Area III: Electronics, Computers, and Systems

Guide to Graduate Study in Area III

Welcome to Area III!

Research in Area III emphasizes electronic circuits and systems, microprocessor based control, and digital and analog signal processing. Design and practical implementation are emphasized. More than forty faculty members have a primary or secondary interest in this area, and are generally located in the Research Laboratory of Electronics, **RLE**, Microsystems Technology Laboratories, **MTL**, the Computer Science and Artificial Intelligence Laboratory, **CSAIL**, the Laboratory for Information and Decision Systems, **LIDS**, the Center for Materials Science and Engineering and the Laboratory for Electromagnetic and Electronic Systems, **LEES**.

Area III faculty chair, **David J. Perreault** Spring, 2012

Image above: ldmos power transistor developed in the laboratory of David J. Perreault.

Degree Programs

Programs for graduate students in electronics, computers, and systems lead to the degrees of Master of Science, Master of Engineering, Electrical Engineer, Doctor of Philosophy, and Doctor of Science. They emphasize both analysis and synthesis of devices and systems for measuring or processing signals, information, or power. Examples of research activities include processing of digital and analog signals representing audio, visual, or other information; analog and digital system design; computer architecture and software/hardware system design; design and analysis of VLSI systems; computer aided circuit design; circuit theory; electric and electronic power systems; and electronics for instrumentation and control.

The programs involve academic study, other professional training, and a thesis that serves as a professional apprenticeship in research and engineering; these components are described in more detail in the successive pages of this website.

Academic Program

Professional expertise requires a thorough understanding of fundamentals together with the more advanced technology unique to one's area of specialization. The core Area III subjects are listed in the **MIT Bulletin** in the section Electronics, Computers, and Systems and are in the 6.3xx group. However, because of the broad area of coverage of Area III, at least half of the other Course 6 subjects are relevant graduate work in Area III.

Students in Area III are advised either to take the fundamental subjects relevant to their special interests, or have learned those fundamentals elsewhere. Note that two advanced undergraduate course can be applied toward an SM degree. In addition, it is generally recommended that one or more additional fundamental electives be taken because professional competence today requires considerable breadth. These courses might form part of a minor for a doctoral program. The recommended curriculum for students in Area III includes at least four courses from the 6.3xx group, including at least one graduate elective course from each of the following three groups: 1) signal processing, communications, and control, 2) devices, circuits, and digital design, and 3) the more specialized or applications courses.

Other Professional Training

In addition to regular academic subjects and thesis work, there are important additional ways to develop professionally. These include teaching and research assistantships, special seminars on current technical topics, and membership and participation in appropriate professional societies. In Area III, it is particularly important to become familiar with current literature because technology today is too diverse and advancing too rapidly for the more formal and academic subjects to keep pace. Seminars and professional journals are appropriate vehicles for developing and preserving such breadth.

Qualification for Doctoral Training

The department has instituted a doctoral qualification procedure that consists of two parts, the TQE (technical qualification exam), and the RQE (research qualification exam). For details, see the **Department TQE grid (pdf)**.

Research Programs:

The laboratories at MIT that are mostly involved with research in Area III are the Research Laboratory of Electronics, the Microsystems Technology Laboratories, the Laboratory for Information and Decision Systems, and the Laboratory

for Electromagnetic and Electronic Systems. Several other laboratories pursue selected programs in this area including the Center for Materials Science and Engineering, the Computer Science and Artificial Intelligence Laboratory, and Lincoln Laboratory. Draper Laboratory, formerly part of MIT, also supports several research assistants. Annual Progress Reports of these laboratories are available in the MIT libraries and in the respective laboratory document rooms.

An overview of research in the EECS Department is provided by 6.961, Introduction to Electrical Engineering Research, which is offered each fall. Area III also conducts an Open House where representative research areas are discussed and laboratory tours are arranged.

