COMP ENG 3DQ5
Digital Systems Design

COURSE OUTLINE

Please refer to the course website for updated information.

COURSE DESCRIPTION

Advanced design methods of digital systems, including modelling, simulation, synthesis and verification using hardware description languages, timing analysis and hardware debugging; implementation of computer peripherals in programmable devices.

Three lectures, one tutorial, one lab (three hours) every week.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): COMPENG 2DI4 and one of COMPENG 2DP4 or 2DX4 or 2DX3
Students taking this course as an elective must receive the permission of the instructor.

Anti-requisite(s): N/A

SCHEDULE and MODE OF DELIVERY

The material for this course will be delivered through a mixture of in-person lectures, tutorials, and labs. The lectures, tutorials and labs will NOT be recorded.

Lectures: Tuesday 12:30 p.m. - 1:20 p.m. and Friday 12:30 p.m. - 2:20 p.m.
Tutorial: Tuesday 1:30 p.m. - 2:20 p.m.
Labs: Weekly 2:30 p.m. - 5:20 p.m. (L01 Tuesday, L02 Wednesday, L03 Thursday)

INSTRUCTOR

Dr. Nicola Nicolici
E-mail: nicolici@mcmaster.ca
Office: ITB-A210
Phone: 905-525-9140 ext. 27598
Office Hours: Technical questions will be taken when the instructor is in the lab
Friday 11 a.m. to noon on Teams – this timeslot will be used to discuss personal challenges faced by the concerned students – for this type of meeting, an appointment request needs to be made at least 24 hours before the meeting)

TEACHING ASSISTANTS

Ali Hussein hussea34@mcmaster.ca
Amr El Hossan elhossaa@mcmaster.ca
Graham Power powerg@mcmaster.ca
Guotong Miao miaog@mcmaster.ca
Eslam Younis younie1@mcmaster.ca
Mark Knez knezm1@mcmaster.ca

TA office hours will be announced on the course website.

COURSE WEBSITE

http://avenue.mcmaster.ca

COURSE OBJECTIVES

By the end of this course, students should be able to:

- Analyze and model complex digital circuits using hardware description languages
- Understand design, verification and implementation methods for digital systems
- Learn how to perform as a practitioner by developing an idea into a working prototype

CEAB GRADUATE ATTRIBUTES (GAS)

The CEAB Graduate Attributes (GAs) defined in this section are measured throughout the course and form part of the Department's continuous improvement process. They are a key component of the accreditation process for the program and will not be considered in determining a student's actual grade in the course. For more information on accreditation, please ask your instructor or visit http://www.engineerscanada.ca.

Attributes	Indicators		Measurement Method(s)
	Number	Description	
Problem Analysis	2.1	Identifies and states reasonable assumptions and suitable engineering fundamentals, before proposing a solution path to a problem	Lab or project reports, or questions on the mid-term exam or final exam
Investigation	3.2	Synthesizes the results of an investigation to reach valid conclusions	Lab or project reports, or questions on the mid-term exam or final exam

Attributes	Indicators		Measurement Method(s)
	Number	Description	
Design	4.1	Defines the problem by identifying relevant context, constraints, and prior approaches before exploring potential design solutions	Lab or project reports, or questions on the mid-term exam or final exam
Design	4.3	Develops models/prototypes; tests, evaluates, and iterates as appropriate.	Lab or project reports, or questions on the mid-term exam or final exam
Use of Engineering Tools	5.2	Successfully uses engineering tools	Lab or project source code

ASSUMED KNOWLEDGE

Students should be knowledgeable of the digital representation of electrical signals, number systems, operation of the basic logic gates (AND, OR, …), combinational logic blocks (multiplexer, adder/subtractor, …), sequential elements (latches, flip-flops, …), sequential logic blocks (counters, shift registers, …), and know how to design finite-state-machines (FSMs).

COURSE MATERIALS

Textbook: There is **NO** textbook used in this course. The main sources of information are labs, lectures and tutorials.
Calculator: No calculator will be allowed during tests and examinations.

COURSE OVERVIEW

Weeks	Topic	Readings
1 to 6	Programmable Logic	Lecture Notes
1 to 6	Design Synthesis	Lecture Notes
1 to 6	Design Verification	Lecture Notes
7 to 12	Implementing Algorithms in Hardware	Lecture Notes
7 to 12	Design Methodology for Digital Systems	Lecture Notes
13	Review	Lecture Notes

At certain points in the course, it may make good sense to modify the schedule. The Instructor may modify elements of the course and will notify students accordingly (in class and on the course website).

LABORATORY OVERVIEW

Labs are NOT held during the first week of term.

