Department of Electrical and Computer Engineering
University of Massachusetts/Amherst

ECE 559/659 VLSI Design Project Spring 2020

ECE Elective, 3 credits

Catalog Data:

Project-oriented course. Design of very-large-scale integrated circuits. Experience in VLSI design through team projects emphasizing issues involved in the design of an entire custom chip. CAD tools used in the design process, resulting in specification of circuitry suitable for fabrication. (3 credits)

Prerequisites: VLSI Design, ECE 558/658 or equivalent.

Instructor: Maciej Ciesielski, Electrical and Computer Engineering
ciesiel@ecs.umass.edu , Office: KEB 207 D
Office Hours: Tu, Th 1:30 – 2:30 PM.

Course Meeting Times: Monday, Wednesday 2:30 - 3:45 pm, ELAB 323

Textbook: *CMOS VLSI Design: A Circuits and Systems Perspective*, Weste and Harris, 4th ed., 2011, the same as used in ECE 558/658.

Additional course materials: notes and articles posted on Moodle.

Course Goals:
Students completing this course will be able to:

1. Design and analyze digital circuits from different circuit families and using different implementation technologies (ASIC, FPGA).
2. Understand various design methodologies, testing and verification methods.
3. Use software tools to synthesize, analyze, simulate, and verify their design.
4. Write a professional-quality technical report describing their design.
5. Present their design in a complete, coherent, and easy to understand form.

Course Description and Organization:

This is a hands-on project course in VLSI design intended for students with acquired background in theory of VLSI Design. Students, working in groups of two to three will work together, partitioning tasks and presenting their work in the form of formal design reviews. The project will consist of a complete specification, design on an appropriate level (RTL, logic, circuit, layout), and verification or simulation of a substantial component of a VLSI system. Students will be offered some ideas of the systems or circuits from which to choose the project, or they can come up with their own design. Regular lectures will cover theoretical aspects of VLSI design as well as standard design practices of industry. Some of the lectures will be devoted to discussions of student projects, presentations and scheduled design reviews. There will be one midterm exam covering the theoretical aspects of VLSI design. Graduate students taking the course as ECE 659 are expected to take on a more advanced project than undergraduate students.

Prerequisites: Introductory course in VLSI design (ECE 558/658).

Lectures:
1) Introduction, course organization
2) VLSI design flow, implementation technologies
3) Case studies, Previous class projects
4) Computer arithmetic, data-path design (adders, multipliers, dividers)
5) Testing, BIST, LFSR
6) Simulation, formal verification
7) Memory design, SRAM, CAM
8) Error detection and correction, ECC
9) Stet of the art: FinFets, Memristors, etc.

Textbook: *CMOS VLSI Design: A Circuits and Systems Perspective*, Weste and Harris, 4th edition, 2011 (same text as used in ECE 558/658).

Computer Requirements:

Web access and familiarity with Windows and Linux OS. Students will be provided with access to CAD tools running on UMass/ECS servers.

Grading:
- Design Proposal – Preliminary Design Review (PDR) 20%
- Comprehensive Design Review (CDR) 20%
- Midterm Exam 30%
- Final Design Review (FDR) 30%

Tentative Schedule

	Topic	Type
Week 1 – Jan. 22	Course intro, VLSI Design flow	Lecture
Week 2 – Jan. 27, 29	Circuit technologies; Case studies	Lecture
Week 3 – Feb. 03, 05	**Proposals** / **PDR** presentations	**Students**
Week 4 – Feb. 10, 12	Arithmetic circuits: Adders	Lecture
Week 5 – Feb. 17, 19	Arithmetic: Multipliers, Dividers	Lecture
Week 6 – Feb. 24, 26	Simulation, Formal Verification	Lecture
Week 7 – March 02, 04	Testing, BIST, DFT, LFSR, MISR	Lecture
Week 8, 9 – March 09 - 18	**Spring Break** + work on projects	
Week 10– March 23, 25	**Comprehensive Design Review (CDR)**	**Students**
Week 11 – March 30, April 01	Material review, **Midterm Exam**	**Students**
Week 12 – April 06, 08	Memory design, SRAM, CAM, I/O ckts	Lecture
Week 13 – April 13, 15	Error detection & correction, ECC	Lecture
Week 14 – April 20, 25	Project discussions, reviews	**Students**
Week 15 – April 27, 29	**Final Design Review (FDR)**	**Students**

STUDENT OUTCOMES	COURSE GOALS				
	1	**2**	**3**	**4**	**5**
1. Able to apply engineering, science, and math to identify, formulate, and solve complex problems	Y	Y	Y	N	N
2. Able to apply engineering design to produce solutions that meet specified needs	Y	Y	Y	N	N
3. Able to communicate effectively with a range of audiences	N	N	N	Y	Y
4. Able to recognize ethical and professional responsibilities, and make informed judgments	N	N	N	N	N
5. Able to function effectively on a team	N	N	Y	Y	Y
6. Able to develop and conduct experiments, analyze and interpret data, and draw conclusions	Y	Y	Y	N	N
7. Able to acquire and apply new knowledge as needed, using appropriate learning strategies	N	N	Y	N	N

Prepared by: Maciej Ciesielski January 17, 2020