McGill School of Computer Science

www.cs.mcgill.ca

Course Outline

Course Name:	Introduction to Computer Systems COMP-273 Winter 2017
Instructor:	Joseph Vybihal
Contact Information:	Office: ENGMC 323 Office Hours: TBD in ENGMC 323 or by appointment Email: jvybihal@cs.mcgill.ca

Course Objectives:

This course covers two major topics in computer systems: assembly language programming and the architecture of a CPU. Programmers are normally familiar with the computer only from a very high level. This is understood as manipulating the computer using an object oriented programming language. They are not aware of the many abstraction layers that hide the underlying structure and functions carried out by a computer. The computer's CMOS, Operating System and machine language manage the underlying mechanics. This course peals back these layers of abstraction allowing the student to directly manipulate and study the engineering of some of the most important components of a computer. Our method of study will be two pronged: First, we will look at the engineering of the computer's CPU, RAM and topics about the system board as a whole. Last, we will learn the MIPS assembly language, as a tool to interact with the internal components as directly as possible. We will use SPIM or MARS as our MIPS emulator (download link on course website).

Primary learning outcomes: to get a clear understanding of how the CPU and RAM are built and function from the microcircuit and functional levels. To then use an actual assembly language that uses the microcircuits discussed in class.

Secondary learning outcome: to demystify the abstraction layers in a computer system and to take advantage of the new found capabilities. The student will be able to intelligently discuss the internal workings of computers and produce solutions that take advantage of the built-in hardware of a machine. Discussions with robotics and modems may be also discussed.

Course Description:

Number representations, combinatorial and sequential digital circuits, MIPS instructions and architecture data-paths and control, caches, virtual memory, interrupts and exceptions, pipelining.

Texts:

Primary Texts:
(1) COMPUTER ORGANIZATION & DESIGN: The Hardware / Software Interface
    Author: Patterson & Hennessy, Publisher: Morgan Kaufmann, ISBN: 1558604286, edition 4 or 5
(2) The Soul of a New Machine
    Author: Tracy Kidder, Publisher: Avon Books, ISBN: 0-380-59931-7

Recommended Readings:
- SEE MIPS RUN
  Author: Dominic Sweetman, Publisher: Morgan Kaufmann, ISBN: 1558604103
- COMPUTER ORGANIZATION & ARCHITECTURE
  Author: Null & Lobur, Publisher: Jones and Bartlet, ISBN: 076370444X

Evaluation:

Assignments	15%	3 Assignments
Project	20%	CPU Design Team Project
Midterm Exam	15%	TBA
Final Exam	50%	TBA

Tutorials: 5 Sessions (1 circuits, 2 assembler programming, examination tutorials)

Detailed Course Outline

WEEK	TOPIC	READINGS	WORK HANDOUT
Tentative Schedule			

WEEK	TOPIC	READINGS	WORK HANDOUT
Computer Hardware and Digital Circuit Design			
1	INTRODUCTION TO COMPUTER HARDWARE AND ELECTRICITY: The system board architecture, machine languages and assembly languages. Bits and Bytes. Special memory locations. The water-flow analogy. Push-marble analogy. Calculating electrical values. Performance & the wall.	Chapter 1: Computer abstractions & Tech.	
2	DIGITAL LOGIC: Number representations (binary, 2's complement & floating point) & ASCII/Unicode, Combinatorial Logic (truth tables, gates, logic circuits) & Basic digital circuits.	Chapter 2.4: Signed & Unsigned numbers C.1 & C.2: Gates, truth tables & logic eq	Assignment #1 LogiSim Lab
3	DIGITAL LOGIC: Combinatorial (ROM, PLA, math circuits, encoder, decoders, multiplexers) and Sequential Logic (RS latch, clocks, D latch, D flip flop, counters, math) & Digital circuit design	C.3 – C.11: The basics of logic design	
4 & 5	MACHINE INSTRUCTIONS & THE MIRCO-ARCHITECTURE: Basic CPU architecture (Classic and Pipeline), Basic introduction to processing in a CPU (data path, control, execution cycle, exception handling/interrupts) & how I/O works (stdin & stdout)	Chapter 4: The processor D: Mapping control to hardware	Assignment #2
Midterm Examination			
6	MIDTERM EXAM: Review, Catch-up lecture time.		Midterm Tutorial MIDTERM EXAM
MIPS Assembler Programming			
7	MACHINE INSTRUCTIONS & THE MICRO-ARCHITECTURE: Intro to MIPS assembly language (representations, absolute vs. immediate addressing, basic instructions), Assemblers/Linkers and the SPIM simulator (directives & instructions), Input and Output	Chapter 2: Instructions language of the computer Appendix B: Assemblers, linkers & SPIM simulator	SPIM MARS Lab – Intro to Programming Project handout (teams)
8	MIPS ASSEMBLY LANGUAGE: Instruction representations, list of instructions, procedures, stacks, and calling conventions.	Chapter 3: Arithmetic for computers	Assignment #3
9	MIPS ASSEMBLY LANGUAGE: recursive procedures, mult/div/floating-point instructions.	Chapter 3	Advanced Programming Lab
System Hardware Architecture			
10	MEMORY AND I/O: caches, virtual memory, interrupts and exceptions, memory mapped I/O, direct memory access.	Chapter 5: Large & Fast exploiting memory hierarchy	
11	MEMORY AND I/O: Buses, synchronous vs. asynchronous I/O, and Graphics.	Chapter 6: Storage & Other I/O topics Appendix A: Graphics & GPUs	
12	MICRO-ARCHITECTURE OF MULTI-CORE CPU Strategies, control flow, queues, the OS involvement, multi-threading, the programmer involvement	E: A survey of RISC architectures Chapter 7: Multicores, multiprocessors, & clusters	Tutorial for Final exam

