ENGG*4540 Advanced Computer Architecture
Winter 2016

UNIVERSITY of GUELPH

School of Engineering

(Revision 0: January 5, 2014)

---

1 Instructional Support

1.1 Instructor

Instructor:	Omar Ahmed, Ph.D.
Office:	RICH 3523, ext. 58262
Email:	oahmed@uoguelph.ca
Office hours:	Tuesday and Thursdays: 3:00 - 4:00 PM

1.2 Lab Technician

Technician::	Nathaniel Groendyk
Office:	THRN 2308, ext. 53873
Email:	groendy@uoguelph.ca

1.3 Teaching Assistants

GTA	Email	Office Hours
Siavash Nazari	snazari@uoguelph.ca	TBA on Corselink

---

2 Learning Resources

2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*4540 CourseLink site. You are responsible for checking the site regularly.

2.2 Required Resources

1. John L. Hennessy and David A. Patterson *Computer Architecture: A Quantitative Approach*, 5th Edition, Morgan Kaufmann Publishers.

2.3 Recommended Resources

1. William Stallings, *Computer Organization and Architecture*, 8th Edition by William Stallings, 2010.
2. *VHDL Handbook*.
3. *VHDL for Engineers*, by K. Short, 2009.

2.4 Additional Resources

1. Lecture Information: All the lecture notes are posted on the web page (week #1-#12).
2. Lab Information: The handouts for all the lab sessions are within the lab section. All types of resources regarding tutorials, links to web pages can be found in this section.
3. Assignments: Download the assignments according to the schedule given in this handout. All the solutions will be posted as indicated.
4. Miscellaneous Information: Other information related to Computer Architecture are also posted on the web page.

2.5 Communication & Email Policy

Please use lectures and lab help sessions as your main opportunity to ask questions about the course. Major announcements will be posted to the course website. It is your responsibility to check the course website regularly. As per university regulations, all students are required to check their "mail.uoguelph.ca" e-mail account regularly: e-mail is the official route of communication between the University and its student.

---

3 ASSESSMENT

3.1 Dates and Distribution

1. Assignments: 15%
   See Section 5 for due dates
2. Labs: 25%
   See Section 5 for due dates
3. Midterm Exam: 20%
   Tuesday Mar 1st 11:30-1:00 PM, In Class
4. Final Exam: 40%
   Friday April 22nd 11:30 AM -01:30 PM, (Room TBA on Webadvisor).

3.2 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Consideration of Religious Obligations:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Passing grade: In order to pass the course, you must pass both the laboratory and exam course portions. Students must obtain a grade of 50% or higher on the exam portion of the course in order for the laboratory write-up portion of the course to count towards the final grade.

Missed midterm/quiz tests: If you miss a test due to grounds for granting academic consideration or religious accommodation, the weight of any missed test will be added to the final exam weight. There will be **no makeup midterm/quizzes tests**.

Lab Work: You must attend and complete all laboratories. If you miss a laboratory due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to complete a makeup lab.

Late Lab Reports: Late submissions of lab reports will not be accepted.

---

4 Aims, Objectives & Graduate Attributes

4.1 Calendar Description

This course covers topics such as: basics of pipeline structure, advanced pipelining and instruction level parallelism, multiprocessor and thread-level parallelism, memory-hierarchy design (main memory, virtual memory, caches), storage systems, interconnection networks, multiprocessor architectures (centralized and distributed). Advanced topics related to new emerging computer architectures will also be presented. The emphasis in each topic is on fundamental limitations and the trade-offs involved in designing computer systems, including memory and processing bandwidth, network bandwidth and latency, synchronization, and storage system bandwidth and latency.
Prerequisite(s): ENGG*3380

4.2 Course Aims

This objective is to gain familiarity with computer architectures and their up-to-date application, which are fundamental elements in computer engineering. The course will start with quantitative principles of computer design. Then the course will present the instruction set principles and examples. In addition to over-viewing advanced pipelining. Then, it will cover instruction/data- level parallelism. