ECE 5221: Fundamentals of Micromachining Processes

Credits and Contact Hours: 3.0 Credit Hours
15 weeks: Two 80-minute lectures + one 3-hour lab per week

Instructor’s Name: Florian Solzbacher

Text Book(s) and/or Required Material:
- Class Slides

Catalog Description: Introduction to the principles of micromachining technologies. Topics include photolithography, silicon etching, thin film deposition and etching, electroplating, polymer micromachining, and bonding techniques. A weekly lab and a review of micromachining applications is included.

Prerequisites:
- Instructor Consent; and
- Full major status in Computer Engineering

Designation: Elective

Contribution of Course to Meeting the Requirements of ABET Criterion 5: This course teaches electrical engineering science and design.

Specific Outcomes of Instruction: In this course, students will be prepared to:
1. Gain an understanding of standard microfabrication techniques and the issues surrounding them;
2. Know the major classes, components, and applications of microsystems and to demonstrate an understanding of the fundamental principles behind the operation of these systems;
3. Understand the unique requirements, environments, and applications of microsystems; and
4. Apply knowledge of microfabrication techniques and applications to the design and manufacturing of a microsystem.

Relationship of the Course to the Program Outcomes:
(a) An ability to apply knowledge of mathematics, science, and engineering. Students are required to apply micromachining and engineering techniques to design and test microstructures with electrical engineering application. These projects require the application of mathematics, modeling, and engineering.

(b) An ability to design and conduct experiments, to analyze and interpret data, and to debug and analyze software. While students do not typically design the experiments, they do analyze and interpret the data collected during characterization of microsystems fabricated in the lab.
(c) An ability to design a system, component, process or software package to meet desired needs. Students are required to identify a need in electrical engineering and design, develop, test, and characterize a device to meet that need.

(d) An ability to function on multidisciplinary teams. Undergraduate students pursue their design projects in teams of 3 or 4 students and are typically mixed with students in bioengineering, mechanical engineering, materials science, and/or computer science.

(e) An ability to identify, formulate, and solve engineering problems. While the problems solved in this course are not typically heavily mathematically based, students do identify manufacturing problems in microsystems, formulate a solution, and solve the manufacturing problem.

(f) An understanding of professional and ethical responsibility. As part of the design project, students are required to address safety and other ethical issues related to the design of their system.

(g) An ability to communicate effectively in written and oral form. Students are required to prepare lab notebooks to convey their learning and understanding. The final design project is presented in a poster session which requires both oral and written communication.

(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. The course does not explicitly cover or test this, but these topics are raised in examples and discussion of the technology, such as environmental impact of processing, improvements in processing and resource use, impact of the product outcome on society and environment.

(i) A recognition of the need for, and an ability to engage in life-long learning. This course is highly interdisciplinary, cutting-edge and forces students to engage in work outside of the typical realm of electrical engineering, thus promoting an understanding of the need to continually learn. Workers in this area who do not stay current quickly become obsolete.

(j) A knowledge of contemporary issues. At least two lectures address the changing markets and opportunities in the microsystems area related to electrical engineering.

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. This course teaches the use of dozens of microfabrication tools as well as modeling, development, and simulation software for microfabricated devices.

**Topics Covered in the Course:**

- MEMS introduction
- Cleanroom technology
- Materials
- Substrate fabrication
- Introduction to vacuum technology
- Chemical Vapour Deposition (CVD)
- Physical Vapour Deposition (PVD)
- Alternative microfabrication processes
- Lithography
- Layer structuring
- Layer modification
- Micromechanical Processes
- Packaging
- Oxidation
- Economical considerations