ECE558/658 – Intro VLSI Design/VLSI Design Principles – Fall 2022

• **Lecture:**	TuTh 11:30-12:45, Marston 132	
• **Professor:**	Daniel Holcomb, holcomb@engin.umass.edu	
• **Prof. Office Hours:**	Thu 1-2pm	Knowles 309F
• **Teaching Assistants:**	Xiang Li, xiang@umass.edu	
	Aleksa Deric, aderic@umass.edu	
• **TA Office Hours:** (for Lab Questions)	Mon 5-7pm	Marcus 220
	Tue 5-7pm	Marcus 220
	Wed 5-7pm	Zoom (`http://umass-amherst.zoom.us/j/99310856727`)
	Thu 5-7pm	Marcus 220
	Fri 1-3pm	Zoom (`http://umass-amherst.zoom.us/j/99310856727`)
• **Piazza:**	`piazza.com/umass/fall2022/ece558ece658/home`	
• **Textbook:**	Neil Weste and David Harris,	
	CMOS VLSI Design: A Circuits and Systems Perspective, 4th Edition, 2011	
• **Further Reading:**	Jan Rabaey, Anantha Chandrakasan and Borivoje Nikolic,	
	Digital Integrated Circuits, 2nd Edition, 2003.	

Description

This mezzanine/grad course provides an introduction to the fascinating world of computer chip design. VLSI (Very Large Scale Integration) is the engineering discipline that organizes huge numbers of transistors and wires into massively complex systems that are functional and manufacturable, while meeting cost, power, and other constraints. The defining characteristic of VLSI is its use of design abstractions to enable automation and manage complexity. Students taking the course will make heavy use of industry-standard design tools. The lab assignments are challenging, but the skills learned are rewarding enough to justify the time investment that is required.

ECE558 and ECE658 meet together. ECE658 is graduate level, and a PhD core course, appropriate for students wanting to pursue a career or research in VLSI. ECE658 students have additional problems on exams, and additional steps on lab assignments. The course uses Moodle to distribute materials, and Piazza as a discussion forum.

Your instructor and TAs conduct research at the intersection of VLSI and security. This research area includes interesting topics such as side channels attacks, physical unclonable functions, fault injection attacks, hardware Trojans, reverse engineering, etc; some of these topics will be discussed in the course.

Major Course Topics (subject to change)

- Overview, History and Trends
- Devices – Basic MOSFET, Variations, Leakage, FinFETs
- Inverter and Gates – Models for DC and Timing Analysis
- Wires – RC models, Repeaters, Buffers, Networks on Chip
- Synthesis – Verilog, Cell Libraries, Place and Route
- Memories – SRAM, DRAM, Non-Volatile memories
- Variations – Impact on Timing and Other Failures
- Power and Energy – Dynamic and Static, Thermal Issues
- FPGAs and Programmable Hardware
- Manufacturing – Process basics, Yield, Reliability and Test
- Semiconductor Business – Fabless model, IP re-use, Chiplets

Grading Policy (Subject to change)

The grades for the course are based on exams, labs, and unannounced in-class quizzes, according to the weighting shown. Quizzes taken, but answered incorrectly, earn half credit for participation. Bonus participation credit may be awarded at the end of semester to students that have been exceptionally helpful on Piazza. Book problems will be

suggested for practice, but will not be turned in or graded. Cutoffs for letter grades will be determined at the end of semester.

Grade Component	Weight
Exam 1	20%
Exam 2	20%
Labs	50%
Quizzes and Participation	10%

Lab Assignments

Lab assignments use industry-standard CAD tools, which you will run on the vlsicad.ecs.umass.edu server. Lab reports will be submitted on Moodle. Learning to navigate the tools and complete the assignments requires time and discipline. The labs cannot be completed in a hurry close to the deadline, so plan accordingly. Outstanding ECE658 students may propose independent research projects in place of the final labs.

- Lab 0: Setting up tools and accounts   *(2 pts)*
- Lab 1: Design, Layout, Extraction, Analysis of combinational CMOS Multiplexer   *(12 pts)*
- Lab 2: Design and analysis of sequential 1-bit accumulator bitslice   *(14 pts)*
- Lab 3: Accumulator from bitsliced layout   *(7 pts)*
- Lab 4: Accumulator from Synthesis and Place-and-Route   *(5 pts)*
- Lab 5: Network-on-Chip using Synthesis and Place-and-Route   *(10 pts)*

Lab help: You can get help with lab assignments from the TAs during office hours. During most weeks we will have office hours each day M-F. During busy office hours the TAs will be switching between students, so try to ask precise well-formed questions in order to get the most effective help possible.

Piazza: You can also get help from your classmates using Piazza. Different students often encounter and resolve similar issues, and public discussion on Piazza efficiently disseminates the information as it is discovered. The TAs and I will also monitor and participate on Piazza. If you want to ask a technical question outside of office hours, please do so on Piazza instead of emailing.

Inclusivity and Climate

My aim is for this course to be equitable, respectful, and inclusive of all participants. Achieving this requires valuing of, and sensitivity to, personal and cultural identities. You can indicate preferred name and pronouns on SPIRE, or by emailing me. I hope that our course climate will be such that you can talk to me directly if you feel unvalued. If not, I hope that you voice your concerns, anonymously if desired, through the College of Engineering Climate Concerns and Suggestions on-line form (`https://tinyurl.com/UMassEngineerClimate`). Because critical examination is an important part of learning, students are encouraged to scrutinize ideas and ask questions, and will never be evaluated negatively for doing so in the course.

Academic Honesty Policy Statement

Academic honesty is required of all students at the University of Massachusetts Amherst. Dishonesty in the course will at minimum result in a grade of F for the assignment along with an additional 10 point penalty on overall course grade. Information about what constitutes academic dishonesty, and the policies used to address violations, can be found at this website: `http://www.umass.edu/honesty/`. Ignorance of honesty standards will not result in a lesser penalty, so if you have any questions, please contact me for clarification.

Disability Statement

The University of Massachusetts Amherst is committed to providing an equal educational opportunity for all students. If you have a documented physical, psychological, or learning disability on file with Disability Services (DS), Learning Disabilities Support Services (LDSS), or Psychological Disabilities Services (PDS), you may be eligible for reasonable academic accommodations to help you succeed in this course. If you have a documented disability that requires an accommodation, please notify me within the first two weeks of the semester so that we may make appropriate arrangements.