**Department of Electrical Engineering and Computer Science**


# Guide to Graduate Study in Area I

Welcome to Area I!

Lying at the critical interface between computation and the physical world, Area I bridges the more traditionally computer science centric and more traditionally electrical engineering centric areas of the department. The research ranges from fundamental system, information, and network science, through to engineering principles and design for a host of important contemporary and emerging applications. Examples include a broad spectrum of problems of communication and coding, systems theory and control, optimization, statistical inference and decision theory, and signal processing, as well as the shared methodological underpinnings of—and increasingly the interactions between—these different fields. Research topics range from fundamental principles to application, from analysis to synthesis, and from theory to experiment and simulation. Thesis research can involve different combinations of the above, depending on the student's interests and the nature of the problem.

Area I faculty chair, **Greg Wornell** Spring, 2012

## Initial Priorities for New Graduate Students

Our graduate program involves a combination of research, course work, and, in most cases, teaching. A number of requirements must eventually be satisfied. Experience has shown that the first-year student will do well to focus on the following primary goals:

- Finding a masters thesis supervisor
- Ensuring fluency in the necessary undergraduate background for Area I
- Successfully completing at least two Area I core graduate courses with mastery

### Finding a Thesis Supervisor

Finding a thesis advisor that is a good match in terms of interests, style, and temperament should be the student's top priority from the moment of arrival, if not earlier. As a result of the popularity of Area I among students, there are many more graduate students in Area I than can be supervised by the Area I Faculty alone. However, there are many faculty and staff whose primary affiliation is an area other than Area I, but who have Area I oriented research projects and supervise Area I graduate students. So, while the opportunities are plentiful, the process of identifying and picking one is less straightforward than in other areas.

Students supported by a research assistantship (RA) have already achieved this goal. Such students should register for 24 units of 6.991 (Research in EECS) or 6.ThG (graduate thesis research), plus at most two 12-unit subjects. (Note that in terms of strategy it is perfectly acceptable to register for more subjects initially, and then to drop all but one or two after sampling the first few weeks of lectures; in general, it is very easy to add and drop subjects at MIT.)

Students supported by a teaching assistantship (TA) or a fellowship (or other support) should start immediately to try to find a thesis advisor. Such students should register for 6.961, a 12-unit subject that introduces the student to graduate research in the department. The first phase of this subject involves finding a research supervisor for the term with an interesting introductory research project. Note that while most 6.961 projects evolve into masters theses, the masters thesis can ultimately go in a different direction and even involve a different research supervisor, depending on opportunities. TA's also typically register for 24 units of 6.981 (Teaching in EECS), leaving them room for one additional 12-unit subject. Students with fellowship support usually have room for two such subjects.

### Undergraduate Background

Most of the Area I graduate subjects have a strong mathematical bent and require not just an exposure to, but a fluency with, undergraduate background in linear systems, probability, and linear algebra. Students should assure themselves that they have such fluency as a solid foundation for their graduate work.

A common mistake is to enroll in an Area I graduate subject thinking that you can correct your background deficiencies as you go along, and then to find out about the time of the midterm exam that you are falling behind and doing poorly because of your inadequate background. It is much better to correct your background deficiencies first (and you will be much happier).

Relevant courses at MIT include: **6.003** (Signals and Systems); **6.431** (Applied Probability); **18.06** (Linear Algebra); **6.011** (Introduction to Communication, Control and Signal Processing)

### Core Area I Graduate Subjects

Area I offers a broad range of graduate subjects in its constituent fields, most of which can be taken with few prerequisites other than the common undergraduate background discussed above.

Certain of these graduate subjects are regarded as “core,” in the sense that they are appropriate for first-year graduate students with adequate undergraduate background, and are prerequisites for further subjects in the same area. These core subjects include: **6.241** (Dynamic Systems and Control); **6.251** (Introduction to Mathematical Programming); **6.255J** (Optimization Methods); **6.262** (Discrete Stochastic Processes); **6.341** (Discrete-Time Signal Processing); **6.436** (Fundamentals of Probability); **6.437** (Inference and Information); **6.438** (Algorithms for Inference); **6.450** (Principles of Digital Communications I). Most first-year graduate students should plan to take at least two of these core subjects in their first year.

