COMP ENG 2DP4
Microprocessor Systems
Winter 2018
Course Outline

CALENDAR/COURSE DESCRIPTION
Introduction to computer organizations; algorithmic state machine design; micro processor based system design including memory and peripheral interfaces; interrupt systems; software development tools; machine-level coding and programming.

PRE-REQUISITES AND ANTI-REQUISITES
Prerequisite(s): Registration in any Computer Engineering or Electrical Engineering Program, COMPENG 2DI4 or ELECENG 2DI4

SCHEDULE
C01 Lectures: Monday, Wednesday, Thursday 10:30am-11:20am
C02 Lectures: Monday and Thursday 12:30 p.m.-1:20, Tuesday 1:30 p.m.-2:20pm
T01 Tutorial: Thursday 8:30am-9:20am
T02 Tutorial: Tuesday 10:30am - 11:20am
Labs: see Laboratory Overview (below)

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Thomas Doyle (C01)
Office: ETB 106
doylet@mcmaster.ca
Ext. 26139
Office Hours: Mondays 12:00 - 2:00pm

Mr. Amin Vali (C02)
Office: ITB-A110
valia2@mcmaster.ca
Office Hours: Tuesday 2:30 – 4:00pm
(By appointment)

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

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

Acton, Neil: aclonn@mcmaster.ca
Aghabali, Iman: aghabali@mcmaster.ca
Dhale, Sumedh: dhales@mcmaster.ca
Gareau, Jacob: gareauj@mcmaster.ca
Kordic, Milan: kordicm@mcmaster.ca
Lewis, Shurwayne: lewiss8@mcmaster.ca
Mehrvarzy, Pooyan: mehrvarp@mcmaster.ca
Rotilli Filho, Silvio: rotillis@mcmaster.ca
Valencia Garcia, Diego: valend1@mcmaster.ca

Office hours and additional contact information available on Avenue to Learn.
The Course Management System (CMS) will be Avenue to Learn. The student is required to check the system daily for assignment release/submission, course related material, and posted announcements.

http://avenue.mcmaster.ca/

The primary objective of this course is to become proficient with the fundamentals of microprocessor systems and their relation to embedded system design.

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

- Discuss the details of microprocessors, microprocessor systems, and microcontrollers
- Program the microprocessor (Assembly, Cross-Assembly, IDE)
- Analyze and synthesize the hardware and software organization of a microprocessor system
- Analyze and synthesize 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, Digital-to-Analog, Sampling, Simple Data Processing, Fixed/Floating-Point Considerations and Standards
- Discuss the impact of microprocessor system design on society
- Design, implement, and discuss a microprocessor system from a given problem specification.

Successful completion Computer Engineering 2D14. Students are expected to be proficient in Digital Logic design and basic electronics. Students will be required to install course software on their personal computer.
COURSE MATERIALS

Required:


2. **Hardware**: Micro Kit – Esduino Xtreme Microcontroller and Programming Kit (IEEE Student branch will facilitate pre-orders/orders) [Tentative deadline by January 12, 2018], and

3. **Software**: CodeWarrior Integrated Development Environment ([Free Edition with Textbook](https://www.mouser.com/catalog)) or can be [downloaded from Freescale]

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

COURSE OVERVIEW

Lectures are complemented by the lab and tutorial lessons and material. To take full advantage of the lecture time, the student must keep up with assigned readings and do the assigned problems. Lectures will be initially focused on course theory and 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). Lectures are mandatory.

The following is anticipated to be the weekly topic in lecture with associated readings. Based upon the lecture feedback, timing and order may be modified.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction, Organization, and Overview</td>
</tr>
<tr>
<td>2</td>
<td>Intro to Embedded Systems &amp; Assembly Programming</td>
</tr>
<tr>
<td>3</td>
<td>Assembly Programming</td>
</tr>
<tr>
<td>4</td>
<td>Advanced Assembly Programming</td>
</tr>
<tr>
<td>5</td>
<td>Advanced Assembly Programming &amp; I/O</td>
</tr>
<tr>
<td>6</td>
<td>C Language for Assembly &amp; I/O</td>
</tr>
<tr>
<td>7</td>
<td>I/O, &amp; Polling, &amp; Interrupts</td>
</tr>
<tr>
<td>8</td>
<td>Timers, Interrupts, Serial Communication</td>
</tr>
<tr>
<td>9</td>
<td>Clocks, Resets &amp; Busses</td>
</tr>
<tr>
<td>10</td>
<td>Analog-to-Digital Conversion (ADC) (Successive Approximation, Quantization Error, Sampling) &amp; Applications (PWM)</td>
</tr>
<tr>
<td>11</td>
<td>Applications (Transducers, Instrumentation)</td>
</tr>
<tr>
<td>12</td>
<td>Memory and Logic</td>
</tr>
</tbody>
</table>

Refer to CMS for assigned reading and questions (2DP4 Schedule).

