Course ID and Title: Integrated Memory Device and Technology
Units: 4
Term—Day—Time: Spring 2022,
Mon. Wed., 4PM – 5:20PM

Location: SOS B44

Instructor: J. Joshua Yang
Office: PHE 608
Discussion: Wed. 2:00-4:00PM
Contact Info: jjoshusy@usc.edu (213) 740-4709.

Teaching Assistant: TBD
Office: TBD
Office Hours: TBD
Contact Info: TBD
Course Description

This graduate course introduces students to the fundamental device physics, advanced integration technology and cutting-edge innovations in memory device innovations and applications in Artificial Intelligence and Machine Learning.

Learning Objectives

Upon completion of this course, students will be able to do the following:

1. Understand the basic device physics and materials principles of semiconductor memory devices.
2. Demonstrate a familiarity with major memory device structures and integration technology.
3. Establish a good knowledge base about the emerging advance memory technologies.
4. To understand the principles of novel Artificial Intelligence and Machine Learning enabled by emerging memory technologies.

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

Co-Requisite(s): none

Concurrent Enrollment: none

Recommended Preparation: introduction courses on semiconductor physics or solid state physics

Course Notes

This course will have Letter grading and lecture slides posted. There will be lab sessions for the students to operate some emerging electronic devices experimentally. There will also be course presentations for the students to practice literature search, reading, team working, presentation and Q&A on topics interesting to them.

Technological Proficiency and Hardware/Software Required

N/A

Required Readings and Supplementary Materials

Course Materials

Lectures and lecture notes are the primary course materials.

Recommended Text


Useful Reference Texts

**Description and Assessment of Assignments**
There will be Homeworks, Midterm and Final exams, Labs and Course Project (presentation), based on which the students are evaluated for grading.
Grading Breakdown

<table>
<thead>
<tr>
<th>Assessment Tool (assignments)</th>
<th>Points</th>
<th>% of Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Homeworks</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Labs</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Midterm exam</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Final exam</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Course Project</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Grading Scale

Course final grades will be determined using the following scale
A  95-100  
A-  90-94   
B+  87-89   
B   83-86   
B-  80-82   
C+  77-79   
C   73-76   
C-  70-72   
D+  67-69   
D   63-66   
D-  60-62   
F   59 and below

Assignment Submission Policy
Each assignment is expected to be submitted on time; late submissions within a week will result in 30% point deduction; late submission over a week will not be accepted.

Grading Timeline
Within two weeks of the submission time.

Additional Policies
N/A
## Course Schedule: A Weekly Breakdown

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics/Daily Activities</th>
<th>Readings/Preparation</th>
<th>Deliverables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Issues of exiting computer hardware for AI and ML</td>
<td>Lecture Notes</td>
<td>Background survey</td>
</tr>
<tr>
<td>Week 2</td>
<td>Solutions with memory based hardware</td>
<td>Lecture Notes</td>
<td></td>
</tr>
<tr>
<td>Week 3</td>
<td>Materials basics (structure, defects, classifications, bonds etc.)</td>
<td>Lecture Notes</td>
<td>Homework 1</td>
</tr>
<tr>
<td>Week 4</td>
<td>Electronic properties of materials (electrical, optical, magnetic etc.)</td>
<td>Lecture Notes</td>
<td></td>
</tr>
<tr>
<td>Week 5</td>
<td>Thermodynamics and Kinetics principles in memory device design</td>
<td>Lecture Notes</td>
<td></td>
</tr>
<tr>
<td>Week 6</td>
<td>Device physics for CMOS devices</td>
<td>Lecture Notes</td>
<td>Homework 2</td>
</tr>
<tr>
<td>Week 7</td>
<td>Midterm exam</td>
<td>Review Lecture Notes and Homeworks</td>
<td>exam</td>
</tr>
<tr>
<td>Week 8</td>
<td>CMOS based memories</td>
<td>Lecture Notes</td>
<td></td>
</tr>
<tr>
<td>Week 9</td>
<td>Magnetic memories</td>
<td>Lecture Notes</td>
<td></td>
</tr>
<tr>
<td>Week 10</td>
<td>Phase change memories</td>
<td>Lecture Notes</td>
<td></td>
</tr>
<tr>
<td>Week 11</td>
<td>Redox memories</td>
<td>Lecture Notes</td>
<td></td>
</tr>
<tr>
<td>Week 12</td>
<td>Machine learning accelerators using emerging devices</td>
<td>Lecture Notes</td>
<td></td>
</tr>
<tr>
<td>Week 13</td>
<td>bio-inspired computing with intelligent materials and devices</td>
<td>Lecture Notes</td>
<td></td>
</tr>
<tr>
<td>Week 14</td>
<td>Machine Learning Lab</td>
<td>Review ML and Computing</td>
<td>Lab Report</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lecture Notes</td>
<td></td>
</tr>
<tr>
<td>Week 15</td>
<td>Course project</td>
<td>Form teams, chose topics, literature search, prepare slides</td>
<td>Slides and Presentations</td>
</tr>
<tr>
<td>FINAL</td>
<td>Final exam</td>
<td>Reviewing Lecture Notes and Homeworks</td>
<td>exam</td>
</tr>
</tbody>
</table>