6.96x Graduate Seminar in Communications

M.I.T. EECS Course Proposal for Fall 2000

Proposing Students:
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Summary

Graduate education in communications at M.I.T. is most directly addressed by three courses: Digital Communications (6.451), Data Networks (6.263), and Information Theory (6.441). There is great and widespread interest in communications within the department, and there is a need for a formal venue in which to explore current and more advanced topics. To address this need, we propose a special subjects course: 6.96x Graduate Seminar in Communications.

Our objectives for the course are to:

- Establish a seminar course based upon graduate-student-led discussions,
- Cover current and advanced topics,
- Create a forum for cross-fertilization of ideas and perspectives,
- Foster the development of our community of faculty and students,
- Maintain an informal style and setting.

To meet these objectives, we propose that the structure of the course be:

Sponsored by a member of the faculty,

Enrollment limited to 13 graduate students (1 per week),

Prerequisites: 6.451, 6.263, 6.441, permission of instructor,

Units: 3-0-9, P/F,

Schedule: Once per week for 2 hours,

Requirements: Attendance, single presentation and writeup.

This proposal is the result of numerous discussions among graduate students from several research groups performing work in communications, as well as interactions with several faculty members.

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1 Background and Proposal Process

Graduate education in communications at M.I.T. is most directly addressed by three EECS courses: Digital Communications (6.451), Data Networks (6.263), and Information Theory (6.263). There is great and widespread interest in communications in the department, but there is no formal venue in which to explore current and more advanced topics in the field.

In Spring 2000, after discussing this situation with Prof. Forney, a number of graduate students from several research groups gathered to brainstorm ways to remedy this deficiency. After meeting with Profs. Chan, Gallager, and Forney to obtain feedback on these ideas, our team reviewed the ideas and put them together into this proposal. We hope to achieve two things with this proposal. First, we hope to assess the level of interest among other students from research labs/groups such as, but not limited to, LIDS, SSG, DSPG, and LCS. Second, we hope to explore with the EECS Department the possibility of offering such a course in Fall 2000.

2 Objectives

We propose a seminar course of graduate student presentations on advanced topics in communications. The style of the class is proposed to be informal and discussion-based, centered around student-delivered tutorials rather than professor-prepared lectures. Our primary objectives for such a course are to:

- Establish a seminar course based upon graduate-student-led discussions,
- Cover current and advanced topics,
- Create a forum for cross-fertilization of ideas and perspectives,
- Foster the development of our community of faculty and students,
- Maintain an informal style and setting.

3 Suggested Topic Areas

The proposed course will cover advanced and current topics otherwise not covered (either at all, or in depth) by the current communications curriculum. The proposed topics are in the areas of:

- Coding,
- Information Theory,
- Wireless Communications,
- Signal Processing/Optimization/Estimation Perspectives,
- Data Networking.

A list of topic areas chosen for Fall 2000 is given in Appendix B, along with the faculty coordinator(s) for each topic area. The final list of topics and suggested readings will be prepared before the start of the Fall term.

4 Course Structure

To meet the above objectives, we propose that the structure of the course be as outlined in Table 1. The class is suggested to be held once per week, for 2 hours each session. Each session will be an

Component	**Reasoning**
Faculty sponsor	Maintain semi-formal atmosphere. Facilitate interaction with faculty.
Enrollment limited to 13	Each student presents a session. Maintain small-class atmosphere. Stimulate active discussions.
Prereq: 6.451, 6.263, 6.441, perm. of instr.	Ensure advanced graduate students. Uniformly strong background.
Units: 3-0-9	See Section 5.
Grading: P/F	Natural choice due to variety of topics. No single grading metric appropriate.
Schedule: 1/wk, 2 hrs.	Focus on one topic per session. Natural addition to research week.
Setting: Small conf. room	Enhance interaction.

Table 1: Discussion of course structure.

informal tutorial-style presentation/discussion led by one of the graduate students. The professor's role is to help enrich, but not direct, the discussion, and to assign grades of P/F based on each student's presentation and class participation.

5 Roles and Responsibilities

In each session, one student presents while another student acts as "scribe". The remaining students listen to the presentation and participate in the discussion. We envision the following roles and responsibilities for the participants in the seminar:

- Professor: Provides experienced perspective on topics.
  Responsibilities:
  - Coordinates student registration.
  - Approves final topics list.
  - Helps recommend relevant papers/books for each topic.
  - Participates in, but does not lead, discussions.
  - Assists student presenter in creating session writeup.
  - Assigns grades (P/F).
- Student Presenter: Presents topic and leads discussion.
  Responsibilities:
  - Reads recommended papers and surveys literature.
  - Distributes final reading list to class.
  - Prepares tutorial.
  - Leads discussion.
  - Writes up notes.
    * Creates an accessible summary of topics by end of course.
    * Tutorial-style. Include general ideas, models, insights, and a few references.
    * Along with presentation, only deliverable for class.
- Student Scribe: Takes notes during presentation and discussion.
  Responsibilities:
  - Capture important discussion points to assist student presenter with session writeup.
  - Discuss material and notes with student presenter.
- Remaining Students: Contribute to discussions.
  Responsibilities:
  - Preview reading list for each session.
  - Attend sessions.
  - Participate in discussions.

A Draft Course-Bulletin Listing

6.96x Graduate Seminar in Communications

Prereq.:	6.451, 6.263, 6.441, or permission of instructor (enrollment limited to 13)
Acad Year 2000-01:	G (Fall)
3-0-9	H-Level Credit [P/F]
Proposed meeting time:	Wed., 2–5 P.M.
Instructor:	Staff (coordination by Profs. Forney and Tarokh; involvement of other communications faculty on specific topics as required)

Graduate seminar exploring advanced topics in communications. Capacity-approaching codes, network information theory, wireless communications, equalization and multi-user detection, advanced wire-line modems, and quantum communications,

Each class member leads discussion for one session. For that week, he or she reviews literature on a specific topic (with faculty assistance as required), prepares and leads a recitation-like survey of the subject, and produces a written summary suitable for distribution.

B Topic Areas, Fall 2000

1. Capacity-Approaching Codes (D. Forney)
   - Codes
     - turbo codes
     - low density parity check codes
     - multilevel codes (trellis representation)
   - Decoding algorithms
     - turbo decoding
     - sum-product algorithm
     - belief propagation
   - Codes on graphs
2. Network Information Theory (B. Gallager)
   - Channel coding
     - multiple access channel
     - broadcast channel
     - relay channel
     - general networks
   - Source coding

- Slepian-Wolf coding
- side information
- multiple descriptions
- successive refinement

- Joint source-channel coding

3. Wireless Communications (V. Tarokh)
   - Models
   - Multiple Access (TDMA, FDMA, CDMA)
   - Diversity techniques (Coding, Spread-Spectrum)
   - Antenna Arrays (Beamforming, Space-Time Coding)
   - Information-theoretic considerations
     - capacity
     - knowledge assumptions (of channel at tx, rx)
     - outage probability

4. Equalization (D. Forney, V. Tarokh)
   - Decision-Feedback Equalization (DFE)
   - Adaptive/Blind techniques
   - Tomlinson-Harashima Precoding
   - Constrained-complexity MLSE
   - Approaching channel capacity on ISI channels
   - Multiuser Detection

5. Advanced Wireline Modems (D. Forney)
   - Digital Subscriber Line (DSL)
   - Cable

6. Quantum Information Theory (D. Forney)