COMP ENG 2DX3

Microprocessor Systems Project
Embedded Intelligence -- "Observe, Reason, and Act"

COURSE OUTLINE

Please refer to course website for updated information.

CALENDAR/COURSE DESCRIPTION

Microprocessor systems, introduction to the design process, project development by small teams of students, oral presentations and engineering report writing.

PRE-REQUISITES AND ANTI-REQUISITES

Pre-requisite(s): COMPENG 2SH4 and COMPENG 2DI4 and either ELECENG 2CI5 or ELECENG 2CI4
Anti-requisite(s): COMPENG 2DP4, COMPENG 2DX4

SCHEDULE

Lecture: Friday, 11:30 am – 12:20 pm
Studio: Friday, 1:30 pm – 2:20 pm

Note: This is a hands-on project-based course, and the instructors will deliver both the lectures and tutorials as hands-on studios (Studio 1 and Studio 2 weekly). Studios have a mandatory attendance requirement.

L01-L10 Labs: see Laboratory Overview section.

Students should refer to their schedule on Mosaic to find the locations of classes, tutorials and labs.

INSTRUCTORS

Dr. Athar

athars3@mcmaster.ca

Dr. Elamien

elamienm@mcmaster.ca

Dr. Haddara

yaser@mcmaster.ca

Individual office hours will be posted on the course website.

TEACHING ASSISTANTS

Names, contact information, and office hours (if applicable) will be provided on the course website.

COURSE WEBSITE

The Course website will be Avenue to Learn (http://avenue.mcmaster.ca/). The student is required to **check the system daily** for assignment release/submission, course related material, and posted announcements.

EMAIL POLICY

When sending an email to your professors or your TA(s) it is important that we can quickly identify it and that it has the necessary information to help you. First, ensure your email subject starts with "CE2DX3:", and include in the body of the message: i) your name, ii) student number, and iii) lab section. Please include prior correspondence and endeavour to keep your email concise. We can only respond to emails sent from your @mcmaster.ca account.

COURSE OBJECTIVES

The primary objective of this course is to become proficient with the fundamentals of microprocessor systems and their relation to embedded system design. The course is project based and structured around the embedded themes of how devices observe, reason, and act within the world around them.

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

- Discuss the details of microprocessors, microprocessor systems, and microcontrollers.
- Program the microprocessor at the assembly level.
- Analyze the hardware and software organization of a microprocessor system.
- Analyze microprocessor system memory (structure, timing, interfacing, decoding, maps).
- Discuss, manipulate, and control microprocessor system Input / Output.
- Discuss, manipulate, and control microprocessor system Interrupts.
- Discuss, manipulate, and control microprocessor system Peripherals.
- Discuss and implement introductory concepts in Digital Signal Processing related to Analog-to-Digital conversion, Digital-to-Analog conversion, Sampling, Simple Data Processing, Fixed/Floating-Point considerations and standards.
- Discuss embedded programming concepts such as control structures, abstract data types, procedural programming, event-based programming, modularity, and unit testing.
- Discuss the impact of microprocessor system design on society.
- Design, implement, and discuss a microprocessor system from a given problem specification.

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	
Design	4.2	Explores a breadth of potential solutions, considering their benefits and trade-offs as they relate to the project requirements.	Course Project
Design	4.4	Justifies and reflects on design decisions, giving consideration to limitations, assumptions, constraints and other relevant factors.	Course Project
Use of Engineering Tools	5.1	Evaluates engineering tools, identifies their limitations, and selects, adapts, or extends them appropriately.	Labs, Course Project, Project Demo and Interview
Communication Skills	7.1	Demonstrates comprehension of technical and non-technical instructions and questions.	Labs, Course Project, Project Report
Communication Skills	7.2	Composes an effective written document for the intended audience.	Theme Reports and Project Report
Communication Skills	7.3	Composes and delivers an effective oral presentation for the intended audience.	Lab Work Demonstration, Project Demonstration
Impact of Engineering on Society and the Environment	9.2	Evaluates the social impact of engineering activities, including health, safety, legal, cultural, and other relevant factors, and identifies uncertainties in decisions.	Theme Report(s)
Life-long Learning	12.1	Reflects on one's own educational needs and opportunities for growth.	Theme Reports
Life-long Learning	12.2	Seeks and acquires appropriate external information as required, including showing awareness of sources of information and ability to critically evaluate them.	Course Project

ASSUMED KNOWLEDGE

Successful completion of ELECENG 2CI4, COMPENG 2SH4, and COMPENG 2DI4. Students are expected to be proficient in these courses and basic electronics.

