete Kalman filtering.

TEXT BOOKS:

[1] H. L. Van Trees, "*Detection, Estimation and Modulation Theory: Part I, II, and III*", John Wiley, NY, 1968.

[2] H. V. Poor, "*An Introduction to Signal Detection and Estimation*", Springer, 2/e, 1998.

REFERENCES:

[1] M. Hays, "*Statistical Digital Signal Processing and Modelling*", John Willey and Sons, 1996.

[2] Steven.M.Kay, *"Fundamentals of Statistical Signal Processing:"* Volume I Estimation Theory, Prentice Hall, USA, 1998.

[3] Steven.M.Kay, *"Fundamentals of Statistical Signal Processing:"* Volume I Detection Theory, Prentice Hall, USA, 1998.

[4] K.SamShanmugam, Arthur M Breiphol, *"Random Signals: Detection, Estimation and Data Analysis"*, John Wiley & Sons, 1998.