LABORATORY OVERVIEW

The laboratory manual is available on the CMS for download. Ensure you have the most recent version while working on your lab as updates occur based on student questions and input.
Labs will typically have the following 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.

*Note that lab exercises are expected to be worked on prior to coming to the lab using the required Micro Kit. Labs should be for final debugging, evaluation, and report completion.

<table>
<thead>
<tr>
<th>Week #</th>
<th>Week Date/Day</th>
<th>Lab Exercise</th>
<th>Mo</th>
<th>Tu</th>
<th>We</th>
<th>Th</th>
<th>Fr</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>EOW1</td>
<td>General Organization of Lab Cycle</td>
<td>L01</td>
<td>L02</td>
<td>L03</td>
<td>L04</td>
<td>L05</td>
</tr>
<tr>
<td>B</td>
<td>EOW2</td>
<td>No Labs</td>
<td>L02</td>
<td>L04</td>
<td>L05</td>
<td>L06</td>
<td>L07</td>
</tr>
<tr>
<td>0</td>
<td>31-Dec</td>
<td></td>
<td>L02</td>
<td>L04</td>
<td>L05</td>
<td>L06</td>
<td>L07</td>
</tr>
<tr>
<td>1</td>
<td>07-Jan</td>
<td></td>
<td>L02</td>
<td>L04</td>
<td>L05</td>
<td>L06</td>
<td>L07</td>
</tr>
<tr>
<td>2</td>
<td>14-Jan</td>
<td>1. Data Path &amp; Memory</td>
<td>L01</td>
<td>L02</td>
<td>L03</td>
<td>L04</td>
<td>L05</td>
</tr>
<tr>
<td>3</td>
<td>21-Jan</td>
<td>2. Intro to the EduinoXtreme HCS12</td>
<td>L01</td>
<td>L02</td>
<td>L03</td>
<td>L04</td>
<td>L05</td>
</tr>
<tr>
<td>4</td>
<td>28-Jan</td>
<td>3. Keypad and LCD interfacing</td>
<td>L01</td>
<td>L02</td>
<td>L03</td>
<td>L04</td>
<td>L05</td>
</tr>
<tr>
<td>5</td>
<td>04-Feb</td>
<td></td>
<td>L01</td>
<td>L02</td>
<td>L03</td>
<td>L04</td>
<td>L05</td>
</tr>
<tr>
<td>6</td>
<td>11-Feb</td>
<td></td>
<td>L01</td>
<td>L02</td>
<td>L03</td>
<td>L04</td>
<td>L05</td>
</tr>
<tr>
<td>7</td>
<td>18-Feb</td>
<td>4. Interrupts and Event Based Programs</td>
<td>L01</td>
<td>L02</td>
<td>L03</td>
<td>L04</td>
<td>L05</td>
</tr>
<tr>
<td>8</td>
<td>25-Feb</td>
<td>5. Analog to Digital Conversion</td>
<td>L01</td>
<td>L02</td>
<td>L03</td>
<td>L04</td>
<td>L05</td>
</tr>
<tr>
<td>9</td>
<td>04-Mar</td>
<td></td>
<td>L01</td>
<td>L02</td>
<td>L03</td>
<td>L04</td>
<td>L05</td>
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<tr>
<td>10</td>
<td>11-Mar</td>
<td></td>
<td>L01</td>
<td>L02</td>
<td>L03</td>
<td>L04</td>
<td>L05</td>
</tr>
<tr>
<td>11</td>
<td>18-Mar</td>
<td></td>
<td>L01</td>
<td>L02</td>
<td>L03</td>
<td>L04</td>
<td>L05</td>
</tr>
<tr>
<td>12</td>
<td>25-Mar</td>
<td></td>
<td>L01</td>
<td>L02</td>
<td>L03</td>
<td>L04</td>
<td>L05</td>
</tr>
<tr>
<td>13</td>
<td>01-Apr</td>
<td>Project Submissions</td>
<td>Demo &amp; Interview</td>
<td>Demo &amp; Interview</td>
<td>Demo &amp; Interview</td>
<td>Demo &amp; Interview</td>
<td>Demo &amp; Interview</td>
</tr>
</tbody>
</table>

LABORATORY OPERATION

The student has chosen or been assigned 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.