Areas of Focus:

The five broad areas of focus within Area III are:

Signal Processing, Communications and Control:

The subjects relevant to signal processing, communications and control include several which are basic to other areas as well as to Area III. Statistics, random signals, and noise are discussed in 6.432, and basic principles of linear system theory are developed in 6.241 and 6.242. Digital signal processing is presented in 6.341 together with some basic linear system theory. 6.343, 6.344 and 6.345 are more advanced subjects in signal processing. Graduate electives develop a variety of other concepts and technologies basic to the analysis and design of communications, control, and signal processing systems. Other more mathematical subjects are not listed here because they normally fall within the province of Area I.

Energy and Power Systems:

Research in this laboratory is directed toward developing the advanced process techniques needed for fabricating surface structures with feature sizes ranging from nanometers to micrometers. Facilities are available for photo-, interferometric, electron-beam, and x-ray lithography. In addition, the NSL houses materials and processing facilities for etching (chemical, plasma and reactive-ion), lift-off, electroplating, sputter deposition and e-beam evaporation. See: http://nanoweb.mit.edu/.

Circuits and Systems:

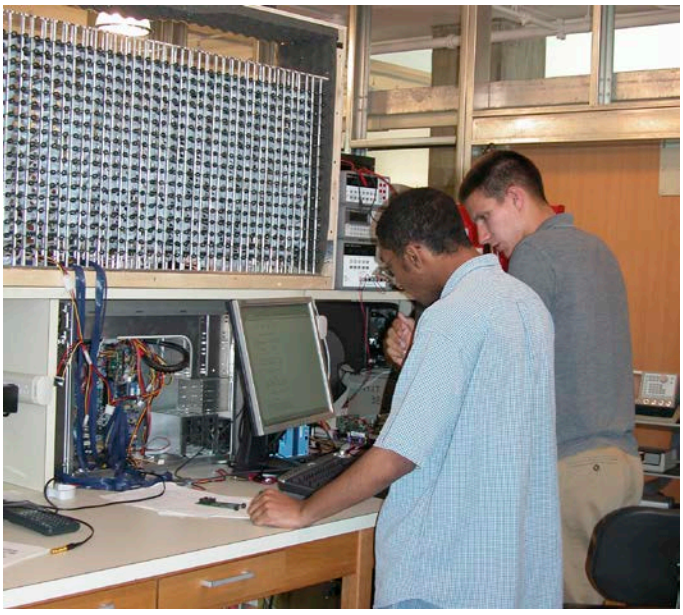
Circuits and systems center on device-level circuit and system design, which are discussed in several undergraduate and graduate subjects. Graduate students may want to take undergraduate laboratory subjects 6.101, 6.111, or 6.115 The electives 6.301 and 6.302 have long provided valuable background for analog electronic circuits. In addition, they may consider graduate subjects such as 6.331, 6.334, 6.374, 6.376, 6.775, and 6.776.

Digital Design and Computer Architecture:

Digital design and computer architecture courses include some useful subjects offered as undergraduate electives. 6.823 is a basic course in computer architecture but requires some computer science background. 6.374 is the advanced subject in VLSI and Integrated Circuit design. The thesis and other individual programs are also very important in developing expertise in this area; these opportunities are discussed later in this guide. Some students may find it beneficial to consider other subjects in this sequence, such as 6.004 (computer architecture) if this material is unfamiliar.

Computer-Aided Design and Numerical Methods:

Computer-aided design and numerical method are covered in graduate-level courses such as 6.336J which introduces computational simulation and optimization, 6.337J for iterative and direct linear solution, FFT, and wavelets, and 6.338J for parallel computing.



Abraham Evans-El '05, pictured far left, and Eugene Weinstein '00, pictured right, operate the LOUD 1020 microphone array connected to the Raw Tiled Multicore Processor in the Computer Science and Artificial Intelligence Laboratory, CSAIL, of Area III Professor Anant Agarwal.

For more information on the work of Prof. Agarwal and the RAW project, a tiled multicore micro-processor architecture and LOUD, a beam-forming microphone array, see:

- Anant Agarwal website: **http://cag.csail.mit.edu/~agarwal/**
- RAW architecture workstation: **http://groups.csail.mit.edu/cag/raw/**
- LOUD Large Acoustic Data Array Project: **http://groups.csail.mit.edu/cag/mic-array/**
- CSAIL: Computer Science and Artificial Intelligence Laboratory: **http://www.csail.mit.edu**