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Graduate Certificate of Advanced Studies in Engineering (CASE) are also available in some of the programs. Professional development short courses and certification programs include:

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Many of the programs are available through distance. For more information, see www.interpro.engin.umich.edu

NSF-Engineering Research Center for Wireless Integrated MicroSystems (WIMS)

This Center is focused on the intersection of three key areas: microelectronics, wireless communications, and MEMS. The resulting integrated microsystems will soon provide hands-on information gathering nodes for applications ranging from environmental monitoring to health care. The WIMS Engineering Research Center is working to make these microsystems a reality. It is developing the technology base needed to produce them, including precision sensors, micropower circuits, wireless interfaces, and wafer-level packaging.

http://www.engin.umich.edu/about/
Integrated Microsystems is an interdisciplinary program in the College of Engineering at the University of Michigan, Ann Arbor. This unique program provides the opportunity for students to gain a deep understanding of Integrated Microsystems and MicroElectroMechanical Systems (MEMS) while gaining breadth in complementary engineering disciplines.

The program also incorporates courses in business and management, and provides students with the opportunity to work on an interdisciplinary team project, creating a microsystem with potential for commercialization.

Students who graduate from this program will have both enhanced interdisciplinary skills in relevant engineering science and the business and teamwork skills necessary to guide product and process development in the field.

Students may earn a master’s degree, certificate, or simply take stand-alone courses. Distance learning options are available.

Program Overview
The Master of Engineering (MEng) is a 30 credit hour program, whereas the Certificate of Advanced Studies in Engineering (CASE) requires 15 credit hours. The courses provide in-depth knowledge in the following areas:
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- Writing technical proposals

This program is designed to strengthen students’ core engineering skills in a given discipline while providing the opportunity to explore complementary areas. Our students gain valuable skills for product and process development. The interdisciplinary design team project focuses on current problems in the microsystems industry.

Admission Requirements
Professionals who are employed in technology-related activities, or recent graduates with science or engineering degrees, may be admitted into the program. Some specific admission requirements include the following:
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# Sample Course Plan

## Course Title | Crd. | Year 1 | Year 2
--- | --- | --- | --- | --- | --- | ---
### A. Technical Depth (Core) Courses: 12 Credit Hours
EECS 414* | 4 | X | | | | Introduction to MEMS
EECS 514 | 4 | X | | | Advanced MEMS Technologies and Devices
EECS 515 | 4 | | | X | Advanced Integrated Microsystems

### B. Technical Breadth Courses: 6–8 Credit Hours
**FABRICATION PROCESS CONCENTRATION EXAMPLE**
EECS 425 | 4 | X | | | Integrated Microsystems Laboratory
EECS 528 | 3 | | X | | Microelectronics Processing

**WIRELESS CONCENTRATION EXAMPLE**
EECS 531 | 4 | | | | Antenna Theory and Design
EECS 430 | 4 | | | Radiowave Propagation

**CIRCUITS CONCENTRATION EXAMPLE**
EECS 413 | 4 | | | Monolithic Amplifier Circuits
EECS 522 | 4 | | | Analog ICs for Communications

**BIO/FLUIDS CONCENTRATION EXAMPLE**
BME 518 | 4 | | | | Biological Systems
EECS 509 | 4 | | | | BioMEMS

### C. Management/Product Development/Manufacturing Processes/Economic Factors: 5–8 Credit Hours
EECS 830 | 2 | X | | | Societal Impact Seminar
MFG 461 | 4 | | | X | Quality Engineering
MFG 599 | 3 | | | | Financial Analysis for Modern Mfg.

### D. Design Project: 4–6 Credit Hours
EECS 599 | 4 | X | | Design Team Project

*ME553 may be substituted as equivalent.
This course is an introduction to CMOS analog and mixed signal design. Some bipolar circuits are considered. The course begins with a review of MOS and bipolar transistors basics, and small signal analysis. Single stage and differential amplifiers are described. CMOS opamps, stability, and frequency compensation are covered. Advanced topics such as switched capacitor circuits, band gap references are discussed. This course includes a major design project. Students work with .25µm CMOS, using industry-standard Cadence design tools for schematic entry, simulation, and layout.

