ECSE 612 – Multiuser Communications

Winter 2011

Hours and location

Lectures MW 10:05 - 11:25 am McConnell 627

Teaching staff

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Prerequisites

- ECSE509, Probability and Random Signal 2, or equivalence.
- Basic knowledge in Information Theory.

Course Description

ECSE612 is an advanced graduate course with focus on theory and practice in multiuser communications. The lectures will focus on multiuser information theory with applications in communications. We cover the fundamentals of the multiple access channel, broadcast channel, cognitive channel, interference channel, relay channel, network coding and MIMO multiuser channels. We will also review information theory basics such as entropy, mutual information, channel capacity, random coding to enable students to grasp the core ideas of the multiuser information theory results.

Students are expected to perform a research project as part of the course credit. For the project, students are encouraged to explore applications of the ideas introduced in class to modern communications, as well as information theory.

Syllabus

1. Information theory and channel capacity (review)
2. Multiuser information theory
   (a) Multiple access channel (successive interference cancelation)
   (b) Broadcast channel (superposition coding, Marton binning, duality)
   (c) Channel with state (causality, Gelfand-Pinsker coding, dirty paper coding)
   (d) Interference channel (rate-splitting, Han-Kobayashi scheme)
   (e) Cognitive channel
3. MIMO multiuser communications
   (a) MIMO multiple access and broadcast
   (b) Iterative waterfilling
   (c) Interference alignment
4. Cooperative network communications
   (a) Relay channel (block Markov encoding, list coding, backward decoding, sliding window decoding)
   (b) Network coding
   (c) Relay network
   (d) Ad hoc network

Some of the advanced topics will be covered as time permits.

Assessment Breakdown

- 10% homework
- 30% midterm exam
- 30% project
- 30% final exam

We reserve the right to change these weights based on the performance of the entire class.

- Exams: The midterm exam is open-book and is in class sometime in March. The final will be a 48 hour take-home exam.
- Homework: Homework sets are due in class. Although homework does not contribute much to the grade, it is essential for learning the materials.
- Project: The project will involve a presentation and a report due on **April 6th**. The presentation will be scheduled during the last week of the semester.

Text and References

1. Abbas El Gamal and Young-Han Kim, *Network Information Theory*, Lecture notes, available online at http://arxiv.org/abs/1001.3404.

References

1. Thomas Cover and Joy Thomas, *Element of Information Theory*, 2nd ed., Wiley-Interscience, 2006.

2. Raymond W. Yeung, *A First Course in Information Theory*, Kluwer, 2001.

3. Imre Csiszar and Janos Korner, *Information Theory: Coding Theorems for Discrete Memoryless Systems*, Akademiai Kiado, Dec 1997.

4. Robert G. Gallager, *Information Theory and Reliable Communication*, John Wiley & Sons, Inc., 1968.

5. David Tse and Pramod Viswanath, *Fundamentals of Wireless Communication*, Cambridge University Press, June 2005.

Format

This course will have 24-26 lectures, each lecture is for 80 minute. In the last week there will be student project presentations.

Course website

http://www.info612.ece.mcgill.ca