ECE 558 Introduction to VLSI Design
Fall 2016
Syllabus

Course Meetings: Tuesday and Thursday 11:30am-12:45pm, Integrated Science 221

Instructor: Wayne Burleson,   Electrical and Computer Engineering
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Course Description:
        This mezzanine course provides an introduction to the fascinating world of computer chip design. VLSI, is the **I**ntegration of **V**ery **L**arge numbers of components into complex **S**ystems that are both functional and manufacturable, while meeting cost, power, reliability and other constraints.   Course will use Moodle extensively.   Public URL for syllabus: http://www.ecs.umass.edu/ece558/

Course Outline:
1. History and Trends
2. Devices - Basic MOSFET, Variations, Leakage, Post-CMOS
3. Inverter and Gates - Models for DC and Timing Analysis
4. Wires - RC models, Repeaters, Buffers, Networks on Chip
5. Synthesis- Verilog, Cell Libraries, Place and Route
6. Memories - SRAM, DRAM, Non-Volatile memories
7. Variations – Impact on Timing and Other Failures
8. Power and Energy - Dynamic and Static, Thermal Issues
9. Case Study: The Xbox-one System on Chip and Kinect
10. FPGAs and other Programmable Components
11. Reliability and Test
12. Manufacturing: Process basics, Yield, FinFets, etc.
13. Semiconductor Business: Top 20 companies, Fabless model, CAD
14. Future Applications: Sensors, Medical, Internet of Things,…

Text: *CMOS VLSI Design: A Circuits and Systems Perspective*, Weste and Harris,
4th edition, 2011.   Available new, used or for rent various places, including Amazon at:
http://www.amazon.com/CMOS-VLSI-Design-Circuits-Perspective/dp/0321547748
The text will be supplemented with papers from IEEExplore and the course Moodle site.

Pre-requisites: Students should be seniors or graduate students in either Electrical and Computer Engineering or Computer Science. Other students should contact the instructor. A basic understanding of circuits (ECE 212), logic (112) and architecture (232) are assumed.

Grading: Mid-term 30%, Final Exam 40%,   CAD Labs 30%

What's new in this version? Prof. Burleson has taught VLSI Design almost every year since 1991. Since then, there has been enormous advancement in the field, some of it predictable (eg Moore's Law and Koomey's law) while some less so. This year we build on a new format piloted in the last 2 years for the course which makes it more broadly applicable to all ECE students. Compared to previous versions of the course, there will be less circuits, more architecture, less design, and more analysis. While the value of design and circuit design in particular is hard to overstress, this new broader format allows us to explore higher level topics such as the Semiconductor Business, Future Applications, Energy Issues and Post-CMOS Technology trends. The Course will include a detailed Case Study of an AMD chip design. There will be several guest lectures by other ECE faculty to expose students to advanced and related topics in VLSI.

Burleson has worked and consulted in the semiconductor industry for many years (Intel, Rambus, HP/Compaq, DEC and various startups). Most recently, he is a Senior Fellow in Low-Power Design at Advanced Micro Devices. He leads research in low-power design techniques, primarily emphasizing high-performance computing and server applications. This experience should significantly improve and differentiate this course from previous versions of this course at UMass and elsewhere.

Difference between 558 and 658:

558 is an introductory course assuming no VLSI background. 658 is a graduate VLSI course and will be offered in the Spring semester. It assumes a basic knowledge of VLSI and probably some experience with Unix and with CAD tools. It has the following additional topics:

- More lab experience to gain mastery/expertise with commercial CAD tools (Cadence, Synopsys…)
- More circuit-level design and analysis, including low-power, leakage, and noise effects critical to modern CMOS design.
- Readings from the research literature (eg. IEEE Journals and Conferences)
- A project building on the research literature, involving critique and creative solutions that can result in publications and MS theses.

658 is a PhD core course so the level is higher. Students are encouraged to take 658 in order to pursue a career or graduate work in VLSI.

ECE 558: *Introduction to VLSI Design*
ECE 658: *VLSI Design Principles*

Fall 2016

Questionnaire (not a test!)

Name and student number:

Are you unsure about whether you should be in 558 or 658?

Have you used Unix/Linux before?

Write a line of Verilog that adds two registers together and puts the result in a third.

What is the set-up time for a flip-flop?

What is meant by the time constant in an RC circuit?

What is an ALU?

What does VLSI stand for?

What is IEEExplore? Have you used it?

Why are you taking this course (<3 sentences)?