COMP ENG 4DS4
Embedded Systems
Winter 2018
Course Outline

CALENDAR/COURSE DESCRIPTION

Embedded processor architectures and SOC organization; EDA tools for hardware/software co-design; co-verification and testability; interfacing; co-processors, soft processors and ASIP design; real-time systems; applications.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): COMPENG 3DQ5, or permission of the department.

SCHEDULE

Lectures: Wednesday 11:30 am – 12:20 pm in BSB-137
           Friday 1:30 pm – 2:20 pm in BSB-137
Tutorial:  Monday 12:30 pm – 1:20 pm in KTH-B132
Labs:      Weekly in ITB-AB109 from 2:30 pm to 5:20 pm (L01 Tuesday, L02 Wednesday, L03 Thursday)

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Nicola Nicolici
ITB-A210
nicolici@mcmaster.ca
ext. 27598

Office Hours:
Wednesday 1:30 pm – 2:20 pm
Or by appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

Trevor Pogue
ITB-A208
poguete@mcmaster.ca
ext.22723

Alex Lao
ITB-A208
laoa@mcmaster.ca
ext.22723

Stefan Dumitrescu
ITB-A208
dumits@mcmaster.ca
ext.22723

Office Hours:
Fridays – 2:30 pm - 5:20 pm
in ITB AB109
One TA each Friday
COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION


COURSE OBJECTIVES

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

- Understand design methods for embedded systems
- Assess the value of both hardware and software components in embedded systems

ASSUMED KNOWLEDGE

Students should be experienced with designing, verifying, and implementing digital systems, field-programmable gate-arrays (FPGAs) and hardware description languages (HDLs) like SystemVerilog, as well as C programming.

COURSE MATERIALS

Required Texts: 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

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Topic</th>
<th>Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 2</td>
<td>Revision of digital systems</td>
<td>Lecture Notes</td>
</tr>
<tr>
<td>2 to 3</td>
<td>Revision of data structures and algorithms</td>
<td>Lecture Notes</td>
</tr>
<tr>
<td>3 and 7</td>
<td>Organization of integrated systems</td>
<td>Lecture Notes</td>
</tr>
<tr>
<td>8 and 11</td>
<td>Real-time operating systems</td>
<td>Lecture Notes</td>
</tr>
<tr>
<td>12 and 13</td>
<td>High—performance/energy-efficient embedded systems and review</td>
<td>Lecture Notes</td>
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LABORATORY OVERVIEW

<table>
<thead>
<tr>
<th>Date/Week</th>
<th>Topic</th>
<th>Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 8 / 2</td>
<td>Lab 1. Digital system implementation with real-time constraints</td>
<td>Lab Manual</td>
</tr>
<tr>
<td>Jan 15 / 3</td>
<td>Lab 2. Introduction to embedded software for the NIOS II processor</td>
<td>Lab Manual</td>
</tr>
<tr>
<td>Jan 22 / 4</td>
<td>Lab 3. Interfacing custom hardware to the NIOS II processor</td>
<td>Lab Manual</td>
</tr>
<tr>
<td>Jan 29 / 5</td>
<td>Lab 4. Hardware acceleration vs. software configuration</td>
<td>Lab Manual</td>
</tr>
<tr>
<td>Feb 5 / 6</td>
<td>Lab 5. Debugging techniques for embedded systems</td>
<td>Lab Manual</td>
</tr>
<tr>
<td>Feb 26 / 8</td>
<td>Lab 6. Introduction to real-time operating systems</td>
<td>Lab Manual</td>
</tr>
</tbody>
</table>

LABORATORY OPERATION

The lab is located in ITB/AB109. There will be eight lab sessions listed above.

Students are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process, in particular during, but not limited to, the group work for lab deliverables.

You are allowed to work in groups of 2. For all the deliverables you must submit not only written reports, but also your source files. It is very important to note that, unless explicitly stated in the lab report, it is assumed that each group member has contributed to all the design/implementation/verification decisions for every take-home exercise. This implies that, when cross-examined, each group member is expected to answer any question. If it is explicitly stated what was the contribution of each group member then the grades will be scaled accordingly.

It is important to note that lab marks are **provisional until the final exam** is written in April 2018 because they are subject to an audit (including, but not limited to, an oral cross-examination).
### ASSESSMENT

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiz</td>
<td>5%</td>
</tr>
<tr>
<td>Labs</td>
<td>55%</td>
</tr>
<tr>
<td>Midterm</td>
<td>10%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>30%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

In addition to the final exam, there will be one in-class quiz on Wednesday January 10 at 11:30 am (during the lecture) and one midterm on Friday February 9 at 1:30 pm (during the lecture). Students who miss the quiz, and who have a valid excuse, will have a 5% larger weight allocated to the final examination component of the final grade. Students who miss the midterm, and who have a valid excuse, will be subjected to a make-up test. Anything (worth credit) missed without a valid excuse will be given zero marks. Please note that the instructor reserves the right to choose the format (e.g., written or oral) of any deferred midterm or exam in this course. Announcements concerning any type of graded material may be made in any format (e.g., announcements may be made only in class).

Conversion from percentage to letter grade will be by way of the standard scale used in the Office of the Registrar. To pass the course you must also obtain at least 40% on the final examination and at least 40% on the labs (i.e., at least 22 marks out of the 55 marks allocated for all the labs). Statistical adjustments will not normally be used.
### ACCREDITATION 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](http://www.engineerscanada.ca).

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Indicators</th>
<th>Measurement Methods(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capable of selecting appropriate model and methods and identify assumptions and constraints</td>
<td>3.2</td>
<td>Students will be requested to analyze the execution time and provide an interpretation for the variation in performance when running an algorithm on different configurations of an embedded processor.</td>
</tr>
<tr>
<td>Applies economic principles in decision making</td>
<td>11.1</td>
<td>Students are asked to extend a reference design to balance the usage of hardware and software components based on the performance requirements.</td>
</tr>
<tr>
<td>Communication skills</td>
<td>7.2</td>
<td>Sections from lab report describing the implementation details are used for assessment.</td>
</tr>
<tr>
<td>Life-long learning</td>
<td>12.1</td>
<td>A survey will be been done in the last week of classes. Students will be asked to provide examples how they have used knowledge, methods and skills procured in through self-directed and self-identified sources and applied them in COE4DS4 (or other courses in our curriculum).</td>
</tr>
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</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/
NOTICE REGARDING POSSIBLE COURSE MODIFICATION

The instructor 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 attend classes, 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.
### 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

- **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**
  - Near all building exit doors on all floors
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>