COURSE MATERIALS

Required:

1. Textbook: Valvano, "Embedded Systems: Introduction to ARM Cortex-M Microcontrollers", **5th edition, 6th printing, January 2019**. Please note the edition, printing, and date! (A low-cost Kindle digital version may be available via Amazon – **confirm version before purchase**)
2. Hardware: A course hardware kit will be required. Information about the kit and purchase procedure will be available on Avenue.
3. Software: A free Integrated Development Environment (IDE) will be used for this course. Refer to the course website for information on obtaining the software.

Optional:

4. Textbook: Valvano, "Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers", 5th edition, 9th printing, July 2024. Please note the edition, printing, and date! (A low-cost Kindle digital version may be available via Amazon – confirm version before purchase)

Calculator: None required. **Not permitted on exams**.

COURSE OVERVIEW

Lectures are complemented by the design studios and labs. To take full advantage of the lecture and studio time, the student must keep up with assigned lecture videos, readings, and do the assigned problems. Lectures are intended to introduce theory and concepts that will be reinforced through experiential studios and integrative labs. This course has a major project that serves as the method of course knowledge synthesis. Lecture time will not be used to teach the software applications or to review hardware bit-level configurations.

The following are anticipated to be the weekly topics in lectures:

Week	Topic
0	Introduction, Embedded Systems & Architecture
1	Signals Around Us (Digital vs. Analog)
2	Transduction & Analog Data Acquisition
3	Timing, I/O, & Structured Program Organization
4	Peripheral Interfacing
5	Interrupts and Event Based Programming
6	Transfer Function & Calibration
7	Communication Protocols
8	System Integration
9	Data Visualization
A	Distributed and Intelligent Embedded Systems
B	Project and Course Overview

Refer to the course website for assigned readings and questions (COMPENG 2DX3 Schedule). Subjects may be reorganized/modified if deemed necessary by the instructor(s). Any reorganization/modification will be communicated to the class.

This schedule is based upon current university and public health guidelines and may be subject to changes during the term. Any changes to the schedule or course delivery will be communicated on the course announcements section on Avenue to Learn. Please check the announcements prior to attending class.

LABORATORY OVERVIEW

The laboratory manual is available on the course website for download. Always check to ensure you have the most recent version while working on your lab because updates occur based on student questions and input. The Avenue to Learn section for the laboratory manual mentions the date of the most recent update.

Labs will typically have the following components: 1) Pre-lab assignment/design, and 2) In-lab build-test-evaluate* milestones. All in-lab milestones must be evaluated by the TAs before the designated end time of the lab session. No extra time would be given. In addition, the course has three Theme reports and one Project report as indicated below. In general, arriving at a lab unprepared will result in an incomplete result. In-person attendance in labs is mandatory.

Week	Lab Topic	Theme Report	Project Report
0	--		
1	--		
2	Introduction to 2DX Labs		
3	Simple Digital I/O		
4	Digital I/O		
5	Acquiring Analog Data (ADC)		
6	Timing, PWM, and Stepping Motor	Yes (Observe)	
7	Peripheral Interface (Keypad)		
8	Project Early Integration Demonstration and Interview**	Yes (Reason)	
9	Event Based Interrupt Systems		
A	Sensor Data		
B	Project**	Yes (Act)	
C			Yes

*Note that lab exercises are to be treated like homework exercises and substantially started prior to coming to the lab. The required Hardware Kit will allow students to perform the labs off campus at home. Lab time should be used for final debugging, data collection for theme reports, and for evaluation by TAs.
**Additional Project documentation required – see project specification.

Notice – All Final Project Demonstrations and Interviews will be scheduled in the final two weeks of classes. It is your responsibility to confirm you have a time and location.

