McMaster University
Department of Computing and Software
Dr. W. Kahl

CS 2GA3, SE $\frac{2}{3}$GA3
Outline
2014-09-04

Computer Architecture

COMP SCI 2GA3, SFWR ENG 2GA3 , SFWR ENG 3GA3

Instructor: Dr. Wolfram **Kahl**, Department of Computing and Software, ITB-245
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Calendar Description:

Measures of performance, instruction set architecture, computer arithmetic, datapath and control, pipelining, the memory hierarchy, I/O systems, multiprocessor systems, multimedia extensions and graphic processors.

Learning Objectives

Precondition: ***Students are expected to have achieved the following learning objectives before taking this course:***

1. Students should know and understand
   a) the basic idea of imperative programming
   b) the basic data types and their corresponding literals, and operations on the data types, the notion of data encoding
   c) the notion of variable and storage, notion of the main memory
   d) expressions, assignments, control statements including loops
   e) the notion of flow of control
   f) functions/methods, local/global variables, function/method call, parameters/arguments
2. Students should be able to
   a) solve simple algorithmic problems
   b) design and implement programs in the programming language of CS 1MD3 / ENG 1D04
   c) debug and test their own programs; execute programs and manipulate their output for testing purposes
   d) read and understand simple programs designed and implemented by other people
   e) provide reasonable documentation embedded in the source program in the form of comments

Postcondition: ***Students are expected to achieve the following learning objectives at the end of this course:***

1. Students should know and understand
   a) Representation of numeric data: signed and unsigned arithmetic, floating-point arithmetic
   b) Instruction set architecture (ISA): functionality and use of resources (registers and memory) of a machine-level instruction
   c) The instruction classes for data movement, arithmetic/logical operations, and flow control
   d) Processor and system performance
   e) Sustainability and performance effects of power consumption
   f) Performance enhancement through instruction pipelining
   g) Memory hierarchies, caches, and virtual memory
   h) I/O fundamentals
   i) GPU architecture
2. Students should be able to
   a) Identify the trade-offs in designing an ISA
   b) Represent numeric data in finite bit-length
   c) Read and write programs in at least one assembly language
   d) Measure the performance of components in a CPU system
   e) Use and modify the design of an ISA
   f) Read and modify a pipelined implementation of an ISA
   g) Make design decisions for memory organization
   h) Assess and compare sustainability and performance effects of power consumption

Course Page: `http://www.cas.mcmaster.ca/~kahl/CS2GA3/2014/`

While most of the internal electronic information exchange for this course will be handled via Avenue, the course pages will contain useful links to external material. The course pages also serve as the central fallback location for making information and material available outside Avenue, in particular in the case of Avenue accessibility problems.
It is the student's responsibility to be aware of the information on the course Avenue site and the course web page, and to check regularly for announcements.

Schedule:

Lectures:	Monday, Wednesday, Thursday 10:30–11:20, HSC-1A1			
Weekly Tutorials:	T1/T4:	Monday	14:30–15:20,	ETB-227/228
	T2/T5:	Tuesday	9:30–10:20,	ETB-227/237
	T3/T6:	Tuesday	15:30–16:20,	BSB-B154/B155
	The first tutorials will be on September 8&9.			
Office Hours:	preliminary: Monday, 12:00-13:00, and by appointment.			

Students are expected to attend all lectures and tutorials.

Textbook: Patterson & Hennessy: **Computer Organisation and Design — The Hardware/Software Interface**, *4th revised edition*, Morgan Kaufmann, 2012.

Additional material may be handed out or made available electronically.

Outline: (With relevant textbook chapters indicated — not all textbook contents will be covered in detail. Times are **rough estimates**.)

