ECE 59500 Semiconductor Memory Technologies and Applications: Fall 2025

Overview

Click on the following links to go directly to a specific component of the syllabus guidelines:

Course Information

- **ECE 59500 Semiconductor Memory Technologies and Applications**
- **CRN: 28221/28222/28281; Course credit hours: 3**
- **Class Meeting Schedule: MWF 11:30am – 12:20PM @ BHEE 222**
- **Instructional Modality: lectures + asynchronous online**

Instructor(s) Contact Information

Instructor: Dr. Haitong Li

- Office: BRK 2038
- Email: haitongli@purdue.edu
- Office Phone: 765-496-0740
- Office hours: Tue: 4:30–5:30PM, Room: BRK 2038
    - Additional time slot TBD for the online section.
    - Additional appointments can be made via emails.

Graduate Teaching Assistant:
Mufeng Chen (chen5240@purdue.edu).
TA Office Hours: update-to-date information will be provided on Piazza.

Where to reach the teaching crew outside office hours: Piazza forum is the recommended channel.

Course Description

This course introduces students to the field of semiconductor memory technologies, which plays an increasingly important role in modern applications. Provides detailed insights into device and circuit fundamentals for SRAM, DRAM (planar DRAM, eDRAM, 3D HBM), Flash (NAND/NOR, 3D V-NAND), and emerging non-volatile memories (RRAM, PCM, MRAM, FeRAM/FeFET). Discusses technology and scaling trends, along with a wide spectrum of case studies on modern applications such as edge computing, machine learning acceleration, datacenter workloads, hardware security, brain-inspired computing, and space electronics.

Learning Resources, Technology & Texts

Textbook: No required textbook for this course.

Course Website: Purdue Brightspace
Lecture notes, videos, and other learning materials will be provided via Brightspace. Major announcements will be sent through Brightspace.

Discussion Forum: Piazza

Assignment Submission and Grading: Digital copies via Gradescope

Learning Outcomes

Students who successfully fulfill the course requirements will be able to:

- Gain an introductory knowledge of the landscape of incumbent and emerging semiconductor memory technologies.
- Gain an industry-relevant understanding of the technology scaling trends.
- Recognize the relevant semiconductor device physics that governs different categories of memory devices.
- Understand the operation principles, design considerations, and tradeoffs associated with different memory devices and circuits.
- Analyze the engineering utility of incumbent and emerging memory technologies across different domains of applications.

Assignments

1. Homework:
About 5 HW assignments will be given throughout the semester. Each HW posted will be due in one week. Each student must turn in your own solution that reflects your thinking and learning.

2. Midterm Exam:

- Professional engineering organizations do not care about your ability to perform on timed examinations, but rather about your ability to thoughtfully address questions in a reasonable amount of time. To reflect this, the exam will be available online over a 48-hour period (designed to be completed in 2–3 hours).
- The midterm exam is open-book, open-reference; however, you must turn in your own solutions. You may not discuss with your classmates, nor may you post questions anywhere online and use others' answers.
- You must cite any work and resources you reference.

3. Final Project:
The project is open-ended, with suggested directions and ideas, and spans the duration of the class. The projects should be conducted in groups of 2. Deliverables include a project proposal, a final report, and a presentation via video.

Deadlines are an unavoidable part of being a professional and this course is no exception. Course requirements must be completed and posted or submitted on or before the specified due date and delivery time deadline. To encourage you to stay on schedule, due dates will be established for each assignment. Grading policy is provided below.

Grading

The course grade is based on the following components:

- Homework: 40% (5 homework, each weighting 8%)
- Midterm exam: 20%
- Project: 40% (project proposal, final report, and final presentation)
- Policy on late submissions: max. 3 days allowed, but you'll lose 20% points per day for the assignment.

Based on learning outcomes achieved with the total accumulative scores (100), the grading scale (subject to change) is the following: A+: [95, 100]; A: [85–95), A-: [80, 85), B+: [75, 80), B: [70, 75), B-: [65, 70), C+: [60, 65), C: [55, 60), C-: [50, 55), D+: [45, 50), D: [40, 45), D-: [35, 40), F: <35

Grades are not curved downward. If all students achieve at the A level, then all will receive an A. In cases where the raw assignment scores do not fully reflect the level of learnings achieved across the class, cutoff ranges may be adjusted upward to better align grades with demonstrated learning progress.

All grades are final once submitted. No extra work is allowed after the semester. Incomplete grade is only for students who do most of the required work but cannot finish the course at the end of the semester due to a well-documented emergency.

Course Evaluation

Toward the end of this semester, you will be provided with an opportunity to give feedback on this course and your instructor. Purdue uses an online course evaluation system, and I will not have access to this anonymous feedback until after final grades are submitted. You will receive an official email from evaluation administrators with a link to the online evaluation site and will receive a prompt to complete the survey when you login to Brightspace. Check your "Junk E-mail" folder occasionally to be sure the evaluation emails were not accidentally routed there. Your participation is an integral part of this course, and your feedback is vital to improving education at Purdue University. I strongly urge you to participate in the evaluation system.