General Course Information

Examination and Grading:

You will be notified in advance of assignment due dates. All assignments are due on My Courses at the indicated time and date. Late assignments will lose 5% of its grade per day late. Assignments beyond 2 days late will not be accepted. You may not submit assignments via e-mail without the permission of the instructor.

Students are responsible for all materials for the tests and exams, whether or not it is covered in class. Exams will be a combination of all types of questions based on all sources, and students may be required to integrate theoretical concepts from the text to substantiate their arguments.

No make-up tests or make-up assignments are allowed in this course. A supplemental exam is possible for 50% of the grade (to replace your final exam).

If you are not satisfied with the grading of an assignment or mid-term test, you may request a review within 7 days of return. Indicate in writing or during a meeting with the instructor where and why you feel the marks are unjustified and give it back to your instructor for re-grading. Note that the entire assignment or mid-term test will be re-graded and your grade can go up or down (or stay the same) accordingly.

Calculators
Only non-programmable, no-tape, noiseless calculators are permitted. Calculators capable of storing text are not permitted in tests and examinations.

Dictionaries
Dictionaries are not permitted, but translation dictionaries are.

Handheld Devices
Handheld devices capable of storing text and having calculator functionality (e.g. Palm, etc.) are not permitted.

Course Requirements: COMP-206 is a co-requisite for this course.

If you already know how to program in C or C++ or received a very good grade in COMP 250 then you can probably take this course without the course requisite.

Additional Information: COMP-308 Computer Systems Lab in a continuation course to COMP-273. It is a hands-on assembler and C lab course that will teach students how to interface with actual computer hardware using low-level programming techniques. This may be of interest to you if you would like to continue learning how to interact at low levels.

The course slides are not meant as a complete set of notes or a substitute for a textbook, but simply constitute the focus of the lecture. Important gaps are left in the slides that are filled in during class, thus lecture attendance should be considered essential.

The material covered in the classroom will be used to supplement textbook readings.

Academic Integrity: *Code of Student Conduct*

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 (see *www.mcgill.ca/integrity* for more information).

L'université McGill attache une haute importance à l'honnêteté académique. Il incombe par conséquent à tous les étudiants de comprendre ce que l'on entend par tricherie, plagiat et autres infractions académiques, ainsi que les conséquences que peuvent avoir de telles actions, selon le Code de conduite de l'étudiant et des procédures disciplinaires (pour de plus amples reseignements, veuillez consulter le site *www.mcgill.ca/integrity*).

Right to submit in English or French written work that is to be graded

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.

Final Exam Policy:

Regulations
Students should not make other commitments during the final exam period. Vacation plans do not constitute valid grounds for the deferral or the rescheduling of examinations. See the Centre Calendar for the regulations governing Examinations:
http://www.mcgill.ca/student-records/exams/regulations/
Students are required to present their I.D. Card (with photo) for entrance to their examination.

Conflicts
If you are unable to write your final examination due to scheduling conflicts, you must submit a Final Exam Conflict Form with supporting documentation at least **one month** before the start of the final examination period. Late submissions will not be accepted. For details, see
http://www.mcgill.ca/student-records/exams/conflicts/

Exam Timetable
Examination schedules are posted at the Centre and on the following page approximately 6-8 weeks before the examination period commences
http://www.mcgill.ca/student-records/exams/
The Centre cannot provide examination dates over the telephone.

Classroom Rules:
All electronic devices (cell phones and beepers) must be turned off or left on silent mode during class time.

Assignments Pickup:
All assignments are submitted to and picked-up from My Courses.

Email Policy:
E-mail is one of the official means of communication between McGill University and its students. As with all official University communications, it is the student's responsibility to ensure that time-critical e-mail is accessed, read, and acted upon in a timely fashion. If a student chooses to forward University e-mail to another e-mail mailbox, it is that student's responsibility to ensure that the alternate account is viable.

Please note that to protect the privacy of the students, the University will only reply to the students on their McGill e-mail account.

Computing Resources:
Trottier 3rd floor.

Students Rights and Responsibilities:

Regulations and policies governing students at McGill University can be downloaded from the website:

http://www.mcgill.ca/deanofstudents/rights/

Students Services and Resources:

Various services and resources, such as email access, walksafe, library access, etc., are available to students:

http://www.mcgill.ca/stundet-records

Minerva for Students: http://www.mcgill.ca/minerva-students/

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