ECE 4225: Fundamentals of Electron Device Design and Characterization

Credits and contact hours: 3 Credits

(Two 75-minute lectures and one 90-minute laboratory per week)

Instructor: Ali Gokirmak

Textbook: Solid State Electronic Devices (Streetman) or Semiconductor Device Fundamentals (Pierret) or Fundamentals of Modern VLSI Devices (Taur & Ning)

Other supplemental materials: MIT Open courseware

***Specific course information*:**

a. *Catalog Description*: Design of micro/nano electronic devices using state-of-the-art computer simulation tools, electrical characterization of semiconductor devices and introduction to modern electronic devices such as high-performance MOSFETs, TFTs, solar cells, non-volatile memories, CCDs, and thermoelectric power generators.

b. *Prerequisite*: ECE 3101

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

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

a. *Specific outcomes of instruction*: Students are able to use semiconductor fundamentals for the analysis and design of commonly used electronic devices. Students can describe their technological advantages and challenges. Students can draw band diagrams and analyze semiconductor devices. Students do research, analysis and presentations on one contemporary electron device technology. Students are able to use a finite-element computer simulation tool (Synopsys Sentaurus – the industry standard for electron device design and evaluation), redesign and analyze a pn-junction diode and a short-channel field effect transistor to satisfy given requirements.

b. *EAC 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 about semiconductor fundamentals, construction of band-diagrams and a finite element simulation for analysis and design of electron devices. The design projects in this course require redesign of a diode and a transistor to meet new specifications.

(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

n/a

(3) an ability to communicate effectively with a range of audiences

Students make two in-class presentations, first as an individual, reviewing a device technology, and second as a team discussing their final design project.

(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

Various electronic device technologies, their impact on the economy, environment and the society, as well as the impact of economic, environmental and social considerations on the device technologies are discussed in class.

(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

The students work as teams for their final project. Each student takes over a specific task and students work together to deliver the results. Team members decide on who is going to take various roles to meet the objectives. Students taking this course always form an inclusive and collaborative environment.

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

The students decide on the design parameters for their projects, construct experiments in the finite-element design tool, analyze the data and decide on the design. The redesign process takes several iterations until all specifications are met.

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Students use the web, Google Scholar, reference books, to gather information and locate review and research articles.

Topics covered:

- Device fabrication (Silicon Run DVDs)
- Semiconductor basics
- PN junctions: Diodes, photo-diodes, Solar Cells, LEDs, Solid-state Lasers
- CCDs (Charge Coupled Devices)
- High performance Si MOSFETs
- Liquid Crystal Display
- Thin film transistors (TFTs)
- FLASH memory / Phase change memory
- Thermoelectric generators and thermoelectric heating / cooling