Date/Week	Topic	Readings
Sep 14 / 2	Lab 1. Introduction to Computer-Aided Design using Verilog	Lab Manual
Sep 21 / 3	Lab 2. Finite State Machine Design for the PS/2 and LCD interfaces	Lab Manual
Sep 28 / 4	Lab 3. Implementation and Utilization of a VGA Interface	Lab Manual
Oct 5 / 5	Lab 4. Embedded Memories and an External SRAM interface	Lab Manual
Oct 19 / 6	Lab 5. Integrating SRAM, VGA and UART Interfaces	Lab Manual
Oct 26 / 7	Project	Project Description
Nov 2 / 8	Project	Project Description
Nov 9 / 9	Project	Project Description
Nov 16 / 10	Project	Project Description
Nov 23 / 11	Project	Project Description
Nov 30 / 12	Project Cross Examination	

LABORATORY OPERATION

- Each student in the course is required to pass the **lab safety** quiz prior to attempting any of the laboratories. The quiz will be on Avenue to Learn.
- The information on accessing and using the lab can be found on the webpage: https://www.eng.mcmaster.ca/ece/resources/health-safety-labs/
- There will be five lab sessions and one comprehensive project. The labs will cover the basics of digital systems design. The project requires you to design, verify, and implement an integrated digital system for image decompression. Project interviews are mandatory and will be held during the week of November 30 in the regular lab time slots. Note that a late course withdrawal will not be permitted if the project has been attempted and the student's name appears on the submission due on November 30.
- You are allowed to work in **groups of two**. You must submit your source code and written reports for all deliverables: five labs and one project. Unless explicitly stated in the lab/project report, it is assumed that each group member has contributed equally to all decisions for every take-home exercise. This means that, when cross-examined, each group member is expected to answer any question. If the contribution of each group member is explicitly stated, the marks will be scaled accordingly.
- Students are expected to demonstrate honesty and ethical behaviour in all aspects of the learning process, particularly during group work on lab and project deliverables. Note that these deliverables (including source code, design files, and lab/project reports) must not be shared in public repositories. Only the two partners in the same group should have access to their group's private repositories.
- Lab and project marks are provisional until the final exam is written in December 2026 because they are subject to an audit (including, but not limited to, an oral cross-examination). For more information, please check the course website regularly.

ASSESSMENT

Component	Weight
Quiz	3%
Midterm	15%
Final Exam	33%
Labs	16%
Project	33%
Total	100%

In addition to the final exam, there will be one in-class quiz on Tuesday, September 15, at 12:30 p.m. (at the beginning of the lecture) and one midterm ***scheduled*** for Monday, October 26, at 7:00 p.m. (the **exact** location **will be confirmed** on the course website in due course). Students who miss the quiz and have a valid excuse will have a 3% higher weight allocated to the final examination component of the final grade. Students who miss the midterm and have a valid excuse will be required to write a make-up test. Anything (worth credit) missed without a valid excuse will receive zero marks. Announcements concerning graded material may be made in any format (e.g., announcements may be made only in class).

Before the “Last day for withdrawing from courses without failure by default” date, you will receive marks for the quiz, several labs, and the midterm, which together constitute at least 25% of the total grade. Conversion from percentage to letter grade will be made using the standard scale from the Office of the Registrar. To pass the course, you must also obtain at least 40% on the final exam and at least 40% on the project. Statistical adjustments will not normally be used.

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. The academic credentials you earn are rooted in principles of honesty and academic integrity. It is your responsibility to understand what constitutes academic dishonesty.

Academic dishonesty is knowingly acting or failing to act in a way that results, or could result, in unearned academic credit or advantage. This behaviour can lead to serious consequences, such as a grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the University. For information on the various types of academic dishonesty, please refer to the Academic Integrity Policy, located at https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/academic-integrity-policy/. The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g., the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

AUTHENTICITY / PLAGIARISM DETECTION

All submitted work is subject to standard verification to confirm that standards of academic integrity have been upheld (e.g., online searches, other software).

COURSES WITH AN ONLINE ELEMENT

Some courses may use online elements (e.g., email, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap). Students should be aware that when they access the electronic components of a course using these elements, private information such as first and last names, McMaster email account user names, and program affiliation may become visible to all other students in the same course. The information available depends on the technology used. Continuing in a course that uses online elements will be deemed consent to this disclosure. If you have any questions or concerns about this disclosure, please discuss them with the course instructor.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and other course materials provided by an instructor are protected by copyright. The Copyright Act protects original literary, dramatic, musical, and artistic works, including lectures by University instructors.

Lectures, tutorials, or other instructional activities may be recorded during a course. Recording may be done by the Instructor for authorized distribution or by a student for 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.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience and the responsibility to demonstrate respectful, dignified interactions across all of our living, learning, and working communities. These expectations are set out in the Code of Student Rights & Responsibilities (the "Code"). All students share responsibility for maintaining a positive environment that supports the academic and personal growth of all McMaster community members, whether in person or online. It is essential that students be mindful of their online interactions, 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., Avenue 2 Learn, WebEx, or Zoom for delivery) will be taken very seriously and investigated. Outcomes may include restrictions or removal of the involved students' access to these platforms.

