

EC410: Estimation and Detection Theory

Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Estimation and Detection Theory	3	0	0	NIL

Course Objective: To introduce the fundamental concepts of detection and estimation in signal processing.

Course Outcomes:

- CO1: Explain the principles of statistical detection and estimation theories.
- CO2: Analyze and compare different detection techniques for signal processing applications.
- CO3: Apply Bayesian, maximum likelihood, and other estimation methods to real-world problems.
- CO4: Design and evaluate matched filters and detectors for signal detection.
- CO5: Implement various non-parametric detection techniques and their applications.
- CO6: Explain and simulate Kalman filters for estimation in dynamic systems

S. No.	Content	Contact Hours
Unit 1	Gaussian variables and Gaussian processes Problem formulation and objective of signal detection and signal parameter estimation Discrete-time signal detection Bayesian, minimax, and Neyman-Pearson detection criteria Likelihood ratio tests and receiver operating characteristics (ROC) curves Hypothesis testing and comparison techniques, Asymptotic relative efficiency of detectors	10
Unit 2	Matched filter detector and its performance Generalized matched filter Detection of sinusoidal signals with unknown phase, frequency, and arrival time Linear signal models and their applications - Estimator-correlator Linear model for signal detection Gaussian random signals and their statistical properties Detection of weak signals using statistical techniques	10
Unit 3	Detection in the absence of complete statistical descriptions of observations Sign detectors and their properties Wilcoxon detector for nonparametric	6

	detection Detection of quantized observations Robustness of detectors to signal variations	
Unit 4	Minimum variance unbiased estimation Cramér–Rao lower bound (CRLB) and its significance Sufficient statistics and complete statistics Linear models for estimation Maximum likelihood estimation (MLE) and its properties Bayesian estimation principles Risk functions and minimum mean square error (MMSE) estimation A posteriori estimation techniques	10
Unit 5	Linear Bayesian estimation Wiener filtering and its applications Dynamic signal models Discrete Kalman filtering and its applications in tracking systems	6
	Total	42

Books:-

S. No	Name of Books/Authors/Publisher
1	Detection, Estimation, and Modulation Theory - Part I /Harry L. Van Trees/ Wiley
2	Fundamentals of Statistical Signal Processing, Volume 1: Estimation Theory/ by Steven M. Kay /Prentice Hall
3	Fundamentals of Statistical Signal Processing, Volume 2: Detection Theory/ Steven M. Kay/ /PrenticeHall
4	Statistical Signal Processing / Louis L. Scharf /Addison-Wesley