Department of Electrical and Computer Engineering University of Massachusetts/Amherst

ECE 559 VLSI Design Project, ECE 659 Advanced VLSI Design Project Spring 2023 ECE Elective, 3 credits

Catalog Data:

<u>Project-oriented</u> 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 <u>ciesiel@ecs.umass.edu</u> Office Hours: Tu, Th 1:30 – 2:30 PM.

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

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 or ECE 658).

Lectures:

- 1) Introduction, course organization
- 2) VLSI design flow, implementation technologies
- 3) Case studies, Previous class projects
- 4) Hardware description language: Verilog
- 5) Computer arithmetic, data-path design
- 6) Testing, BIST, LFSR
- 7) Simulation, formal verification
- 8) Memory design, SRAM, CAM
- 9) Error detection and correction, ECC
- 10) Invited lectures (optional): FinFETs, Memristors, Security

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%

Differencesbetween ECE 559 and ECE 659

The two courses have been already taught jointly to two groups (undergraduate and graduate) of students over several years. Such a combined offering is justified because both groups are equally prepared for the course by taking a prerequisite VLSI Design course, either ECE 558 (Intro to VLSI Design), or the ECE 658 (VLSI Design Principles), also taught jointly.

The two version of the courses differ in the following, recognizing a different level of experience and maturity of the two constituencies.

- Level of difficulty in midterm exam (which covers more advanced topics for graduate students)
- Expected complexity of the resulting project: graduate students, possibly having more experience with CAD tools, simulators, and hardware description languages

Accommodation 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), 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. For further information, please visit Disability Services (*https://www.umass.edu/disability/*)

Academic Honesty Statement

Since the integrity of the academic enterprise of any institution of higher education requires honesty in scholarship and research, academic honesty is required of all students at the University of Massachusetts Amherst. Academic dishonesty is prohibited in all programs of the University. Academic dishonesty includes but is not limited to: cheating, fabrication, plagiarism, and facilitating dishonesty. Appropriate

sanctions may be imposed on any student who has committed an act of academic dishonesty. Instructors should take reasonable steps to address academic misconduct. Any person who has reason to believe that a student has committed academic dishonesty should bring such information to the attention of the appropriate course instructor as soon as possible. Instances of academic dishonesty not related to a specific course should be brought to the attention of the appropriate department Head or Chair. Since students are expected to be familiar with this policy and the commonly accepted standards of academic integrity, ignorance of such standards is not normally sufficient evidence of lack of intent (*http://www.umass.edu/dean_students/codeofconduct/acadhonesty/*).

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Disability Services

University provides a wide variety of services to students with disabilities. Details can be found at the following link: https://www.umass.edu/disability/students/accommodations-students