ECE 4261 Introduction to Memory Device Technologies

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

Instructor: Helena Silva

Textbook: none required;

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

b. *Suggested reference texts*:
Ben Streetman, Sanjay Banerjee, *Solid State Electronic Devices*, Prentice Hall
Taur and Ning, Fundamentals of Modern VLSI devices, Cambridge University Press
Jan M. Rabaey, *Digital Integrated Circuits*, Prentice Hall

***Specific course information*:**

a. *Catalog Description*: Current and future digital solid-state memory device technologies including DRAM, SRAM, flash memory, ferroelectric memory, magnetoresistive memory, phase-change memory and resistive memories, with an emphasis on the underlying physical mechanisms.

b. *Prerequisite*: ECE 3201 or 3421 or 4225; open only to students in the School of Engineering.

c. *Required, elective, or selected elective:* Elective

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

a. *Specific outcomes of instruction*: Students will be able to

- Describe the principles of operation, fabrication processes, and applications of memory devices used in today's technologies
- Explain the main physical mechanisms behind the various memory devices
- Justify the limitations of current memory devices
- Describe the advantages and disadvantages of current candidates for future memory devices

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 apply principles of semiconductor device physics to understand the operation of main electronic memory technologies. General physics and engineering principles are also discussed in relation to the materials and fabrication technologies behind these technologies.

(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
Each student delivers an oral presentation on a topic of his choice related to memory devices.

(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
Homework problems on established technologies such as MOSFETs, DRAM, SRAM and flash memory, make use of example data and parameters that students use to analyze or design certain device geometries or operation conditions.

(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 reports and presentations.

Topics covered:

- *Introduction – Memory overview*
- *Semiconductors and MOSFETs review*
- *DRAM*
- *SRAM*
- *Non-volatile memory*
    - *3.1 Flash memory*
    - *3.2 Ferroelectric RAM (FeRAM)*
    - *3.3 Magnetic RAM (MRAM)*
- *New memory devices*
    - *Phase-Change Memory (PCM)*
    - *RRAM (resistive memory)*
    - *STT-MRAM (spin-transfer-torque MRAM)*
    - *3D XPoint Memory*