University of Southern California

Ming Hsieh Department of Electrical Engineering

Course Number & Title: EE 576, Integrated Memory Device and Technology

Units: 3

Semester: Fall 2018

Schedule: Mondays & Wednesdays 3:30 pm – 4:50 pm

Location: TBD

Instructor: Han Wang

Office: PHE 631

Office Hours: Tuesdays 4:30 pm – 5:30pm

Contact Information: han.wang.4@usc.edu, 213-821-4293

Teaching Assistant: TBD

Catalogue Description:

Fundamental device physics, advanced integration technology and cutting-edge innovations in integrated microelectronic memory devices. Applications of emerging memory devices and technology in both data storage applications and applications in emerging beyond-von-Neumann computing systems.

Course Description:

EE 576 covers the fundamental principles of semiconductor memory devices and their applications in both traditional memory technology and emerging beyond-von-Neumann computing. The various types of memory technology to be covered include magnetic memories, NAND and NOR flash memory, phase change memory, resistive memory (memristor), etc. We will discuss emerging trends in memory technology including multi-cells and 3D integration. The advanced applications of memory or memory-like devices in the emerging field of neuromorphic computing and in-memory computing will also be an important focus of the course.

Learning Objectives:

This graduate course introduces students to the fundamental device physics, advanced integration technology and cutting-edge innovations in memory device innovations. Upon completion of this course, students will be able to do the following:

1. Understand the basic device physics of semiconductor memory devices.
2. Demonstrate a familiarity with major memory device structures and integration technology.
3. Apply device models to analyze various types of memory devices.
4. Establish knowledge base about the emerging advance memory technologies and applications in new computing architectures.

Prerequisite: Understanding of basic semiconductor device physics and fabrication technology will be useful, but is not required.

Supplementary Reference Texts:

- Devices, Circuits, and Systems: Nanoscale Semiconductor Memories : Technology and Applications. by Kurinec, Santosh K, 12/2013 (This book is available as ebook from USC Library.)
- NAND Flash Memory Technologies, by Seiichi Aritome November 30, 2015, John Wiley & Sons
- Nonvolatile Memory Technologies with Emphasis on Flash: A Comprehensive Guide to Understanding and Using Flash Memory Devices
- Joe Brewer (Editor), Manzur Gill (Editor) ISBN: 978-1-118-21162-5, September 2011, Wiley-IEEE Press.

Readings: All lecture notes will be available on Blackboard.

Grading:

5% participation
10% homework
10% project presentation
30% mid-term
45% final

Tentative Weekly Schedule

Week	Subject	HW
1	Understand the basic operation of transistor devices	
2	Understand the basic properties of magnetic materials	HW 1 Assign
3	Explain the basic operations of magnetic memory devices.	
4	Analyze transistor based memory devices part 1	HW 1 Due
5	Analyze transistor based memory devices part 2	HW 2 Assign
6	Explain the basic operations of NAND Flash memory technology	
7	Explain the basic operations of NOR Flash memory technology	HW 2 Due Mid-Term Exam
8	Analyze multi-level cells of flash memory devices.	HW 3 Assign
9	Understand the fundamental properties of various types of phase change materials.	Class Project Assign
10	Explain the operating principles of phase change memory devices.	HW 3 Due
11	Understand the operations of resistive memory (memristor) devices	HW 4 Assign
12	Understand the cross-bar architecture	
13	Gain the understanding of the 3D memory device technology	HW 4 Due
14	Introduction to advanced applications of memory or memory-like devices in the emerging field of neuromorphic computing.	
15	Class presentation by students and final review	Class Project Due

Homework

Unless otherwise notified, the homework will be due at the beginning of the lecture on the due date specified when each homework is assigned. The solutions will be posted on the Blackboard website on the same day after the submission. Late submission will not be accepted with the exception of only emergency reasons established and approved by the university.

The students are expected to complete the assignments independently. Minimum amount of discussion is allowed among students provided that the discussion partner is disclosed in the submission. The discussion and collaboration should be limited to only the current EE 576 students and the TA. Discussion and consultation with people outside the class or finding answers on the web or elsewhere etc. are not permitted.

Late submissions or submissions that violate the rules above will have deductions at the discretion of the instructor and the TA/Grader.

Class Project and Presentations

Class project will consist of the case study of an existing or emerging memory device technology in terms of its design principles, fabrication and integration technology, and unique applications in memory and computing. The study will include both qualitative and quantitative analysis of the device technology and performance advantages. The study will be presented in the class. Project grading will be based on both the written study and the oral presentations.

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards*https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct/.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* http://equity.usc.edu/ or to the *Department of Public Safety* http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us. This is important for the safety whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* http://www.usc.edu/student-affairs/cwm/ provides 24/7 confidential support, and the sexual assault resource center webpage sarc@usc.edu describes reporting options and other resources.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* http://dornsife.usc.edu/ali, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.htmlprovides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information http://emergency.usc.edu/*will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.