GENERATIVE AI: USE PROHIBITED

Students are not permitted to use generative AI in this course. In line with McMaster's academic integrity policy, it "shall be an offence knowingly to submit academic work for assessment that was purchased or acquired from another source". This includes work created by generative AI tools. "Contract Cheating is the act of "outsourcing of student work to third parties" (Lancaster & Clarke, 2016, p. 639) with or without payment." Using generative AI tools constitutes contract cheating. Charges of academic dishonesty will be forwarded to the Office of Academic Integrity.

ACADEMIC ACCOMMODATIONS

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

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 the term in which they anticipate needing 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.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar titled "Requests for Relief for Missed Academic Term Work".

EQUITY, DIVERSITY, AND INCLUSION

The Faculty of Engineering is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Faculty, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the Equity and Inclusion Office.

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.

www.eng.mcmaster.ca/ece

Electrical and Computer Engineering Lab Safety

Information for Laboratory Safety and Important Contacts

This document provides important information for the healthy and safe operation of ECE instructional laboratories. This document is required reading for all laboratory supervisors, instructors, researchers, staff, and students working in or managing instructional laboratories in ECE. It is expected that revisions and updates to this document will be done continually. A McMaster University lab manual is also available to read in every laboratory and online https://hr.mcmaster.ca/app/uploads/2019/07/McMaster-Lab-Manual.pdf

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following whether conducting lab work at school or at home:

1. Food and beverages are not permitted in the instructional laboratories.
2. A Laboratory Information Sheet on each lab door identifying potential hazards and emergency contact names should be known.
3. Laboratory equipment should only be used for its designed purpose.
4. Proper and safe use of lab equipment should be known before using it.
5. The course TA leading the lab should be informed of any unsafe conditions.
6. The location and correct use of all available safety equipment should be known.
7. Potential hazards and appropriate safety precautions should be determined, and the sufficiency of existing safety equipment should be confirmed before beginning new operations.
8. Proper waste disposal procedures should be followed.
9. Personal ergonomics should be practiced when conducting lab work. https://bit.ly/3fOE71E
10. Current University health and safety issues and protocol should be known. https://hr.mcmaster.ca/employees/health_safety_well-being/

Location of Safety Equipment

Fire Extinguisher
On walls in halls outside of labs

First Aid Kit
ITB A111, or dial "88" after 4:30 p.m.

Telephone
On the wall of every lab near the door

Fire Alarm Pulls
Near all building exit doors on all floors

Who to Contact

Emergency Medical / Security: On McMaster University campus, call Security at extension **88** or **905-522-4135** from a cell phone.
Non-Emergency Accident or Incident: Immediately inform the TA on duty or Course Instructor.
University Security (Enquiries / Non-Emergency): Dial 24281 on a McMaster phone or dial 905-525-9140 ext. 24281 from a cell phone.
See TA or Instructor: For problems with heat, ventilation, fire extinguishers, or immediate repairs
Environmental & Occupational Health Support Services (EOHSS): For health and safety questions dial 24352 on a McMaster phone or dial 905-525-9140 ext. 24352 from a cell phone.
ECE Specific Instructional Laboratory Concerns: For non-emergency questions specific to the ECE laboratories, please contact 24103.

In Case of a Fire (On Campus Dial 88)

When calling to report a fire, give name, exact location, and building.
1. Immediately vacate the building via the nearest Exit Route. Do not use elevators!
2. Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
3. The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself!
4. In the event of a fire in your work area shout "*Fire!*" and pull the nearest fire alarm.
5. Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs are equipped with Class A, B, and C extinguishers. Do not attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.
6. Do not attempt to fight a major fire on your own.
7. If possible, make sure the room is evacuated; close but do not lock the door and safely exit the building.

Clothing on Fire

Do not use a fire extinguisher on people

1. Douse with water from safety shower immediately or
2. Roll on floor and scream for help or
3. Wrap with fire blanket to smother flame (a coat or other nonflammable fiber may be used if blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

Equipment Failure or Hazard

Failure of equipment may be indicative of a safety hazard - You must report all incidents.

Should you observe excessive heat, excessive noise, damage, and/or abnormal behaviour of the lab equipment:

1. Immediately discontinue use of the equipment.
2. In power labs, press the wall-mounted emergency shut-off button.
3. Inform your TA of the problem.
4. Wait for further instructions from your TA.
5. TA must file an incident report.

Protocol For Safe Laboratory Practice

Leave equipment in a safe state for the next person - if you're not sure, ask!

In general, leave equipment in a safe state when you finish with it. When in doubt, consult the course TA.

Defined Roles

TA	The first point of contact for lab supervision	
ECE Lab Supervisor	Steve Spencer - ITB 147	spencers@mcmaster.ca
ECE Chair	Shahram Shirani - ITB A111/B	shirani@mcmaster.ca
ECE Administrator	Shelby Gaudrault - ITB A111/A	gaudraus@mcmaster.ca
ECE Course Instructor	Nicola Nicolici – ITB A210	nicolici@mcmaster.ca