ECE 5231/5232: Microsensors/Microsensors Lab

Credits and Contact Hours: 3.0/1.0 Credit Hours, Respectively
15 weeks: Three 50-minute lectures + one 3-hour lab per week

Instructor’s Name: Florian Solzbacher

Text Book(s) and/or Required Material: None – Course slides and supplemental material are distributed

Catalog Description:
ECE 5231: This course builds on ECE 5221/6221, Fundamentals of Micromachining. Topics include definitions, categorization, comparison and application fields of microsensors. The course discusses related solid-state physics, piezoresistive sensors, semiconductor-based temperature sensors, magnetoresistive sensors, thermoelectric sensors, photoelectric sensors, micro gas and fluid concentration sensors, molecular diagnostics arrays and other sensors. Registration for a weekly lab (1) is required. Extra work required of graduate students.

ECE 5232: The lab is a compulsory section to the lecture Microsensors (ECE 5231/6231) and builds on ECE 5221/6221, Fundamentals of Micromachining. The lab will include the following topics: design and simulation of microsensors, process design, packaging and assemble, characterization and testing of microsensors. The first part of the lab will focus on the acquirement of additional technological skills and understanding of sensor characteristics. The second part of the lab will lead to the fabrication, characterization and presentation of a variety of fully functional microsensors. Examples of these are pressure, force, acceleration, and gas sensors.

Prerequisites:
ECE 5231
- C- or better in ECE 5221: Fund. of Micromachining Processes; and
- Full major status in Computer Engineering

Corequisites:
For ECE 5231
- ECE 5232: Microsensors Lab

Designation: Elective

Contribution of Course to Meeting the Requirements of ABET Criterion 5: Engineering science and engineering design.

Specific Outcomes of Instruction: In this course, students will be prepared to:
1. Identify existing characteristics, problems and issues of key microsensors and their underlying technologies;
2. Interpret the problems in multi disciplines;
3. Develop probable solutions for them; and
4. Design, fabricate, and test micro sensors.

Relationship of the Course to the Program Outcomes:
(a) **An ability to apply knowledge of mathematics, science, and engineering.** Students apply fundamental concepts of solid state materials, thermal and electrical conduction, theory of electric, magnetic, thermal fields and their response to external stimuli. They also apply design, development and testing skills to the development and fabrication of microsensors and integrate materials and system integration knowledge.

(b) **An ability to design and conduct experiments, as well as to analyze and interpret data, and to debug and analyze software.** The compulsory lab conveys skills in design of experiments, technical experimental skills in microfabrication, assembly and testing. Upon completion of fabrication and testing of a packaged/ assembled pressure sensor, they carry out a design project leveraging the conveyed skills.

(c) **An ability to design a system, component, process or software package to meet desired needs.** Throughout the course, the students design, fabricate and test a piezoresistive, micromachined pressure sensor. Financial considerations associated with development and manufacturing, as well as manufacturability considerations, are integrated into all parts of the curriculum. Social, ethical, health and safety aspects are covered through integration into application examples but are not explicitly listed in the syllabus.

(d) **An ability to function on multidisciplinary teams.** Compulsory lab sections integrate electrical, mechanical, bioengineers, and materials scientists who have to complete the laboratory assignments, analysis and reports together. They also carry out the end-of-class-project in teams of three students from diverse backgrounds.

(e) **An ability to identify, formulate, and solve engineering problems.** In class problems, homework problems and project work require the identification and analysis of problems

(g) **An ability to communicate effectively.** Students have to verbally pass lab entrance tests in brief oral exams where they have to also convey their knowledge to their peers. Class work includes problem solving with students actively involved or leading the solution at the white board. The end-of-term project includes a preliminary and a final oral presentation and an IEEE-format paper.

(h) **The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.** Global economic and societal context is included in examples that show how the technologies are being implemented and used.

(k) **An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.** Students use semiconductor manufacturing tools, instrumentation, and computer tools for data generation and analysis.

**Topics Covered in the Course:**

- Introduction to MEMS fabricated sensors, technologies, markets and key drivers
- Introduction to solid state physics and relevant materials aspects
- Selected fabrication technologies
- Mathematical description of sensor transfer functions and essentials of metrology and sensor testing/characterization
- Mechanical sensors (capacitive, piezoelectric, piezoresistive, etc.)
- Selected key packaging and system integration technologies
- Radiation sensors
- Magnetic sensors
- Chemical and bio sensor
- Thermal sensors