Instructor:
Professor Michael P. Flynn received his BE and MEngSc degrees from the National University of Ireland at Cork, and PhD degree from Carnegie Mellon University. He has worked at the National Microelectronics Research Centre, National Semiconductor, Texas Instruments, and Parthus Technologies. He was an adjunct faculty member at the National University of Ireland, Cork, from 1997 to 2001. Dr. Flynn joined the University of Michigan in 2001. His technical interests are in data conversion, gigabit serial transceivers, and RF circuits. In 2004, he received the NSF Early Career Award. He serves on the Technical Program Committees of ISSCC and A-SSCC. He is a senior member of the IEEE, a member of Sigma Xi, and a Thrust Leader for Wireless Interfaces at University of Michigan’s WIMS-NSF Engineering Research Center.
Designed to teach the fundamentals of devices and systems, this class is the first in a five-class structure teaching integrated Microsystems and microelectromechanical systems (MEMS). It covers micromachining and microfabrication techniques, sensing and transduction mechanisms, and design and analysis of devices and systems. Undergraduate seniors and graduate students who are not familiar with MEMS, microfabrication, micromachining, and devices and systems are this class’ target.

Instructor:

Professor Khalil Najafi received the BS, MS, and the PhD degrees in 1980, 1981, and 1986, respectively, all in electrical engineering from the Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI. From 1986 to 1988, he was employed as a research fellow; from 1988 to 1990, as an assistant research scientist; from 1990 to 1993, as an assistant professor; from 1993 to 1998, as an associate professor; and since September 1998 as a professor and the director of the Solid-State Electronics Laboratory in the Department of Electrical Engineering and Computer Science at the University of Michigan. In 1998, he was named the Arthur F. Thurnau Professor and received the College of Engineering’s Research Excellence Award. He is a Fellow of the IEEE.
This class is an undergraduate capstone design experience. Throughout the semester, students form interdisciplinary teams to develop a complete two-chip microsystem from inception to final test. As a secondary emphasis, students use their designed chips as examples of scientific principles being taught to secondary schools and learn technical communication.

A capacitative microphone chip and its integrated readout circuitry.

Instructor:

**Professor Kensall D. Wise** received the BSEE degree from Purdue University, West Lafayette, Indiana, in 1963 and the MSEE and PhD degrees in electrical engineering from Stanford University, Stanford, California, in 1964 and 1969, respectively. From 1963 to 1965, and from 1972 to 1974, he was a member of the technical staff at Bell Telephone Laboratories. In 1974, he joined the University of Michigan, where he is now the William Gould Dow Distinguished University Professor of Electrical Engineering and Computer Science, the J. Reid and Polly Anderson Professor of Manufacturing Technology, and Professor of Biomedical Engineering. He is a Fellow of the IEEE and the AIMBE and a member of the United States National Academy of Engineering.
EECS 509: bioMEMS

Prerequisite: EECS 414 or equivalent

Distance Learning Option

This graduate course covers the latest advances in bioMEMS, with specific attention to microsystems targeting developmental biology and cell culture. An organism’s development—from genome to multicellular tissue—is used as a framework for teaching bioMEMS devices: from microPCR chips to microfluidic mixers to tissue scaffolds. The aim is to provide students familiar with microfabrication and microsystems with a context from which to view and evaluate bioMEMS devices and innovations. The course also covers implantable and diagnostic microsystems. The format consists of lectures followed by in-class paper review and discussion led by students: the bulk of the technology is presented through published literature. Critical evaluation of publications is demanded. A principal component of the grade is a written NSF or NIH exploratory proposal due at the conclusion of the course.

