



First Course Handout

EE930 Detection for Wireless Communication and Machine Learning

Department of Electrical Engineering
Indian Institute of Technology Kanpur

1. Objectives:

This course aims to cover principles of detection theory and algorithms for wireless communication systems and machine learning (ML) applications. Concepts in detection lay the foundation for several procedures in the implementation of 4G, 5G wireless systems, especially at the receiver. Detection techniques play a fundamental role in the demodulation of the symbols toward mapping them to a digital constellation. Furthermore, detection algorithms also play a vital role in Machine Learning (ML) applications, toward face recognition, fraud detection etc. Also, decision rules based on detection theory are used extensively for primary user discovery in cognitive radio (CR) technology, slated for use in 5G and beyond networks. Distributed detection techniques are of significant interest toward decision making and learning in Wireless Sensor Networks (WSNs) that power IoT applications in 5G. Hence, principles of detection theory are of great value for research, design and implementation of wireless communication systems and machine learning, which will be rigorously covered in this course

2. Prerequisites:

Students are expected to be familiar with basic concepts of

- Probability, Random Variables and Random Processes
- Linear Algebra, Properties of Matrices etc.
- Calculus, differentiation, integration

3. Course Contents:

S.No	Broad Title	Topics	Number of Lectures
1	Introduction and Maximum Likelihood Detection	Basics of Detection, Maximum Likelihood (ML) Detection, Likelihood Ratio Test (LRT)	4
2	Application in wireless systems	Binary Hypothesis Testing, Probabilities of Detection and False Alarm, Probability of Error	4
3	NP Criterion, Multiple Hypothesis Testing	Neyman-Pearson Criterion for Optimal Detection, Multiple Hypothesis Testing, Face Recognition	4
4	MAP Detector, Gaussian Discriminant Analysis	Maximum A posteriori Probability (MAP) Detection rule, Probability of Error, Gaussian Discriminant Analysis	4
5	MIMO OFDM	Detection in MIMO/ OFDM Systems and Bit-Error Rate (BER)	4
6	Bayesian Detection	Bayesian detection for random signals, Energy Detector and Performance, Chi-squared random variables	4
7	Generalized Likelihood Ratio Test (GLRT)	Detection with unknown parameters, Generalized Likelihood Ratio Test (GLRT) and performance	4
8	Distributed Detection	Principles of Distributed detection, applications in Sensor Networks and IoT	4

4. Special Emphasis:

- Maximum-Likelihood (ML) Detection
- Neyman Pearson (NP) criterion
- MAP decision rule
- Applications: Signal Processing, Machine Learning, Wireless Comm.

5. Live Interaction:

- Sunday 12 noon via zoom.

- Students can also contact both instructor as well as TAs via e-mail.

6. Evaluation Components & Policies:

	Proposed Weightage
Assignments (Theory)	20%
Quizzes	30%
End-Sem	40%
Attendance Minimum 80% attendance	10%

Best 3 out of four quizzes
Best 6 out of 8 assignments

7. Course Policies: Attendance, Honesty Practices, Withdrawal (within the limits of DOAA Guidelines)

Attendance Policy: Minimum 80% attendance is required to score the 10% marks specified for attendance. Attendance will be recorded in every session.

All participants **MUST** keep their video feed **ON** during the live interaction to monitor attendance and participation.

Students are expected to observe a **personal code of honesty** in submission of assignment solutions, quizzes and exams. This will be based on honor code. 25% marks will be deducted for plagiarism or copying.

8. Books & References: Properly Formatted along with listing of possible internet sources.

Text Book	
Fundamentals of Statistical Signal Processing, Volume II: Detection Theory	Steven M. Kay

Mathematical Methods and Algorithms for Signal Processing	T.K. Moon and W.C. Stirling
Detection, Estimation, and Modulation Theory, Part I: Detection, Estimation, and Linear Modulation Theory	Harry L. Van Trees

9. Instructor and TA Information

Instructor	
Prof. Aditya K. Jagannatham	ACES 205D Mailbox on 2nd floor ACES Building. e-mail: adityaj@iitk.ac.in
Course TAs	
Sudhakar Rai	sudhrai@iitk.ac.in