# ECSE-324-Fall-2021 Outline

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# CONTENTS

CHAPTER

ONE

# GENERAL INFORMATION

- Course Title: Computer Organization
- Course code: ECSE 324
- Credits: 4
- Contact Hours: (3,4,5)
- Course Prerequisite(s): ECSE 200 and ECSE 222
- Course Corequisite(s): N/A
- Course Description: Basic computer structures; instruction set architecture; assembly language; input/output; memory; software; processor implementation; computer arithmetic. Lab work involving assembly language level programming of single-board computers.

## 1.1 Introduction

In this class we will learn about the design of computers, both hardware and software. In previous classes you have learned about the building blocks of digital hardware (ECSE 222 and how to write programs in ahigh-level computer language such as C or Java (ECSE 202). In this class we will fill in the missing details to find out how a digital machine run programs. You will learn about the basics of computer organization, seeing how the hardware is implemented out of the digital circuits you already know. We will peek "under the hood" of the machine, and see how programs you write in high-level languages (such as C or Java) actually execute on a real machine.

You will learn how to program a computer at the machine level, in what is known as assembly language.

What will you take away from this class:

- You will learn about the main computer structures and how the processor hardware executes a program.
- You will learn how to write programs at the machine level in "assembly language" for one of the most popular modern processors (ARM). ARM processors are used in almost every smartphone (95%).
- You will learn how high-level languages are translated into assembly language.

The knowledge and skills you learn in this class will not only prepare you to design and analyze computer hardware, but also write better computer software.

## 1.2 Format

The course has three hours of weekly lecture, two hours of weekly tutorials and two hours of weekly labs. The laboratory experiments are meant to reinforce the lecture material and form an integral part of the learning experience in this course. There will be a total of 4 lab experiments, done individually. Lab 0 will be ungraded and labs 1-3 will be graded.

## 1.3 Prerequisites

ECSE 200 -(Electric Circuits 1) and ECSE 222-(Digital Logic).

The chain of courses ECSE 202 (Introduction to Software Development), ECSE 222 (Digital Logic) contain the key prerequisite knowledge to be successful in this course. I expect you to be able to write programs in a "C-like" high-level language, such as C or Java and to be able to think in terms of algorithmic models. I also expect that you know all about the basics of digital logic: binary numbers, logic gates, binary addition, and finite-state machines. These are the building blocks of computers.

## 1.4 Textbook

Carl Hamacher, Zvonko Vranesic, Safwat Zaky, and Naraig Manjikian, "Computer Organization and Embedded Systems", 6 th Edition, McGraw-Hill, 2012. Available at VitalSource, an online academic bookstore.

## 1.5 Webpage

Information for the course will be posted on this website http://ecse324.ece.mcgill.ca and this should be the first place you look to get information about the course.

## 1.6 Communication

All communications with the instructors or TAs should be done via the online forum. You should register using this link: https://edstem.org/us/join/ng4MNK

## 1.7 Professor Office hours

In person, location: MC-758.

- Wednesday 9.00-9.30am
- Wednesday 3.00-3.30pm

## 1.8 Evaluation

- Mid-Term Exam: 20%
- Lab Experiments: 30%
- Final Exam: 50%
- Online participation bonus: 5%

Each of the three graded lab will bear the same weight.

### 1.8.1 Online participation bonus

The Online participation bonus will reward students who provide useful inputs on the online forum. The amount of bonus points will be a function of the number of endorsed answers (answers are endorsed by the TAs/instructor). The bonus distribution will be normalized using quantile normalization. The normal distribution with a mean of 2.5% will be used as reference (i.e. half of the students who contribute will receive at least 2.5% of bonus point). Any student reaching over 20 endorsed answers, will automatically be awarded the full bonus (to give a chance to other students).

**Warning:** Any student trying to game the system, for instance by teamig up with other students to ask/answer each other's question, will be reported to the faculty as a case of academic misconduct.