Instructor:

Assistant Professor Michel M. Maharbiz is with the Department of Electrical Engineering and Computer Science, the Biomedical Engineering Department, and the Chemical Engineering Department. He received his PhD from the University of California at Berkeley for his work on microbioreactor systems (which led to the foundation of a bioinstrumentation company—www.microreactor.com). Professor Roger T. Howe (EECS) and Professor Jay D. Keasling (ChemE) were his thesis advisors. Dr. Maharbiz has been a GE Scholar and an Intel IMAP Fellow. Professor Maharbiz’s current research interests include micro/nano systems for cell culture and biology, parallel assembly processes and bio-derived fabrication methods. His group is currently focused on micro/nanosystems designed to pattern and control diffusible microgradients during cell and embryo development. His group’s long term goal is understanding developmental mechanisms as a way to engineer and fabricate machines. Professor Maharbiz is a Member of the IEEE and ACS and is Vice President of Technical Operations for the IEEE Sensors Council.
This course will cover most of the well-known analog and digital conversion schemes. These include the flash, folding, multi-step, and pipeline Nyquist-rate ADC architectures. Oversampling converters will also be discussed. The main focus will be on CMOS circuits, but some bipolar schemes will also be covered. (The emphasis is on designing circuits which can be built with state-of-the-art commercial processes.)

The course will begin with a review of mixed-signal design. Common building blocks, such as comparators and opamps will be examined in detail. However, students are expected to have a good knowledge of analog design fundamentals—i.e., feedback, small signal analysis, stability, etc.—and should also be familiar with Spice before taking this course. EECS 413 (or an equivalent) is a prerequisite. Practical design work is a significant part of this course. Students design and model complete converters. Design work will be done with the aid of Matlab, Composer, or Spectre.

Instructor:

Professor Michael P. Flynn received his BE and MEngSc degrees from the National University of Ireland at Cork, and PhD degree from Carnegie Mellon University. He has worked at the National Microelectronics Research Centre, National Semiconductor, Texas Instruments, and Parthus Technologies. He was an adjunct faculty member at the National University of Ireland, Cork, from 1997 to 2001. Dr. Flynn joined the University of Michigan in 2001. His technical interests are in data conversion, gigabit serial transceivers, and RF circuits. In 2004, he received the NSF Early Career Award. He serves on the Technical Program Committees of ISSCC and A-SSCC. He is a senior member of the IEEE, a member of Sigma Xi, and a Thrust Leader for Wireless Interfaces at University of Michigan’s WIMS-NSF Engineering Research Center.
EECS 514 covers advanced MEMS technologies, transduction mechanisms, and microfabricated sensors and actuators. Examples include: magnetic and piezoelectric devices, and micromachining methods for bulk metals and dielectrics. Students work in teams to design sensors and actuators as part of the project component.

Electroplated Cu tools (left) are used to micromachine WC-Co alloy gears (right) by \(\mu\)EDM technology.

Instructor:

**Yogesh B. Gianchandani** is a Professor in the EECS Department and holds a courtesy appointment in the Department of Mechanical Engineering at the University of Michigan, Ann Arbor. His research interests include all aspects of design, fabrication, and packaging of micromachined sensors and actuators and their interface circuits. Professor Gianchandani serves on the editorial boards of several journals, and is a co-editor-in-chief of *Comprehensive Microsystems* (Elsevier). He also served as a General Co-Chair for the IEEE/ASME International Conference on Micro Electro Mechanical Systems (MEMS) in 2002. At the University of Michigan, Professor Gianchandani serves as the Director of the College of Engineering Interdisciplinary Professional Degree Program in Integrated Microsystems.
Interface electronics for sensors and their influence on system performance. Interface standards, MEMS and circuit noise sources, packaging and assembly techniques, testing and calibration approaches, and communication in integrated microsystems. Applications, including RF MEMS, optical MEMS, bioMEMS, and microfluidics. Design project using CAD. NSF-style proposal preparation; panel reviews.

A multi-chip assembly of micromachined neural probe electrode arrays with integrated electronics.

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The course examines a number of important issues facing society and the roles that microsystems can play in their solution. The course also reviews the impact of electronics on our present society and the lives of some of its key pioneers. Students will get a feeling for past challenges, for the pioneers that helped address them, and for the future challenges that they themselves will address.

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