Course Syllabus

EEL 5415/4414 Modern Memory Device Technologies

(Spring 2022, MWF 5th period, 11:45-12:35, MAEA0327)

Instructor:

Dr. Jing Guo

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Class Web site: UFL elearning canvas website

Office Hours: 9-10am, Mon. (Zoom: https://ufl.zoom.us/j/9976443936 (Links to an external site.) (Links to an external site.) Meeting ID: 997 644 3936)

Course Description:

Big data applications drive growing needs of big memory. These applications will require lower latency to access your data, as well as cheaper and massive memories to store your data. It has presented a new challenge for the semiconductor industry. This course discusses how various modern memory device technologies work. The topics include discussions of various state-of-the-art volatile and nonvolatile memory device technologies and their limitations. To go beyond these limitations, the course explores emerging memory device technologies, including those that could be adopted by industry in the next decades in computers and mobile devices due to potential performance, density, power and cost advantages.

In addition, deep learning and neuromorphic computing algorithms do not run efficiently in state-of-the-art computer hardwares. Device technologies in future neuromorphic processors that mimic how human brain works, such as memristors, will be discussed. The realization of memristive functionalities is closely related to the emerging memory device technologies.

Course Pre-requisites:

Students are expected to have already completed an introductory level device course at the undergraduate level, such as EEE3396c here at UF or any equivalent course at other institutes.

Course Objectives:

(1) Explore state-of-the-art memory technologies

(2) Introduce emerging memory technologies for future big data applications

(3) Understand mechanisms and limitations of each memory device technology

(4) Introduce memristive devices for neuromorphic computing

Recommended Materials

(1) Class notes

(2) A. Chen, J. Hutchby, V. Zhirnov, and G. Bourianoff, "Emerging Nanoelectronic Devices," Wiley, 2015, Part Two: Nanoelectronic Memories

Topics:

1. Brief introduction of field-effect transistors
2. State-of-the-art volatile memory devices: DRAM, SRAM
3. State-of-the-art nonvolatile memory devices: Flash memory technology
4. Spin transfer torque memory devices
5. Phase change memory devices
6. Resistive memory devices
7. Crossbar architecture
8. Device models of memristors
9. Other devices for neuromorphic computing
10. Course project and research paper presentation

Attendance Policy, Class Expectations, and Make-Up Policy

Excused absences must be in compliance with university policies in the Graduate Catalog (http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance (Links to an external site.)) and require appropriate documentation.

Grading:

- 15% Homework: Late homework results in loss of points.
- 30% Exam: The exam is based on class notes including oral comments, problems solved in classroom and homework problems. The students are responsible for the above materials.
- 15% Midterm research paper presentation: Each student will choose a research paper, preferably related to their term project, in the field of memory device

technology and present it in class. The presentations will be graded based on 1) the presenter's ability to clearly describe the problem, explain the solution, and evaluate the (experimental or simulation) results, 2) the quality of answers provided to the questions, and 3) the content of the slides.

- 40% Project: 35% final presentation, and 5% peer review participation. The schedules of the presentations will be available in the course e-learning website.

Half of the project presentation should be overview of the research field for the project, and the other half shall clearly identify a problem, perform calculation, modeling, or simulation, and reach YOUR OWN conclusion on the memory device studied in the project.

Suggested project topics on memory device technologies include but are not limited to: CBRAM, ferroelectric memory, FTJ memory, MTJ memory, STT memory, Phase change memory, flash memory, SRAM, DRAM, artificial synapse and RRAM, artificial neurons, hardware for brain-like computing.

Make-Up Exam Policy: If you have a University-approved excuse and arrange for it in advance, or in case of documented emergency, a make-up exam will be allowed and arrangements can be made for making up missed exam. University attendance policies can be found at: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx The student must submit a written petition to the instructor two weeks prior to the scheduled exam and the instructor must approve the petition.

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/ (Links to an external site.). It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/ (Links to an external site.). Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/ (Links to an external site.). Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/ (Links to an external site.).

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/ (Links to an external site.)) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html