SIGNAL DETECTION & ESTIMATION THEORY
(ELECTIVE –I)

Course Code:15EC2106

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

Course Outcomes: At the end of the course, student is able to

CO1: Acquire basics of statistical decision theory used for signal detection and estimation.

CO2: Examine the detection of deterministic and random signals using statistical models.

CO3: Comprehend the elements and structure of nonparametric detection.

CO4: Examine the performance of signal parameters using optimal estimators.

CO5: Analyze signal estimation in discrete-time domain using filters.

UNIT-I (10-Lectures)

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 (10-Lectures)

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 (10-Lectures)
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 (10-Lectures)
ESTIMATION OF SIGNAL PARAMETERS:
Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, Sufficient statistics, minimum statistics, complete statistics; linear models; best linear unbiased estimation; maximum likelihood estimation, invariance principle; estimation efficiency; Bayesian Estimation: philosophy, nuisance parameters, risk functions, minimum mean square error estimation, maximum a posteriori estimation.

UNIT – V (10-Lectures)
SIGNAL ESTIMATION IN DISCRETE-TIME:
Linear Bayesian estimation, Weiner filtering, dynamical signal 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. Sam Shanmugam, Arthur M Breiphol, *"Random Signals: Detection, Estimation and Data Analysis"*, John Wiley & Sons, 1998.