

University of Notre Dame
Department of Electrical Engineering

EE-87005: ADVANCED TOPICS IN MULTIUSER COMMUNICATIONS

Course Information
Fall 2006

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Coordinator

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Overview

Welcome! *EE-87005: Advanced Topics in Multiuser Communications* is a discussion based graduate course exploring advanced topics in multiuser communications and information theory. Objectives for the course are to develop understanding of the basic models, fundamental performance limits and tradeoffs, and practical approaches for communication in these environments. Interaction and cross-fertilization of ideas from different research areas will also be emphasized. A successful course will allow students to become aware of multiuser issues, digest research papers in the area more readily, and interact with other researchers more fluently.

Each class will be an informal, tutorial-style presentation and discussion led by the coordinator or one of the graduate students, with the remainder of the class participating in the discussion. A written summary of the class topic, with examples and key references, will be distributed one week before the presentation. The coordinator's role is to help enrich, but not direct, the discussion, and to assign grades based on each student's summary, presentation, and class participation.

Prerequisites

The un-official but important prerequisites for EE-87005 are the following: *EE-60553: Advanced Digital Communication* and *EE-80653: Information Theory*—or their equivalents. As a discussion based course, EE-87005 will be more forgiving of the prerequisites than a typical lecture course. Nevertheless, the course will require a high-level of maturity, dedication, and commitment to understanding the material in depth. Please feel free to discuss your background with me before participating in the course.

Meeting Times

Meeting days and times will be:

Wednesday afternoons, nominally 1:00-3:00pm, Location TBD

Our meetings will work best (and be most fun) when they are highly interactive, so your participation is important and strongly encouraged. Remember that asking questions in class is a sign of engagement in the material, not an expression of weakness!

Proposed Roles and Responsibilities

In lieu of problem sets and exams, each class member will lead the discussion for one (or more) weeks. For a given week, he or she reviews literature on a specific topic (with faculty assistance as required), selects one or two key papers and produces a written summary suitable for distribution to the class, and leads a tutorial-style survey of the subject during class. It is the responsibility of all other members of the class to read the summary and papers, attend class, and participate in the discussion. To allow for sufficient preparation, the summary and papers must be distributed at least one week before the presentation.

Course Grade

Auditing this course will be discouraged, as it will affect the dynamics and level of participation of the students. The objective is to make it reasonable for senior graduate students, with their research commitments and hectic schedules, to take this course for credit.

The course grade will be based upon my best assessment of your participation and level of engagement with the material during the semester. Roughly, the weights used in the grade assignment will be:

Summary	20%
Presentation	20%
Attendance	30%
Participation	30%

Although the focus of the course is obviously learning, not grades, I know the course grade is important to you, and I want you to know that I take the process seriously.

Course Materials, Webpage, and E-mail List

Materials—*e.g.*, handouts, summaries, papers, and so forth—will be made available on the course webpage at:

<http://www.nd.edu/~jnl/ee87005/>

In addition to making announcements during class, we may make announcements using e-mail. The course e-mail list is:

ee87005-01-fa06@listserv.nd.edu

All announcements will be archived at:

<http://listserv.nd.edu/archives/ee87005-01-fa06.html>

By registering for the course, you should automatically be a member of the e-mail list. If this is not the case, please let me know.

Possible Topics

Depending upon the interest of the students, and subject to sufficient enrollment, the following topics may be covered:

- Background
 - Overview
 - Jointly Typical Sequences (Weak and Strong)
 - Convexity (Convex Sets, Support Lemma)
 - Auxiliary Random Variables (Time Sharing, Binning)
- Multiuser Source Coding
 - Slepian-Wolf Coding
 - * Binning
 - Wyner-Ziv Coding
 - * Dirty Paper Coding
 - Multiple Descriptions
 - Successive Refinement
 - The CEO Problem
- Multiuser Channel Coding
 - Multiple-Access Channel
 - * Successive Interference Cancellation
 - * Multiuser Detection
 - Broadcast Channel
 - * Degradeness
 - * Duality with Multiple Access Channel
 - Interference Channel
 - Relay Channel
 - * Block-Markov Encoding and Decoding

- * Decode-Forward, Compress-Forward, ...
- Network Coding
 - * Multicasting
 - * Random Linear Coding
- Cross-Cutting Issues
 - Multiple Antenna Systems (MIMO)
 - Channel State Information
 - Resource Allocation (Power, Bandwidth)
 - Feedback

References

In addition to many articles in, among other journals, the *IEEE Trans. on Communications*, *IEEE Trans. on Wireless Communications*, and *IEEE Trans. on Information Theory*, the following books are useful starting points to and references for the material. A complete reference list will evolve on the course web site throughout the semester.

1. T. M. Cover and J. A. Thomas, *Elements of Information Theory*, John Wiley & Sons, Inc., 2006.
2. T. S. Rappaport, *Wireless Communications: Principles and Practice*, Prentice Hall, 2001.
3. W. Stallings, *Wireless Communications and Networks*, Prentice Hall, 2001.
4. S. Verdú, *Multiuser Detection*, Cambridge University Press, 1998.
5. S. Verdú and S. W. McLaughlin (Eds.), *Information Theory: 50 Years of Discovery*, Wiley-IEEE Press, 1999.
6. A. J. Viterbi, *CDMA: Principles of Spread Spectrum Communication*, Prentice-Hall, 1995.