Computer Engineering 5210: Introduction to VLSI Design
Prior Number – Computer Engineering 311

Credit and Contact Hours
3 credit hours lecture (Two 75-minute lectures per week). Three laboratory exercises are assigned; Schematic design and simulation of a minimum sized inverter; Layout design of the inverter and post-layout simulation; CMOS logic block design, layout and simulation.

Instructor
Y. Shi, Ph.D.

Text(s)

PowerPoint lecture slides and Tutorials & notes about Cadence CAD tools

Catalog Information
An introduction to the design and implementation of very large scale integrated systems. Procedures for designing and implementing digital integrated systems, structured design methodology, stick diagrams, scaleable design rules, and use of computer aided design tools.

Prerequisites
Computer Engineering 3150 (213).

Required or Elective
Elective course

Course Goals
General Outcomes
1. Learn basic concepts in VLSI circuits and systems
2. Understand transistors and wires: what they are and how they work, their respective models
3. Learn basic metrics to evaluate VLSI designs: power, delay, and area
4. Learn to perform detailed analysis of simple CMOS circuits
5. Understand the techniques to design complex combinational circuits
6. Understand the fundamentals of sequential circuits
7. Learn memory basics
8. Learn custom Design flow: layout, physical design, simulation, verification, testing
9. Be able to apply the above objectives by individually designing simple logics in Cadence environment
10. Be able to apply the above objectives by designing complex designs in a team and optimizing the design in Cadence environment
### Relationship of course to Program Outcomes

<table>
<thead>
<tr>
<th>ECE Outcome</th>
<th>Course Outcomes</th>
<th>Comments</th>
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<tbody>
<tr>
<td>a</td>
<td>S</td>
<td>A balanced approach is taken in introducing the theory of FET avoiding unnecessary physics theorems</td>
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<td>b</td>
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<td>c</td>
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<td>d</td>
<td>S</td>
<td>Students are introduced to the multidisciplinary applications of CMOS technology in ICs industry</td>
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<td>e</td>
<td>W</td>
<td>Students are exposed to life-long learning through self-guided research and design project ownership.</td>
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<td>f</td>
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<td>Students implement industry ethics standards throughout the design project</td>
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<td>g</td>
<td>M</td>
<td>Students present their lab assignments to the instructor or course TA and their final design project to class</td>
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<td>i</td>
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<td>Students are required to understand the principles of design in CMOS technology and apply their knowledge and skills for the design project.</td>
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<td>k</td>
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<td>Students are exposed to the state-of-the-art of the industry standard CAD tools and use them in lab assignments and design project</td>
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S – strong connection; M – medium connection; W – weak connection

### Topics Covered

1. Intro to CMOS, FET, fabrication, layout  
   - 2 weeks
2. Implementing combinational Logic in CMOS families  
   - 2 week
3. Dynamic CMOS Logic design  
   - 1 week
4. Cell Delay and Power Estimation  
   - 1.5 weeks
5. Sequential circuits and flop/latch Design; timing analysis  
   - 2 weeks
6. Clock distribution, PLL design and clock skews  
   - 1.5 weeks
7. Design complex CMOS blocks and Testing  
   - 3 Weeks
8. Floor planning, Routing and Placement, Future Trends  
   - 2 weeks
9. Project Class presentations  
   - 1 week