DETECTION AND ESTIMATION THEORY

Course Code	20EC6601D	**Year**	III	**Semester**	II
Course Category	HONORS	**Branch**	ECE	**Course Type**	THEORY
Credits	4	**L-T-P**	3-1-0	**Prerequisites**	Linear Algebra, Random Process
Continuous Internal Evaluation:	30	**Semester End Evaluation:**	70	**Total Marks:**	100

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand fundamentals of signal/ parameter detection and estimation principles (L2)
CO2	Apply suitable detection and estimation techniques to solve the problems of different systems (L3)
CO3	Analyse the signal and parameter estimation problems to make inferences (L4)
CO4	Analyse the signal detection problems to support generalizations (L4)

Mapping of course outcomes with Program outcomes (CO/ PO/PSO Matrix)
Note: 1- Weak correlation 2-Medium correlation 3-Strong correlation
* - Average value indicates course correlation strength with mapped PO

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3							1	2	2				
CO2	2							1	2	2			2	1
CO3		3						2	2	3			2	1
CO4		3						1	3	2			2	1
Average* (Rounded to nearest integer)	**3**	**3**						**1**	**2**	**2**			2	1

Syllabus		
Unit No.	**Contents**	**Mapped CO**
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 **Experimental Topics-** Minimum variance unbiased estimation Cramer-Rao lower bound Generalized MVU	CO1, CO2

II	**Deterministic Parameter Estimation:** Least Squares Estimation, Best Linear Unbiased Estimation, and Maximum Likelihood Estimation **Experimental Topics-** Least Squares Estimation BLUE	CO1-CO3
III	**Random Parameter Estimation**: Bayesian Philosophy, Selection of a Prior PDF, Bayesian linear model, Minimum Mean Square Error Estimator, Maximum a Posteriori Estimation **Experimental Topics-** Minimum Mean Square Error Estimator Maximum a Posteriori Estimation	CO1-CO3
IV	**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. **Experimental Topics-** Generalized likelihood ratio test (GLRT) Receiver Operating Characteristic Curves	CO1, CO2, CO4
V	**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 **Experimental Topics-** Binary Detection of Known Signals in WGN M-ary Detection of Known Signals in WGN	CO1, CO2, CO4

Learning Resources
Text Books
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.
Reference Books
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) KungYao, Flavio Lorenzelli, and Chiao-En Chen, Detection and Estimation for Communication and Radar Systems, Cambridge University Press, 2013
e- Resources & other digital material
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/ 3. https://ece.iisc.ac.in/~spchepuri/e1244.html 4. https://www.eecs.umich.edu/courses/eecs206/public/lab/lab,all,student.pdf