LABORATORY OPERATION

Students choose or are assigned a specific laboratory section. The day and time of these sections are listed in the McMaster Undergraduate Master Timetable. Attendance of the assigned laboratory is compulsory. The student must attend the assigned room and section. Attendance will be taken. Refer to the Laboratory Manual for specific deadlines.

At the beginning of every term, every Undergraduate student using an ECE Lab is required to complete the ECE Lab Safety Quiz. The quiz and other information is provided on the course web site.

Penalties for late submission, tardiness, or absence without a valid reason are typically a zero on the assigned work.

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.

All work is required to be done individually and, unless explicitly stated, no collaborative work is permitted.

Please be aware of the following penalties for lab work:

1. Failure to properly upload and submit your pre-lab assignment and theme/project reports will result in being assigned a 0 for that evaluation. **This means ALL files necessary to evaluate your work**.
2. Failure to submit a pre-lab assignment by the specified time up to 10 minutes late will not lead to any penalty. If more than 10 minutes late, then a 100% penalty is applied.
3. Failure to submit a Theme Report or Project Report by the specified time up to 10 minutes late will not lead to any penalty. If more than 10 minutes late, then a 100% penalty is applied.

In terms of submission time, the Avenue to Learn clock will be the official time. Should Avenue be unavailable, the TA will specify the reference clock for submission deadlines.

The TAs and the instructors reserve the right to interview students to assess their understanding of the lab material (including pre-lab and bonus). Such interviews will be held at random and we reserve the right to adjust the lab mark based on the outcome of the interview.

ASSESSMENTS

Component	Total Weight
Lab Evaluation	16%
Theme Reports	9%
Midterm Exam(s)	30%
Individual Project	30%
Final Exam	15%
Total	100%

Regular labs are equally weighted over the Lab Evaluation total weight (Lab 6 is the first project deliverable and is not included in this total). Theme reports are equally weighted over the Theme Reports total weight.

There are two midterm tests. The better test mark will have twice the weight as the lower test mark to obtain the combined 30% Midterm Exam(s) total weight (i.e., 20/10 or 10/20).

The final exam must be written else a final grade of F will be awarded with the notation DNW (Did Not Write). Statistical adjustments (such as bell curving) will not normally be used.

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

Midterm exams information will be posted to Avenue early in the term. These dates/times are subject to change and the student must confirm on the course web site. No make-up midterm tests will be granted. Weight of a missed midterm test will be transferred to the final exam only after an approved MSAF is received.

Final exam details are set by the Registrar. The instructor(s) reserves the right to choose the format (i.e. written or oral) of any deferred exam in this course.

Unless otherwise stated, all assessments are closed-book. No aids are permitted in assessments.

Please note that announcements concerning any type of graded material may be in any format (e.g., announcements may be made only in class). Students are responsible for completing the graded material regardless of whether they received the announcement or not. This means that if you skip a class and an announcement for a quiz, lab, test, project, etc. is made in that class, then you are still responsible for that material.

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 this link.

The following illustrates only a few 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.
- In case a course is being repeated, submitting work done earlier by the student may constitute self-plagiarism. Students should discuss with the instructor for clarity.
- Improper collaboration in group work.
- Copying or using unauthorized aids in tests and examinations.
- Using generative AI tools to do work that is to be submitted for credit if the instructor has prohibited such use.

Note: The use of generative AI tools (such as ChatGPT) is prohibited in this course unless explicitly allowed by the instructor. Any violation in this regard will constitute academic dishonesty.

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 this link.

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, usernames 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, Microsoft Teams, 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 to make arrangements with a Program Coordinator. For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

Students requiring academic accommodations 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". The applicable policy is located at this link.

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 at this link.

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. Please see this link.
10. Current University health and safety issues, and protocols should be known. Please see this link.

Location of Safety Equipment

Fire Extinguisher
On walls in halls outside of labs

First Aid Kit
Main Lobby of ITB 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 non-flammable 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	spencers@mcmaster.ca
ECE Chair	Dr. Shahram Shirani - ITB A111	shirani@mcmaster.ca
ECE Administrator	Shelby Gaudrault - ITB A111	gaudraus@mcmaster.ca
ECE Course Instructor	Please contact your specific course instructor directly	