

## **COMP ENG 2DI4** **Logic Design**

### **COURSE OUTLINE**

Please refer to course website for updated information.

#### **COURSE DESCRIPTION**

Binary numbers and codes; Boolean algebra; combinational circuit design; electrical properties of logic circuits; sequential circuit design; computer arithmetic; programmable logic; CPU organization and design.

#### **PRE-REQUISITES AND ANTI-REQUISITES**

Pre-requisite(s): Registration in a program in Computer Engineering, Electrical Engineering, Engineering Physics (Photonics Engineering Stream), Physics, or Integrated Biomedical Engineering and Health Sciences (IBEHS)

Anti-requisite(s): COMPSCI 2MF3, SFWRENG 2DA4

#### **SCHEDULE and MODE OF DELIVERY**

The lectures, tutorials, and labs for this course will be delivered in-person

##### **Section C01:**

**Instructor:** Dr. Bauman

**Lectures:** Monday (9:30-10:20am), Tuesday (10:30-11:20am), Thursday (9:30-10:20am)

**Tutorials:** Friday (8:30-9:20am) Tutorials start the week of Sept. 11, 2023.

##### **Section C02:**

**Instructor:** Dr. Doyle

**Lectures:** Tuesday (10:30-11:20am), Thursday (9:30-10:20am), Friday (8:30-9:20am)

**Tutorials:** Thursday (10:30-11:20am) Tutorials start the week of Sept. 11, 2023.

##### **Both Sections:**

**Labs:** Every other week 2:30 pm – 5:20 pm beginning September 18, 2023. A detailed lab schedule is provided in the Week 1 lecture slides on Avenue to Learn.

## INSTRUCTORS

### **Section C01:**

Dr. Jennifer Bauman

Email: [Jennifer.bauman@mcmaster.ca](mailto:Jennifer.bauman@mcmaster.ca)

Office: ITB-A220

Phone: 905-525-9140 ext. 27599

Office Hours: Monday 1:30pm – 2:30pm or by appointment

### **Section C02:**

Dr. T. E. Doyle

Email: [doylet@mcmaster.ca](mailto:doylet@mcmaster.ca)

Office: ETB-106

Phone: 905-525-9140 ext. 26139

Office Hours: Monday 1:30pm – 2:20pm or by appointment

When emailing your instructor, ensure your email subject starts with “COE2DI4:” and include in the body of the message your name, student number, lab section, and lecture section. Please include prior correspondence and endeavour to keep your emails concise. You must send emails from your @mcmaster.ca account.

## TEACHING ASSISTANTS

Names and contact information are provided in the Week 1 lecture slides on Avenue to Learn.

## COURSE WEBSITE/s

<http://avenue.mcmaster.ca>

## COURSE OBJECTIVES

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

- Manipulate and simplify Boolean expressions
- Analyze combinational and sequential logic designs
- Synthesize combinational and sequential logic designs
- Design and implement combinational and sequential logic circuits
- Use a hardware description language to implement digital logic design
- Analyze and design digital error detection
- Discuss computer organization in relation to digital systems
- Discuss the impact of digital system design on society

### CEAB GRADUATE ATTRIBUTES (GAs)

Note: 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 taken into consideration 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	
Knowledge Base for Engineering	1.4	Competence in Specialized Engineering Knowledge	Lab
Problem Analysis	2.2	Proposes problem solutions supported by substantiated reasoning, recognizing the limitations of the solutions.	Final Exam
Investigation	3.1	Selects appropriately from relevant knowledge base to plan appropriate data collection methods and analysis strategies.	Lab
Design	4.1	Defines the problem by identifying relevant context, constraints, and prior approaches before exploring potential design solutions.	Final Exam
Use of Engineering Tools	5.2	Succesfully uses engineering tools	Lab

### ASSUMED KNOWLEDGE

Successful completion of first year engineering. Students are expected to be proficient in first year engineering mathematics and computation. Students will be required to install course software on their personal computer.

### COURSE MATERIALS

#### Required items:

1. Textbook: ``*Digital Design: With an Introduction to Verilog HDL, VHDL, and System Verilog*'', 6th edition by M. Morris Mano

#### Optional Items:

1. The following text is recommended as a reference for technical writing – “*Technical Communication: Principles and Practice, Third Edition*” by Raman and Sharma.
2. The following book is suggested to students for supplemental independent reading - ``*Ones and Zeros: Understanding Boolean Algebra, Digital Circuits, and the Logic of Sets*'', by John Greg.

**Calculator:** No calculator permitted on tests or exams.

### COURSE OVERVIEW

Lectures are complemented by the labs and tutorials. Lectures will be initially focused on theory and then transition into a more balanced theory-application presentation. The lecture time will not be used to teach the software applications (this is done in lab and tutorial). It is the student's responsibility to keep up with assigned readings and do the assigned problems. The tutorials will include a short review of lecture concepts, but focus mainly on taking up assigned homework problems. The following is anticipated to be the weekly topic in lectures with associated readings. Based upon the lecture feedback, timing and order may be modified.