When attending labs and tutorials, the student must attend the assigned room and section. Attendance will be taken. Labs are due at the end of the session.

Penalties for late submission, tardiness, or absence without a valid reason are typically a 0 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 and tutorial 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, or 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.

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Evaluation</td>
<td>15%</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>30%</td>
</tr>
<tr>
<td>Individual Project</td>
<td>20%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>35%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
</tr>
</tbody>
</table>

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.

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.

**Midterm exam is scheduled for Tuesday February 13, 2018 from 7:00pm to 9:00pm.** This date/time is subject to change and student must confirm the date/time on the CMS. The instructor(s) reserves the right to choose the format (i.e. written or oral) of any deferred midterm or exam in this course.

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 midterm or exam in this course.

Unless otherwise stated, tests, practical labs, and examinations are closed-book.

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.
ACREDITATION LEARNING OUTCOMES

Note: The Learning Outcomes 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.

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Indicators</th>
<th>Measurement Methods(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Demonstrates and ability to identify reasonable assumptions when designing a data acquisition system that could or should be made before a solution path is proposed.</td>
<td>2.1</td>
<td>Documented final project assumptions for the data acquisition requirements</td>
</tr>
<tr>
<td>• Can estimate the digital mapping of an analog signal based upon the combination of applying Shannon’s Sampling Theorem and the quantization effect from Analog-to-Digital Conversion (Successive Approximation Method).</td>
<td>3.3</td>
<td>Compare and contrast different data acquisition systems during an interview.</td>
</tr>
<tr>
<td>• Using specialized software and hardware to demonstrate designing, building and troubleshooting microprocessor systems.</td>
<td>5.2</td>
<td>Evaluation of ability to use design and synthesis tools for implementation of microprocessor system.</td>
</tr>
<tr>
<td>• Assesses possible options and design configurations from a sustainability engineering perspective, which emphasizes environmental stewardship, life-cycle analysis, and long-term decision-making principles</td>
<td>9.3</td>
<td>Textual analysis related to final project report.</td>
</tr>
</tbody>
</table>

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.

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.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at http://www.mcmaster.ca/academicintegrity.

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one’s own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.
**ACADEMIC ACCOMMODATIONS**

Students who require academic accommodation must contact Student accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contact by phone at 905.525.9140 ext. 28652 or e-mail at sas@mcmaster.ca. For further information, consult McMaster University’s Policy for Academic Accommodation of Students with Disabilities.

**NOTIFICATION OF STUDENT ABSENCE AND SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK**

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” : [http://www.mcmaster.ca/msaf/](http://www.mcmaster.ca/msaf/)

**NOTICE REGARDING POSSIBLE COURSE MODIFICATION**

The instructor(s) and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

**ON-LINE STATEMENT FOR COURSES REQUIRING ONLINE ACCESS OR WORK**

In this course, we will be using Avenue to Learn. Students should be aware that, when they access the electronic components of this course, 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 this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

**REFERENCE TO 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](http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf).
Information for Laboratory Safety and Important Contacts

This document is for users of ECE instructional laboratories in the Information Technology Building.

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.

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following:
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.

Location of Safety Equipment

<table>
<thead>
<tr>
<th>Fire Extinguisher</th>
<th>First Aid Kit</th>
</tr>
</thead>
<tbody>
<tr>
<td>On walls in halls outside of labs</td>
<td>ITB A111, or dial “88” after 4:30 p.m.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Telephone</th>
<th>Fire Alarm Pulls</th>
</tr>
</thead>
<tbody>
<tr>
<td>On the wall of every lab near the door</td>
<td>Near all building exit doors on all floors</td>
</tr>
</tbody>
</table>
In Case of a Fire (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 Lab, 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
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

<table>
<thead>
<tr>
<th>Role</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA</td>
<td>The first point of contact for lab supervision</td>
</tr>
<tr>
<td>ECE Lab Supervisor</td>
<td>Steve Spencer- ITB 147 <a href="mailto:steve@mail.ece.mcmaster.ca">steve@mail.ece.mcmaster.ca</a></td>
</tr>
<tr>
<td>ECE Chair</td>
<td>Tim Davidson- ITB A111 <a href="mailto:davidson@mcmaster.ca">davidson@mcmaster.ca</a></td>
</tr>
<tr>
<td>ECE Administrator</td>
<td>Kerri Hastings- ITB A111 <a href="mailto:hastings@mcmaster.ca">hastings@mcmaster.ca</a></td>
</tr>
<tr>
<td>ECE Course Instructor</td>
<td>Please contact your specific course instructor directly</td>
</tr>
</tbody>
</table>