

# **CT537 – Advanced Wireless Communications**

**(credits: 3-0-0-3)**

**Instructor: Dr. Laxminarayana Pillutla**

**Email: [laxminarayana\\_pillutla@daiict.ac.in](mailto:laxminarayana_pillutla@daiict.ac.in)**

**Office: Room # 4203, Faculty Block 4,**

**Telephone Extension: 621**

## **Introduction:**

The aim of the course is to introduce the students to some of the latest advances in wireless communications and networking. The course focuses its attention on the physical and MAC layer design aspects of wireless networks. The course will also introduce the students to some of the optimization theory related concepts, which are used extensively in the analysis of wireless networks. The course aims to keep a right balance between theory and practice. The course is open to fourth year undergraduate with good CPI and third semester M. Tech students. A good background in basic probability theory and random processes is required. However to make the course self contained few important probability theory concepts will be covered briefly. The course outline is as follows:

## **Module 1: Mathematical preliminaries**

- Review of probability theory
- Essentials of (convex) optimization theory.
- Essentials of information theory.

## **Module 2: Wireless channel models and latest multiple access technologies**

- Introduction to various channel models (namely frequency flat, frequency selective, Rayleigh and Rician fading models).
- Introduction to CDMA and associated standards.
- Introduction to OFDM.

## **Module 3: Capacity of scalar wireless channels**

- Introduction to the notion of channel capacity.
- Capacity of time invariant channels.
- Capacity of time varying (or fading) channels.

## **Module 4: Capacity of vector (MISO, SIMO, MIMO) channels and spatial multiplexing**

- Capacity of MISO and SIMO channels for both time varying and time invariant cases.
- Capacity of MIMO systems.
- V-BLAST and D-BLAST
- STBC and STTC.

### **Module 5: Multiuser detection (MUD):**

- Introduction to MUD.
- Linear decorrelator.
- MMSE MUD
- Adaptive MUD

### **Module 6: Application of convex optimization to wireless design**

- Minimizing PAPR in OFDM systems via convex optimization
- Applications of convex optimization to MAC and flow control problems.

### **Note:**

1. All the topics mentioned above are tentative. New topics may be added or existing topics may be deleted as required.
2. Only one of the last two modules may be covered in case time is short.

### **Text Book:**

1. Fundamentals of wireless communications by David Tse and Pramod Viswanath.
2. Convex optimization by Steven Boyd and L. Vandenberg (available online at [www.stanford.edu/~boyd](http://www.stanford.edu/~boyd)).

### **Reference Books:**

1. Wireless Communications by Andrea Goldsmith.
2. Digital Communications by John Proakis
3. Introduction to space-time wireless communications by Arogyaswami Paulraj, Rohit Nabar and Dhananjay Gore.
4. Multiuser detection by S. Verdu.
5. Wireless Networking by Anurag Kumar, D. Manjunath, Joy Kuri.
6. Probability, Random Variables and Stochastic processes by A. Papoulis and U. Pillai.
7. Non-linear programming by Dimitri P. Bertsekas.

**Text book rotation policy:** The library has only one copy of the text book and hence that lone book need to shared by all (including me). Therefore I have decided to check out the book myself, and whoever is interested can check it out from me (by signing a sign out sheet) for a maximum of 3 days for their study. The duration of book check out may be reduced in case of heavy demand.

### **Grading policy:**

- Home works: 20%
- Pop (or Surprise) quizzes: 10%
- Mid term exam: 20%
- Final exam: 30%
- Project: 20%

**About Projects:** A list of project titles, which typically come from the leading IEEE journals will be provided to you as we progress. This will happen in the first two weeks of the course. The students are advised to go through the project titles

and pick one title that interests them. Alternatively, the students may suggest titles of their own. **The project team size cannot be more than two.** The students are required to submit their choice of project titles along with a brief summary of what they would like to accomplish as part of the project no later than **September 15<sup>th</sup>**.

The students are required to go through the paper and other relevant references, reproduce at least some of the important results of the paper and finally summarize to the class via a good presentation. A presentation slot of 15 minutes will be allotted to each group (you will be notified of the exact date in the due course). Finally the students are required to submit a detailed project report. **As an incentive you can get an extra credit of 20% in case you propose a novel (I determine what is novel) idea.**

**Note:**

1. In case of group projects, the project report should contain a detailed breakup of as how the project burden has been shared among both the members of the group.
2. It is enough to submit one report per project team.

**Policy on typesetting:** In order to familiarize the students with LATEX that is commonly used for typesetting research papers all the home works and the final project report need to be typeset via LATEX. Please submit the pdf output file as a hard copy or as a soft copy to: ([laxminarayana\\_pillutla@daiiict.ac.in](mailto:laxminarayana_pillutla@daiiict.ac.in)) before the deadline.

**Policy on academic dishonesty and plagiarism:** In case if a student is found to have resorted to unethical academic practices (such as copying home works, copying projects, copying during exams, claiming others work to be yours, etc.), then the DA-IICT academic honor code will be invoked. Typical punishment can vary from getting a zero in that particular home work/project/exam to an “F” in the course. Multiple offences would automatically lead to an “F” in the course.

**Note:** However you are free to discuss about home works and projects with your fellow students, but when you put pen to paper it should be totally your work. **I do not want to see verbatim similar copies of home works or projects.**

**Office hours:** In case if you have any doubt on the topics covered as part of the course you are welcome to see me on **Tuesday and Thursday between 3:00 - 4:00 PM.** If these timings are not convenient to you please mail me an alternate time and day and I will try to accommodate you. Although I really appreciate if you can come and see me on the above mentioned days and times.

**Course Feedback:** I always welcome constructive suggestions, so I would appreciate if you can drop a line and let me know as how the overall experience of the course could be improved.