Date/Week	Topic
1	Introduction, Number Systems, Boolean Algebra, Logic Gates
2	Gate Level Minimization
3	Combinational Logic: Circuit Analysis and Design, Multiplexers, Adders, Encoders/Decoders
4	Hardware Description Language
5	Synchronous Sequential Logic: Analysis, Latches, Flip-Flops
6	Synchronous Sequential Logic: Analysis, Mealy and Moore Models
7	Synchronous Sequential Logic: Synthesis
8	Synchronous Sequential Logic: Synthesis
9	Digital Systems, Digital Data Error Detection
10	Computer Organization, Memory
11	Register Transfer Level Design
12	Introduction to Assembly
13	Review

Refer to Avenue for assigned reading and homework questions. A more detailed time line is available on the course website. 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, on the course website).

### LABORATORY OVERVIEW

**Labs are NOT held during the first or second weeks of term.**

Labs 1-5 have three components: 1) pre-lab assignment/design, 2) in-lab build-test-evaluate, 3) report. In general, arriving at a lab unprepared will result in an incomplete result. Attendance is mandatory.

When attending labs the student must attend the assigned room and section. Attendance will be taken. **Labs are due at the end of the session.** A laboratory exercise deemed to be partially

or fully copied will be considered an academic offence and be subject to the terms laid out under the McMaster Academic Integrity Policy.

Please be aware of the following penalties for lab work:

1. Failure to properly upload and submit your lab evaluation assignment will result in being assigned a 0 for that evaluation. **This means ALL files necessary to evaluate your work.**
2. Failure to submit a lab evaluation assignment by the specified time will result in a 20% penalty up to two minutes late and 100% if more than two minutes.

*For example, failure to submit your lab report, code, designs, etc. after completing a lab exercise will result in a grade of 0 for the entire lab (not just a 0 for the marks associated with missing piece(s)).*

In terms of submission time, the lab room clock will be the official time. Should the lab room not have a clock or it is unavailable, the TA will specify the reference clock for submission deadlines.

Lab details and schedule will be posted in the Week 1 lecture notes on Avenue.

Topic	
Lab 1	Logic Gates
Lab 2	Combinational Logic
Lab 3	Programmable Logic
Lab 4	Sequential Logic
Lab 5	Design and Implementation of Synchronous Sequential System

#### 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.
- Access to all labs is restricted in the interest of security and safety. Information on accessing and using the lab can be found on the webpage:  
<https://www.eng.mcmaster.ca/ece/labs-and-health-safety/#tab-content-labs-access-and-use>
- All labs must be completed in groups of 1 or 2 students, with group member names marked clearly on the lab title page. Students may only work in a group of one if space permits in the lab.

## ASSESSMENT

Component	Weight
Lab Evaluation (5 labs x 6% each)	30%
Midterm Exam	25%
Final Exam	45%
Total	100%

### Grading and Evaluation Policies

The final exam must be written else a final grade of F will be awarded with the notation DNW (Did Not Write). To pass the course you must obtain at least 50% on the final examination. Statistical adjustments (such as bell curving) will not normally be used. If the midterm is not written, or a student achieves a higher grade on the final exam, the midterm mark will be replaced by the final exam mark. No make-up midterm tests will be granted. Weight of a missed midterm test will be transferred to final exam.

In a case where the component weight cannot be fulfilled as a result of unforeseen and/or uncontrollable circumstance(s) in the course operation or execution, the grades assigned to that component may be pro-rated.

### See Avenue for dates, times, and instructions for Midterm Exam and Final Exam.

## ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. 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 to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the 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-proceduresguidelines/>

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

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit

their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to [www.mcmaster.ca/academicintegrity](http://www.mcmaster.ca/academicintegrity).

#### **COURSES WITH AN ON-LINE ELEMENT**

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). 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, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

#### **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.

### **CONDUCT EXPECTATIONS**

As a McMaster 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.

### **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](mailto:sas@mcmaster.ca) to make arrangements 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 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.

### **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 “Requests for Relief for Missed Academic Term Work”. Note that if more than two labs are missed due to MSAFs, the student must meet with their instructor to arrange for a lab make-up schedule. At least three labs must be completed with passing grades in order to pass the course.

### **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](http://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/2019/07/2019-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 condition.
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 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/resources/covid19/workplace-health-and-safety-guidance-during-covid-19/>

## Location of Safety Equipment

<b>Fire Extinguisher</b> On walls in halls outside of labs	<b>First Aid Kit</b> ITB A111, or dial "88" after 4:30 p.m.
<b>Telephone</b> On the wall of every lab near the door	<b>Fire Alarm Pulls</b> 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 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

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	steve@mail.ece.mcmaster.ca
ECE Chair	Mohamed Bakr – ITB A111	mbakr@mcmaster.ca
ECE Administrator	Shelby Gaudrault- ITB A111	gaudraus@mcmaster.ca
ECE Course Instructor	Please contact your specific course instructor directly	