## 1.9 Staff

**Instructor**: Prof. Christophe Dubach (Dept. of Electrical and Compute Engineering / School of Computer Science)

Office: McConnell Engineering Building, Room 758

**Lab TAs**

- TBA
- TBA
- TBA

**Tutorial TAs**

- TBA
- TBA

**Important:** Instructors and TAs will not reply to any email (unless it is a very personal matter). All communications/questions should go through the online forum.

## 1.10 Canadian Engineering Accreditation Board (CEAB)

Accreditation Unit (AU) breakdown:

- Engineering Design: 50%
- Engineering Science: 50%

Graduate Attributes:

- Design (DE): Developed (D)
- Use of Engineering Tools (ET): Developed (D)
- Knowledge Base for Engineering (KB): Developed (D)

CHAPTER

TWO

# LECTURE SYLLABUS

1. Computer Technology and Abstractions
    1. Brief history of computer technology
    2. Classes of computers
    3. Basic abstractions
    4. Binary integer arithmetic
    5. Basic computer organization
2. Instruction Set Architecture
    1. ARM ISA
    2. Addressing modes
    3. Assembly language
    4. Subroutines
3. Software
    1. Assembler, Linkers, Compilers, Debuggers
    2. Interaction between C and assembly
    3. Operating systems
4. Input/Output
    1. Polling
    2. Interrupts
    3. Bus protocols
    4. Parallel and serial interfaces
5. Memory
    1. Memory Types: SRAM, DRAM, SDRAM
    2. DMA
    3. Memory hierarchy
6. Processor Implementation
    1. Datapath design
    2. Control design

    3. Pipelining
7. Arithmetic
    1. Addition and subtraction
    2. Multiplication
    3. Floating-point

CHAPTER

THREE

# POLICIES

## 3.1 Late policy

Deadlines will be strictly enforced.

**Warning: A grade of zero will be applied for any submissions more than 1 second late.**

## 3.2 Academic Integrity

McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures. (approved by Senate on 29 January 2003)

**Warning: Cheating**

Cheating is a serious offense and all suspected cases will be reported to the faculty.

**For this course:**

- *Never* share your code or text (either from the labs or from the exam).
- *Never* use someone else code or text in your solutions (even if you change it).
- *Never* consult project code or text that might be on the Internet.
- *Always* write your own code.

**On the other hand, you are allowed to:**

- Share ideas.
- Help someone else *debug* their code if they have run into a wall (you can point out at the error they are making, but never write code for them!).

If you obtain help of any kind, always **write the name(s) of your sources** and explicitly state how you were helped.

## 3.3 Absence policy

Absences for evaluation components other than the formal final examination will be handled according to the guidelines of the McGill Faculty of Engineering. It is your responsibility to prepare your request per the guidelines, supported by documentation, within the required time frames. In no circumstance, will requests be considered, or documentation be accepted longer than one week after the absence. Acceptance of notes will be entirely at the instructor's discretion. If a request is not conducted per the Faculty guidelines or not accepted by the instructor, then a grade of zero will be entered.

The above policy does not apply to the formal final exam. Deferral of a final examination is handled by the Faculty of Engineering and please contact them directly.

## 3.4 Special accommodations

Students who may require disability-related accommodations, as well as those experiencing mental or physical health challenges, to please advise the Office for Students with Disabilities as early in the term as possible so that we can provide appropriate accommodation to supportyour success.

## 3.5 Submission language

In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded. (approved by Senate on 21 January 2009)

## 3.6 Instructor generated course materials

All course materials (e.g. handouts, notes, Lectures, summaries, exam questions) are protected by law and may not be copied or distributed in any form or in any medium without explicit permission of the instructor. Note that infringements of copyright can be subject to follow up by the University under the Code of Student Conduct and Disciplinary Procedures.

## 3.7 Grading policy

In the Faculty of Engineering, letter grades are assigned according to the grading scheme adopted by the professor in charge of a particular course. This may not correspond to practices in other Faculty and Schools in the University.

## 3.8 Changes to content/evaluation scheme

In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.