



First Course Handout

EE909 Estimation for Wireless Communications

Department of Electrical Engineering

Indian Institute of Technology Kanpur

1. Objectives:

This course covers principles of estimation theory and algorithms for wireless communication systems. Estimation theory provides a large variety of tools and techniques that are widely applied in the design and implementation of 4G, 5G wireless systems. Various signal processing procedures in communication systems such as channel estimation, equalization, synchronization etc., which are also employed in MIMO (Multiple-Input Multiple-Output) and OFDM (Orthogonal Frequency Division Multiplexing) based 3G/ 4G wireless systems, are based on fundamental concepts in estimation theory. Further, recent research developments in areas such as Wireless Sensor Networks (WSNs) also employ several tools from estimation theory towards distributed parameter estimation etc. Therefore, principles of estimation are naturally of a significant interest in research and industry, which will be introduced 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	Basics of Estimation, Maximum Likelihood (ML) Application: Wireless Sensor Network, Reliability of Estimation	4
2	Application in wireless systems – channel estimation	Application: Wireless Fading Channel Estimation, Cramer-Rao Bound for Estimation	4
3	ML for vector parameters	Vector Parameter Estimation, Properties of Estimate; Applications: Multi-antenna Wireless Channel Estimation	4
4	Vector ML applications	Application: MIMO Wireless Channel Estimation, Error Covariance of Estimation, Equalization for Frequency Selective Channels Application: OFDM Estimation, Sequential Estimation	4
5	MMSE Principle for scalar parameters	Minimum Mean-Squared Error (MMSE) Estimate, Gaussian Parameter Application: Wireless Sensor Network, Wireless Fading Channel Estimation	4
6	MMSE for vector parameters	Application: MMSE Estimation for Multi-Antenna Channel	4
7	Application of MMSE for OFDM channel	Application: MMSE for MIMO Channel Estimation, Properties of Estimate, Application: MMSE for Equalization of Wireless Channel	4
8	Application of MMSE for MIMO Channel	Application: MMSE for OFDM Channel Estimation	4

4. Special Emphasis:

- Maximum-Likelihood (ML) Principle
- Minimum Mean Square Error (MMSE)
- Kalman Filter
- Neyman-Pearson Criterion
- 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:

	Weightage
Assignments (Theory)	10%
Quiz-I	10%
Quiz-II	10%
Quiz-III	10%
End-Sem	50%
Attendance Minimum 80% attendance	10%

Exam/ Assignment/ Term Paper Policy:

If a student misses any one or more of Quiz-I/ Quiz-II/ Quiz-III, marks will be prorated based on remaining ones, if valid reason is provided along with supporting documents. If a student misses the end-sem exam, he/ she can apply to DOAA for makeup examination. No makeup or prorating will be done for missed assignment submissions.

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 as per **Evaluation Policies** in Section 7. 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: Estimation Theory	Steven M. Kay	

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	
Meesam Jafri	meesam@iitk.ac.in
Sudhakar Rai	sudhrai@iitk.ac.in