# COMP ENG 3DR4
# Computer Organization
Fall/Winter 2015/16
Course Outline

## CALENDAR/COURSE DESCRIPTION

Instruction set design, computer arithmetic, assembly language, controller and datapath design, cache and memory systems, input-output systems, networks interrupts and exceptions, pipelining, performance and cost analysis, computer architecture history and a survey of advanced architectures.

## PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): Registration in any Computer Engineering or Electrical Engineering Program, COMPENG 3DQ4 or COMPENG 3DQ5
Antirequisite(s): COMPSCI 2CA3, SFWRENG 3GA3

## SCHEDULE

**Lectures:** Tuesday, Thursday & Friday 11:30 am – 12:20 pm, BSB-136
**Tutorial:** Monday 10:30 am – 11:20 am, HH 104
**Labs:** Every Other Week: L01 Tuesdays 2:30 pm - 5:20 pm ; L02 Tuesdays 2:30 pm - 5:20 pm , ITB 155
**Online Video Lectures:** To keep up with the times, the instructor will video-record most lectures and post the compressed videos on Avenue to Learn. A few lectures may be delivered online only, i.e., in case of winter storms.

## INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

**Dr. Ted Szymanski**
ITB-A314
teds@mcmaster.ca
ext. 27697

**Office Hours:**
TBA
Or by appointment

## TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

| NAME | EMAIL | OFFICE HOURS |
|---|---|---|
| **Haleh Shahzad** | shahzah@mcmaster.ca | **TBA** |
| **Naby Nikookaran** | TBA | TBA |

## COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

http://avenue.mcmaster.ca/ (Avenue to Learn)

## COURSE OBJECTIVES

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

- 1. List different classes of computers
- 2. List the major components of a computer.
- 3. Define several computer performance metrics.
- 4. Select the most appropriate performance metric when evaluating a computer.
- 5. Explain the relationship between the representation of machine instructions at the binary level and their representation by a symbolic assembler.
- 6. Explain why a designer adopted a set of instruction formats, such as the number of fields per instruction.
- 7. Explain how positive, negative and fractional numerical values are represented in digital computers
- 8. Explain the limitations of computer arithmetic and the effects of errors on calculations.
- 9. Appreciate the effect of a processor's arithmetic unit on its overall performance.
- 10. Explain how an instruction is fetched from memory and executed.
- 11. Compare alternative implementation of datapaths.
- 12. Discuss the generation of control signals using hardwired or microprogrammed implementations.
- 13. Explain basic instruction level parallelism using pipelining and the major hazards that may occur.
- 14. Explain what has been done to overcome the effect of branches in pipelining.
- 15. Discuss the way in which instruction sets have evolved to improve performance; for example, predicted execution.
- 16. Identify the main types of memory technology.
- 17. Explain the effect of memory latency and bandwidth on performance.
- 18. Explain the use of memory hierarchy to reduce the effective memory latency.
- 19. List different cache structures.
- 20. Appreciate how errors in memory systems arise and what can be done about them.

## ASSUMED KNOWLEDGE

Digital logic, basic logic modules (adders, multiplexers, registers, etc), digital systems design.

## COURSE MATERIALS

**Required Texts:**

**Calculator:**
Only the McMaster Standard Calculator {CASIO FX-991} will be permitted in tests and examinations. This is available at the Campus Store.

**Other Materials:**
Textbook: "Computer Organization and Design", Fifth edition, by Patterson and Hennessy, Morgan Kaufman, 2014, ISBN 978-0-12-407726-3.

## COURSE OVERVIEW

| Date/Week | Topic | Readings |
|---|---|---|
| **Week 1** | Computer abstractions and technologies | |
| **Week 2** | Computer abstractions and technologies | |
| **Week 3** | MIPS assembly language | |
| **Week 4** | MIPS assembly language | |
| **Week 5** | MIPS assembly language | |
| **Week 6** | Computer Arithmetic | |
| **Week 7** | Computer Arithmetic | |
| **Week 8** | Processor and pipelining | |
| **Week 9** | Processor and pipelining | |
| **Week 10** | Processor and pipelining | |
| **Week 11** | Processor and pipelining | |
| **Week 12** | Memory Hierarchy and cache | |
| **Week 13** | ARM assembly language | |

## LABORATORY OVERVIEW

| Date/Week | Topic | Readings |
|---|---|---|
| **Week 2** | Lab orientation and safety | |
| **Week 4** | MIPS assembly language programming (Fibonacci numbers) | |
| **Week 6** | MIPS assembly language programming (Floating Point) | |
| **Week 8** | MIPS assembly language programming (Floating Point) | |
| **Week 10** | Exceptions and Exception Handling | |
| **Week 12** | Exceptions and Exception Handling | |

## LABORATORY OPERATION

Perform lab in supervised lab sessions. Submit lab report on Avenue to Learn shortly thereafter.

