CSCE 613: INTRODUCTION TO CMOS VLSI DESIGN

Catalog Description:
613—CMOS VLSI Design. (3) (Prereq: CSCE 211, ELCT 371) Design of CMOS switch-level circuits, review of standard CMOS fabrication processes, circuit design at CMOS switch-level, device and interconnect analysis, CMOS circuit layout, CMOS design rules, and CAD layout and simulation tools. Lecture and guided design projects.

Prerequisite(s) By Topic:
Digital logic
Circuit analysis

Textbook(s) and Other Required Material:
Jan M. Rabaey, A. Chandrakasan, and B. Nikolic , *Digital Integrated Circuits, 2ed*., Pearson Prentice-Hall Publishers, Inc., 2003

Computing Platform: Unix, Windows XP

Course Objectives: {Assessment Methods Shown in Braces}
1. Circuit Analysis: Demonstrate the ability to use mathematical methods and circuit analysis models in analysis of digital electronics circuits, including logic components and their interconnect {tests, homework, project}
2. Circuit Synthesis: Demonstrate the ability to create models of moderately sized CMOS circuits that realize specified digital functions {project}
3. Circuit Layout and Verification: Demonstrate the ability to apply CMOS technology-specific layout rules in the placement and routing of CMOS transistors and interconnect, and to verify the functionality, timing, power, and parasitic effects using simulation {tests, homework, project}
4. Circuit Technologies: Demonstrate an understanding of the characteristics of CMOS circuit construction and the comparison between state-of-the-art CMOS 1.8 micron process and emerging nanometer-scale electronic circuit technologies and processes {homework, tests}.
5. Requirements Specification and Design Planning: Demonstrate the ability to follow specifications, to prepare deliverables according to requirements, and to devise test planning and time tracking/time management (task effort distribution) deliverables {homework, project}
6. Project Execution and Reporting: Demonstrate the ability to complete a significant VLSI design project having a set of objective criteria and design constraints {project}

Topics Covered:
1. CMOS transistors (n-channel and p-channel),
2. The CMOS Switch model
3. CMOS Inverter model
4. Logic devices and interconnect
5. CMOS circuit analysis: transistors, inverters, interconnect modeling, parasitics

6. Analytical modeling: Ellmore Delay, Transmission models, RC, RLC lumped parameter models
7. Layout for custom logic: Sea of Gates (SoG) model, Design rules
8. Circuit fabrication methods for CMOS
9. Levels of abstraction: VLSI circuits to systems
10. Circuit modeling and layout (laboratory)
11. CMOS design and layout project
12. Nano-electronics circuits versus CMOS microelectronics circuits
13. Nano-computing techniques and device platforms

Laboratory Projects:
Students complete a significant CMOS design project using circuit layout and simulation tools. In addition, students complete homework assignments using tools and analysis methods.

Difference between Undergraduate and Graduate Work:
Graduate students work on the project by themselves rather than in teams of two and are also graded on a more rigorous scale (exams), and are given additional assignments (homework).

Syllabus Flexibility: High. Choice of textbook and design project determined by instructor.

Relationship of Course to Program Outcomes:
The contribution of each course objective to meeting the program outcomes is indicated with the scale:
3 = major contributor, 2 = moderate contributor, 1 = minor contributor. Blank if not related.

	Program Outcomes										
Course Objectives	1. Logic & Math	2. Computing Fundamentals	3. Apply Computing Principles	4. Work on teams	5. Communicate Effectively	6. Liberal arts & Soc. Sciences	7. Basic Science and Lab Procedures	8. Learn New Tools & Processes	9. Employed upon Graduation	10. Application Area	11. Electronics and Digital Sys Design
1. Circuit analysis	2	1	1					3	2	1	3
2. Circuit synthesis		2	2					3	1		2
3. Circuit layout and verification			1	1			1	3	1		3
4. Circuit technologies				1				1	2		3
5. Requirements specification and design planning				1	1				2	2	1
6. Project execution and reporting			2	1	1		1		2		1

Estimated Computing Category Content (Semester hours):
Computer Science majors do not take this course.

Estimated Information Systems Category Content (Semester hours):
Computer Information Systems majors do not take this course.

Oral and Written Communication:
Documentation for major VLSI design project, comprised of a project report, testing and simulation results, effort distribution data (task breakdown)

Social and Ethical Issues: None

Theoretical Content:
Circuit analysis of switching transistors, power dissipation analysis, driving loads, logical effort, transmission lines and field effects.

Analysis and Design:
Significant VLSI design project; application of electronic circuit analysis methods in the analysis of logic circuits and interconnect; application of CMOS design rules in the synthesis of CMOS circuits

Class/Laboratory Schedule:
Lecture: 3 periods of 50 minutes or 2 periods of 75 minutes per week

Course Coordinator: Jim Davis

Modification and Approval History:
Initial description March 22, 1999
Revised June 2001
Revised June 2005 by Jim Davis to update text and content