ECE 4242: Micro/Optoelectronics Devices and Circuits Fabrication Laboratory

Credits and contact hours: 3 Credits (One 60-minute lecture and one 3 hour lab per week)

Instructor: Faquir Jain

Textbook: Microelectronics and Optoelectronics Devices and Circuits Fabrication Laboratory, F. Jain (2018)

a. *Other supplemental materials*: Selected reference materials/articles distributed in class and posted on line.

***Specific course information*:**

a. *Catalog Description*: Semiconductor wafer preparation and characterization including: determination of carrier concentration, mobility, and lifetime; oxidation, diffusion, metallization, mask layouts and photolithographic techniques as employed in the realization of discrete devices (e.g., bipolar and MOS transistors, solar cells) and integrated circuits; design of basic IC components such as transistors, resistors, and capacitors; monolithic fabrication of simple digital/analog circuits. Design project. Written and oral presentations of laboratory results.
b. *Prerequisite*: ECE 4211 or 4225; open to students in the School of Engineering.

c. *Required, elective, or selected elective:* Selected elective (EE)

***Specific goals for the course*:**

a. *Specific outcomes of instruction*: Students will be able to
   - Apply the principles of electronic devices (from ECE 4211) to fabricate devices and compare theoretical models and experimental data.
   - Perform wafer characterization using four-point probe, Hall effect, thermoelectric probe, and orientation.
   - Fabricate discrete devices such as p-n diodes, solar cells, photodetectors, MOS capacitors; analyze I-V, C-V characteristics using Parametric Analyzer and other instrumentation; measure oxide thickness, junction depth and compare with theoretical models.
   - Select and design devices and simple integrated circuits.
   - Communicate via oral presentation and written report the project including processing steps, device/circuit performance and compare with analytical models.
   - Search for, acquire and use new knowledge from multiple sources.

b. *ABET Criterion 3 Student Outcomes addressed by the course*:

   (1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
   Students learn to analyze the behavior of fabricated semiconductor devices by applying techniques from mathematics, science and engineering,

(2) **an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors**
For their projects, students formulate and implement design to provided specifications.

(3) **an ability to communicate effectively with a range of audiences**
Students write pre and post lab technical report; also present the results of their project to the class.

(4) **an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts**
n/a

(5) **an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives**
n/a

(6) **an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions**
Students learn to make laboratory measurements of mobility, resistivity, doping type, crystal orientation, and I-V characteristics.

(7) **an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.**
Students use the web, library databases, and other resources for their technical reports.

Topics covered:

- Semiconductor wafer characterization
- Measurements of mobility, resistivity, doping type, crystal orientation.
- Diffusion of p- and n-type dopants in Si to form unction diodes and solar cells; compare their I-V characteristics with theoretical models.
- Perform dry and wet oxidation of Si to fabricated MOS capacitors and characterize them in terms of flat band and threshold voltage. Compare C-V data to theoretical models.
- Project work include fabrication of inverters using FETs, nonvolatile memories, SRAMs and biosensors.