ECE 4211: SEMICONDUCTOR DEVICES AND NANOSTRUCTUES

Credits and contact hours: 3 Credits (Two 75-minute lectures per week)

Instructor: Faquir Jain

Textbook: SEMICONDUCTOR DEVICES AND NANOSTRUCTUES, F. Jain (2018)

a. *Other supplemental materials*: Selected reference materials/articles posted online

***Specific course information*:**

a. *Catalog Description*: Principle and application of contemporary solid-state devices such as light-emitting diodes, injection lasers, solar cells p-n-p-n diodes, SCRs and Triacs, bipolar and MOS transistors, nonvolatile memories, and fundamentals of integrated circuits. Impact of nanostructures on devices.

b. *Prerequisite*: ECE 3201; open only to the 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 3201) to derive current transport equations relating to semiconductor material parameters and device structures.
- Explain the development of equivalent circuit models of semiconductor devices.
- Select, specify, and design lasers and solar cells, and nano-FETs.
- Communicate the design of lasers and solar cells using an iterative process.
- 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 semiconductor devices and formulate their design to specifications provided 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
Solar panel design is investigated as an alternative energy source for an improved environment.

(3) an ability to communicate effectively with a range of audiences
Students write a technical report on their final designs.

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(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
n/a

(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:

- Introduction to Semiconductor Physics
- P-n Junctions and Heterojunctions
- Bipolar junction transistors (a design example is covered)
- Optoelectronic Devices: Light-emitting diodes, laser diodes, solar cells, and photodetectors, and Si nanophotonics.
- Field-Effect Transistors (FETs): transport in Si FETs and logic gates, short channel effects and scaling laws. NanoFET design, nonvolatile/flash memories.
- Systems: Imaging systems, Nanophotonics, and Displays