Attendance Policy

This course follows the guidelines outlined in "Office of the Dean of Students: Class Absences" and "Academic Regulations: Attendance" within the University regulations. Students are encouraged to refer to the University Policies and Statements content in course Brightspace.

Academic Integrity

Academic integrity is one of the highest values that Purdue University holds. Students should check the University Policies and Statements content under Brightspace. The policies apply to this course. Every member of the Purdue community is expected to practice honorable and ethical behavior both inside and outside the classroom. Any actions that might unfairly improve a student's score on assignments or examinations will be considered cheating and will not be tolerated.

With evidence and at the instructor's discretion, cheating on an assignment or examination will result in a reduced score, a zero score, or a failing grade for the course. All occurrences of academic dishonesty will be reported to the Assistant Dean of Students and copied to the ECE Associate Head of Education. If there is any question as to whether a given action might be considered as cheating, please see the instructor before you engage in any such action.

Students should also refer to the University Policies and Statements content under Brightspace.

Authorized and unauthorized use of AI: use of LLM for the purpose of facilitating understandings of concepts and filling in the gaps of related background knowledge is allowed for non-assignments. For all assessed work (HW, exam, and project) in this course, using generative AI/LLM to produce solutions or technical contents is unauthorized.

Nondiscrimination Statement

Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. A hyperlink to Purdue's full Nondiscrimination Policy Statement is included in the Academic Resources table on your Brightspace homepage.

Accessibility

Purdue University strives to make learning experiences accessible to all participants. If you anticipate or experience physical or academic barriers based on disability, you are encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

If you have been certified by the Disability Resource Center (DRC) as eligible for accommodations, you should contact your instructor to discuss your accommodations as soon as possible.

Mental Health/Wellness Statement

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try Therapy Assistance Online (TAO), a web and app-based mental health resource available courtesy of Purdue Counseling and Psychological Services (CAPS)**.** TAO is available to all students at any time by creating an account on the TAO Connect website, or downloading the app from the App Store or Google Play. It offers free, confidential well-being resources through a self-guided program informed by psychotherapy research and strategies that may aid in overcoming anxiety, depression and other concerns. It provides accessible and effective resources including short videos, brief exercises, and self-reflection tools.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 a.m.- 5 p.m.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc., sign up for free one-on-one virtual or in-person sessions in West Lafayette with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is free and can be done on BoilerConnect. Students in Indianapolis will find support services curated on the Vice Provost for Student Life website.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS offices in West Lafayette or Indianapolis.

Emergency Preparedness

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis. A link to Purdue's Information on Emergency Preparation and Planning is located on our Brightspace under "University Policies and Statements." This website covers topics such as Severe Weather Guidance, Emergency Plans, and a place to sign up for the Emergency Warning Notification System. I encourage you to download and review the Emergency Preparedness for Classrooms document.

Course Schedule

Key University dates for the semester: refer to update-to-date Purdue Academic Calendar.

Week	Dates	Lecture Topics	Assignments & Milestones
Week 1	08/25–08/29	Course intro, memory technology landscape	Start networking & team forming
Week 2	09/01–09/05	SRAM: operations, design, fabrication	
Week 3	09/08–09/12	SRAM: variability, reliability, scaling trends	HW1 out
Week 4	09/15–09/19	DRAM: device technologies, operations	
Week 5	09/22–09/26	DRAM: circuits, memory banks, architectures	HW2 out
Week 6	09/29–10/03	Embedded DRAM (eDRAM), 3D high-bandwidth memory (HBM), advanced 3D DRAM concepts	
Week 7	10/06–10/10	Flash: physics, operations, fabrication	
Week 8	10/13–10/17	Flash: NAND/NOR Flash, reliability	HW3 out
Week 9	10/20–10/24	Flash scaling trends, 3D Vertical NAND	
Week 10	10/27–10/31	Intro to emerging non-volatile memories (NVMs), Phase change memory (PCM)	Midterm Exam (covering Week 1–9 contents)
Week 11	11/03–11/07	Resistive RAM (RRAM), selectors, array architectures, scaling trends	
Week 12	11/10–11/14	Conductive-bridge RAM (CBRAM), Magnetic RAM (MRAM)	Project Proposal due; HW4 out
Week 13	11/17–11/21	Ferroelectric FETs (FeFET), Ferroelectric RAM (FeRAM), Ferroelectric NAND (FeNAND)	
Week 14	11/24–11/28	Memory-centric computing	HW5 out
Week 15	12/01–12/05	Modern/exploratory applications (case studies)	
Week 16	12/08–12/12	Modern/exploratory applications (case studies)	
Finals Week	12/15–12/20		Final Project Deliverables due

Notes:

- Video lectures without in-person meetings on: Sep. 22 (Mon), Oct. 8 (Wed)
- Sep 1 (Mon) – Labor Day; Oct 13–14 (Mon–Tue) – Fall Break; Nov 26–29 (Wed–Sat) – Thanksgiving Break

Disclaimer

This syllabus is subject to change. You will be notified of any changes. Monitor your email for updates.