



# First Course Handout

## EE917: PYTHON-Based Simulation, Design and Analysis of Wireless Systems

Jan-Mar 2024

**E-masters in Communication Systems**  
**Department of Electrical Engineering**  
**Indian Institute of Technology Kanpur**

### 1. Objectives:

As part of the course, students will participate and successfully complete several PYTHON-based projects on key 4G/ 5G wireless technologies such as **Multiple-Antenna Systems, OFDM, MIMO, MIMO-OFDM** in significant detail. Students will also be introduced to various concepts from a practical perspective such as beamforming, channel estimation, optimization, detection, and bit-error rate (BER) performance. In these projects, students will also gain exposure to a variety of Python libraries and develop the skills to effectively use integrated development environments (IDEs) for tackling more extensive projects in the future

### 2. Prerequisites:

EE920 Wireless communication

Students are also 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 to PYTHON	<b>Project 1:</b> Introduction to PYTHON Programming and Packages for Simulation and Analysis of Communication Systems.	4
2	Wireless channel modeling and digital system simulation	<b>Project 2:</b> PYTHON-Based Wireless Channel Modeling and Analysis. <b>Project 3:</b> PYTHON-Based Digital Comm. System Simulation and Performance.	4
3	Wireless system simulation and analysis	<b>Project 4:</b> PYTHON-Based Wireless System Simulation and Performance.	4
4	Multiple antenna systems, beamforming, diversity and BER performance	<b>Project 5:</b> PYTHON-Based MRC Beamforming for Multi-Antenna Systems. <b>Project 6:</b> PYTHON-Based EGC and Selection Combining for Multi-Antenna Systems.	4
5	MIMO systems – Transceiver design and Analysis	<b>Project 7:</b> PYTHON - Based MIMO ZF/MMSE Receiver Design <b>Project 8:</b> PYTHON - Based MIMO ML Receiver Design.	4
6	MIMO optimization for rate maximization, MIMO channel estimation	<b>Project 9:</b> SVD-Based MIMO optimization. <b>Project 10:</b> PYTHON - Based MIMO channel estimation – ML and MMSE estimators.	4
7	Orthogonal Frequency Division Multiplexing (OFDM) Simulation	<b>Project 11:</b> PYTHON-based 4G/ 5G OFDM System Design, Simulation and Analysis.	4
8	High Speed MIMO OFDM technology for 4G and 5G	<b>Project 12:</b> PYTHON-based Project for Simulation and Performance of 4G/ 5G MIMO-OFDM Technology.	4

#### 4. Special Emphasis:

PYTHON-based simulation of below systems

- Fading channel modeling, Deep fade
- Diversity, Multi-Antenna Systems
- MIMO Technology
- OFDM Technology
- MIMO-OFDM Technology

## 5. Live Interaction:

- Sunday 4:00 PM – 5:00 PM 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%
Final exam	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

<b>Principles of Modern Wireless Communications</b>	Aditya K. Jagannatham McGraw Hill Education - 2015 <a href="http://www.mheducation.co.in/9781259029578-india-principles-of-modern-wireless-communications-systems">http://www.mheducation.co.in/9781259029578-india-principles-of-modern-wireless-communications-systems</a>
<b>Reference Books</b>	
<b>Practical Numerical Computing Using Python: Scientific &amp; Engineering Applications</b>	Mahendra K Verma
<b>Fundamentals of Wireless Communication</b>	David Tse and Pramod Viswanath Cambridge University Press, 2005 <a href="http://www.eecs.berkeley.edu/~dtse/bo ok.html">http://www.eecs.berkeley.edu/~dtse/bo ok.html</a>
<b>Wireless Communications</b>	Andrea Goldsmith Cambridge University Press

## 9. Instructor and TA Information

Instructor	
<b>Prof. Aditya K. Jagannatham</b> <b>Arun Kumar Chair Professor</b> <b>Electrical Engineering</b>	ACES 205D Electrical Engineering Department IIT Kanpur Kanpur 208016 e-mail: <a href="mailto:adityaj@iitk.ac.in">adityaj@iitk.ac.in</a>
<b>Course TAs</b>	
<b>Anand Mehrotra</b>	<a href="mailto:anandme@iitk.ac.in">anandme@iitk.ac.in</a>

## 10. Assignment format

- One assignment every week. Total 8 assignments
- Number of questions in each assignment: 10
- Question format: Multiple choice objective questions with four given options and only one correct option

- One mark per question
- NO negative marking

#### 11. Quiz format

- One quiz every 2 weeks. Total 4 quizzes
- Number of questions in each quiz: 10
- Question format: Multiple choice objective questions with four given options and only one correct option
- One mark per question
- NO negative marking
- Quiz 1 – Based on Assignments 1/2
- Quiz 2 – Based on Assignments 3/4
- Quiz 3 – Based on Assignments 5/6
- Quiz 4 – Based on Assignments 7/8
- Duration 30-45 min.

#### 12. Final exam format

- Total questions in Final: 40
- Question format: Multiple choice objective questions with four given options and only one correct option
- One mark per question
- NO negative marking
- Closed-book exam
- Duration is 3 hours
- **Question Paper PATTERN**
  - 8 questions: Recall type (Purely formula), one from each week Assignments/ Quizzes
  - 16 questions: Seen, Directly from Assignments/ Quizzes, two from each week
  - 16 questions: Unseen, Roughly 2 from every week based on Assignment/ Quiz questions