The labs are in the form of take-home mini-projects. Students will use a simulator (SPIM or MARS) to complete these mini projects. There will be three mini projects. Students will meet the TA every other week to discuss their progress in the take home labs and seek help if needed. The MARS simulator is newer and as a better user interface, It is a simple Java program that you can download from the University of Missouri.

## ASSESSMENT

| Component | Weight |
|---|---|
| Assignments and quizzes | 20 % |
| Mini-projects (take home labs) | 20 % |
| Midterm test | 20 % |
| Final Exam | 40 % |
| Total | 100 % |

Quizzes might be given in class. The quizzes will be short (15-20 minutes in length) and will be announced at least one week in advance. No make-up quizzes will be given for any reason. There will be 3 or 4 homework assignments during the term. Assignments will have equal marks. Students are responsible for understanding and following the University's Code of Academic Integrity. Bell curving might be applied in this course. Students who do not perform well on the midterm test can request some of the midterm weight to be shifted to the final exam.

## 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 .

| Outcomes | Indicators | Measurement Methods(s) |
|---|---|---|
| **List different classes of computers.** | 1.4 | |
| **List the major components of a computer.** | 1.4 | |
| **Define several computer performance metrics.** | 1.4 | |
| **Select the most appropriate performance metric when evaluating a computer.** | 3.2 | |
| **Explain the relationship between the representation of machine instructions at the binary level and their representation by a symbolic assembler.** | 1.4 | |
| **Explain why a designer adopted a set of instruction formats, such as the number of fields per instruction.** | 4.2 | |
| **Explain how positive, negative and fractional numerical values are represented in digital computers.** | 1.4 | |

| | |
|---|---|
| **Explain the limitations of computer arithmetic and the effects of errors on calculations.** | 1.4 |
| **Appreciate the effect of a processor's arithmetic unit on its overall performance.** | 3.3 |
| **Explain how an instruction is fetched from memory and executed.** | 1.4 |
| **Compare alternative implementation of datapaths.** | 2.2 |
| **Discuss the generation of control signals using hardwired or microprogrammed implementations.** | 1.4 |
| **Explain basic instruction level parallelism using pipelining and the major hazards that may occur.** | 1.4 |
| **Explain what has been done to overcome the effect of branches in pipelining.** | 1.4 |
| **Discuss the way in which instruction sets have evolved to improve performance; for example, predicted execution.** | 1.4 |
| **Identify the main types of memory technology.** | 1.4 |
| **Explain the effect of memory latency and bandwidth on performance.** | 3.1, 3.3 |
| **Explain the use of memory hierarchy to reduce the effective memory latency.** | 1.4 |
| **List different cache structures.** | 1.4 |
| **Appreciate how errors in memory systems arise and what can be done about them.** | 3.1, 3.3 |
| **Use SPIM or Mars simulator to simulate the MIPS processor and implement short assembly programs.** | 5.2, 5.3 |
| **Work in lab and communicate with the TA.** | 7.1, 7.2 |

## 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

1. If you are seeking relief for missed academic work because of an absence lasting less than three days in duration, you must use the McMaster Student Absence Form.
2. Absences lasting more than three days must be reported to the Associate Dean's Office (JHE-A214) and appropriate documentation must be provided. For medical absences, the University reserves the right to require students to obtain medical documentation from the Student Wellness Centre.
3. You should expect to have academic commitments Monday through Saturday but not on Sunday or statutory holidays.
4. Students may submit requests for relief using the MSAF once per term. You must report to the Associate Dean's Office (JHE-A214) for any request for relief in a term where the MSAF has been used previously in that term. Relief for missed academic work is not guaranteed.
5. You are responsible to contact your instructor(s) immediately to discuss the appropriate relief. Failure to do so may negate the opportunity for relief.
6. It is the prerogative of the instructor of the course to determine the appropriate relief for missed term work in his/her course.

## 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 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 (OPTIONAL)

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.

# Electrical and Computer Engineering Lab Safety

## 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 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

## 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

| | | |
|---|---|---|
| TA | The first point of contact for lab supervision | |
| ECE Lab Supervisor | Steve Spencer- ITB 147 | steve@mail.ece.mcmaster.ca |
| ECE Chair | Tim Davidson- ITB A111 | davidson@mcmaster.ca |
| ECE Administrator | Kerri Hastings- ITB A111 | hastings@mcmaster.ca |
| ECE Course Instructor | Please contact your specific course instructor directly | |