- Ch. 1: Computer Abstractions and Technology (<1 week)
- Ch. 2: Instruction Set Architecture and Assembly Programming (3.5 weeks)
- Ch. 3: Arithmetic for Computers (1.5 weeks)
- Ch. 4: Processor Architecture, Pipelining, Parallelism (3 weeks)
- Ch. 5: Caches, Memory Hierarchy (1 week)
- Ch. 6: Storage and I/O (1 week)
- Ch. 7 / Appendix A: Multicores, Multiprocessors, Clusters, GPUs (2 weeks)

Exercise Sheets, Tutorials, and Assignments:

Exercise Sheets will be posted on Avenue, and will contain:

- **Exercise Questions**, to be discussed in the tutorials.
  The main purpose of the **tutorials** is to **discuss student work** on these exercise problems. Therefore, every student is expected to complete the scheduled work, i.e., exercise problems and necessary reading, **before** the corresponding tutorial session, and bring their solutions and solution attempts to the Exercises Questions to the tutorial. **Use of the Exercise Questions for collaborative learning is encouraged.** The tutorials are not normally expected to be able to cover all the Exercise Questions.

- **Assignment Questions** will be grouped into **five Assignments**; each of these will usually be due about two weeks after they are provided. Assignment Questions will frequently be somewhat similar to some Exercise Questions.

  Submit only your own solutions to Assignment Questions. If you have trouble with any particular assignment question, identify related exercise questions and possibly work with others on those to improve your understanding of the relevant topics.

It is essential that you meet the deadlines for the Assigment Questions; there is no credit for documents handed in after the deadline.

If you cannot hand in your assignment on time **due to (e.g.) illness reasons**:

- **Hand your assignment in as soon as possible, before the next tutorial**. If the assignment in question required handing in paper, hand your solution either to the instructor, or to a TA, or to Tina in the departmental office. (Outside office hours: Insert into the drop box in front of the departmental office ITB-202.) We will make note of the time of your submission.
- **Follow the usual procedures for missed work** with your Associate Dean's office. The outcome of that process will decide whether/how the late submission can be counted.
- **A one-day illness will usually be accommodated via a one-day extension.**

Grading:

All examinations in this course will be **Closed Book**. That is, no written or printed material nor electronic aids other than the standard McMaster calculator may be used during the examinations.

Accomodations for missed work, including **late assignments**, require the corresponding form from the Associate Dean's office. Where you use the electronic system, note that you are still **required** to get in touch with the instructor to actually be granted any accomodation.

Final Exam: The **final examination** will be scheduled by the Registrar's Office in the usual way. It will be a closed book examination of three hours duration and cover the material of **all** lectures, tutorials, handouts, and assignments.

Midterms: In addition, there will be **one midterm examination**, details to be announced.

Grade Calculation: All exam grades will be percentage grades.

For every student, the course grade is calculated as a weighted average:

- 30% of the weight are given to the **five assignments**;
- if your **midterm** result is better than your result in the final, your midterm counts 30%; otherwise your midterm counts 15%;
- the remaining weight (between 40% and 55%) is given to the **final exam**.
- As with every course at McMaster, every student will have the opportunity to evaluate the effectiveness of this course. The feedback that is received from the course evaluation is very valuable to the CS/SE *GA3 teaching staff, and so we are providing a **course evaluation bonus** to each student based on the level of class participation in the course evaluation according to the following table:

Class Participation	Bonus	Class Participation	Bonus
60-64%	0.25	80-84%	1.25
65-69%	0.50	85-89%	1.50
70-74%	0.75	90-94%	1.75
75-79%	1.00	95-100%	2.00

Thus, for example, if 75% of the students enrolled in CS/SE *GA3 participate in the course evaluation of CS/SE *GA3, every student's final mark will receive a 1.00 percentage point bonus.

The final course grade will be converted from a percentage grade to a letter grade according to the scale of the Registrar's Office.

The instructor reserves the right to conduct any deferred exams orally.

Course Adaptation

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.

Academic Ethics

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 four 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. **Collaboration where individual work is expected.**

   You have to produce your submissions for assignment questions yourself, and without collaboration (except where and as far as group work is explicitly allowed or specified by the assignment statement).
   For each assignment question there will normally be exercise questions similar to it — you **are allowed** to collaborate on these **exercise questions**. (The tutorials are typically not expected to cover all exercise questions.)
3. Improper collaboration in group work.
4. **Copying or using unauthorised aids in tests and examinations.**

Discrimination

The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem that cannot be resolved by discussion among the persons concerned, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Office or the Human Rights Consultant, as soon as possible.