ECE 748 Special Topics in Microelectronics
Computer-Aided Digital Integrated Circuit Design

COURSE OUTLINE

Please refer to course website for updated information.

CALENDAR DESCRIPTION

This course offers a comprehensive exploration of design methodologies and Electronic Design Automation (EDA) techniques for digital integrated circuits. Key subjects encompass synthesizable Hardware Description Language (HDL), basics of cell-based design, design for testability, functional simulation, gate-level synthesis and optimization, technology mapping, static timing analysis, basics of physical design, standard cells and Intellectual Property (IP) core placement, power grid planning, clock network synthesis, placement and routing of IO pads, global and detail routing, parasitic extraction, back-annotation and gate-level simulation, metal and poly fillers, seal ring, Design Rule Checking (DRC), Layout Versus Schematic (LVS). The complete design process will be demonstrated using industry-standard CAD tools.

SCHEDULE And MODE OF DELIVERY

The material for this course will be delivered through a mixture of lectures, reading, and practical assignments.

Please check with Instructor and/or Avenue to Learn for Schedule and Mode of Delivery.

Lecture: Tuesdays, 11:30 a.m. – 2:30 p.m @ PC 335

INSTRUCTOR

Dr. Ameer Abdelhadi
Email: ameer@mcmaster.ca
Office: ITB-A322
Phone: 905-525-9140 ext. 26008
Office Hours: by appointment

COURSE WEBSITE/S

Most of the course material will be primarily sent by email.
Also http://avenue.mcmaster.ca

COURSE OBJECTIVES

By the end of this course, students will have gained both theoretical understanding and practical experience in designing digital integrated circuits that are ready for fabrication.

ASSUMED KNOWLEDGE

An undergraduate or graduate senior-level course in digital systems design (e.g., COMPENG 3DQ5)

COURSE MATERIALS

Lecture notes, application notes, data sheets, tool manuals, research papers, and other materials provided by the instructor.

COURSE OVERVIEW (APPROXIMATE)

Week	Topic
1	**Introduction:** Course introduction; Overview of the design methodology of digital integrated circuits; Cell-Based Design Flow
2	**Basics of logic design:** Synthesizable RTL; Logic synthesis and optimization; Technology mapping; Functional simulation
3	**Timing Analysis and Optimization:** Design and timing constraints; Delay models; Timing and cell libraries; Sequential circuits
4	**Timing Analysis and Optimization, cont'd:** Static timing analysis (STA); Functional and gate-level timing analysis; False path and multi-phase path analysis; Timing optimization
5	**Basics of physical design:** Standard cells and IP block placement; Power grid planning
6	**Basics of physical design, cont'd:** Clock network synthesis; Placement and routing of IO pads; Global and detail routing
7	**Post layout analysis and simulation:** Parasitic extraction; Back-annotation and gate-level simulation
8	**Design for Testability (DFT):** Design Verification; Fault models; Test generation; Testability analysis and DFT basics; Scan design flow; Scan cell design and insertion
9	**Methods and techniques for low power design:** Power analysis models**;** Switching activity analysis and reduction; Glitches**;** Low-power PDK; Cell sizing; Supply voltage reduction, multi-voltage and multi-VT design; Power and clock gating**;** Dynamic voltage and frequency scaling
10	**Basics and design integration of silicon IP cores and SRAM compilers**
11	**Basics of Cadence SKILL language for physical design automation**
12	**Design closure and signoff:** Metal and poly fillers, Seal ring insertion, Design Rule Checks (DRC), Layout Vs. Schematic (LVS)
13	Course overview

A more detailed timeline is available on the course web site.

The instructor may modify elements of the course and will notify students accordingly (in class or through the course website).

ASSESSMENT

Component	Weight
Assignments	60%
Presentations	20%
Project	20%
Total	100%

The instructor may modify the assessment components and will notify students accordingly (in class or through the course website).

Late submissions of assignments or project report are subject to 20% penalty per day (less than one day is counted as one day).

CONDUCT EXPECTATIONS

As a McMaster graduate student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

ACADEMIC ACCOMMODATIONS OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office ***normally within 10 working days*** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf.

www.eng.mcmaster.ca/ece