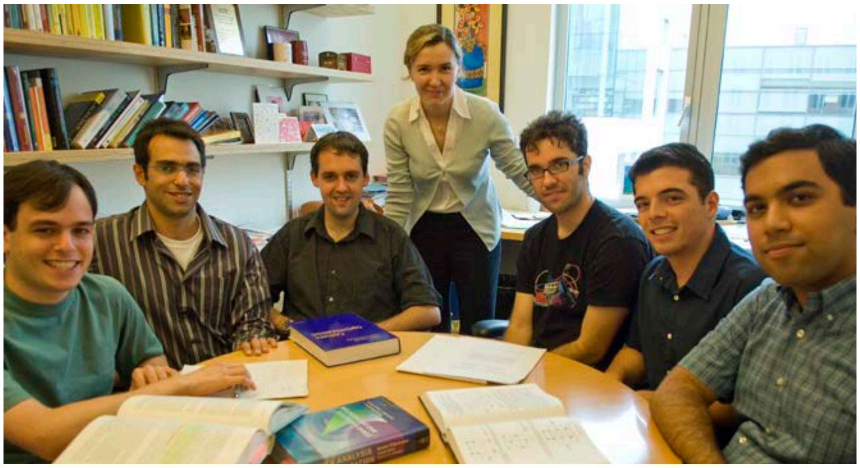
### The Technical Qualifying Evaluation

The TQE is a departmental exam which involves proving competence in the fundamentals based on performance in four subjects drawn from three groups in the **EECS TQE subject grid**. Two of the subjects must be from one group in the grid; this constitutes the depth component. The remaining two subjects must be from two different groups; this constitutes the breadth component. Note that most (but, perhaps paradoxically, not all) of the core Area I graduate subjects listed in the previous section can be used to satisfy the graduate portion of the TQE. The TQE is passed immediately and no oral exam component is required if a student obtains either 4 A’s, or 3 A’s and a B.

If a student does not meet this grade threshold, they proceed to the next portion of the exam, in which follow-up oral exam(s) are taken in the area(s) of identified weakness until adequate competence is demonstrated. It should be emphasized that there is no shame in taking an oral exam; until relatively recently in our department’s history all graduate students took an oral exam. The current TQE format simply removes this component of the exam for the subset of students for whom there is already evidence that their backgrounds are sufficiently sound to proceed.

### Beyond the Core Subjects

The student may choose as many additional courses as he or she can handle in order to obtain greater depth in the various topical sub-areas of Area I, greater breadth in other areas, or just to satisfy intellectual curiosity or be exposed to a great teacher. However, keep in mind that: again, it is best to do well in fewer courses than not so well in more courses and there will be plenty of time at MIT to take all the courses your heart desires. Some of the historically popular Area I follow-on offerings include: **6.231** (Dynamic Programming and Stochastic Control); **6.242** (Advanced Linear Control Systems); **6.243J** (Dynamics of Nonlinear Systems); **6.245** (Multivariable Control Systems); **6.252J** (Nonlinear Programming); **6.263J** (Data-Communication Networks); **6.291** (Seminar in Systems, Communication, and Control Research); **6.343** (Digital Speech Processing); **6.344** (Two-Dimensional Signal and Image Processing); **6.345** (Automatic Speech Recognition); **6.435** (System Identification); **6.441** (Transmission of Information); **6.442** (Optical Networks); **6.451** (Principles of Digital Communication II); **6.452** (Principles of Wireless Communication); **6.454** (Graduate Seminar in Area I); **6.455** (Sonar, Radar and Seismic Signal Processing); and **6.456** (Array Processing).



Pictured left: Graduate student group of Area I Professor Asuman Ozdaglar, including, left to right, Noah Stein, Ishai Menache, Ilan Lobel, Prof. Ozdaglar, Kostas Bimpikis, Ozan Candogan, Ali Parandeh Gheibi.

“The research in our group spans the areas of optimization theory, with emphasis on nonlinear optimization and distributed optimization methods, game theory, network economics, and network optimization and control.

The group focuses on problems that arise in the analysis and optimization of large scale dynamic multi-agent networked systems, including communication networks, transportation networks, and social and economic networks.”

Read about other Area I faculty at: http://www.eecs.mit.edu/grad/area1/faculty.html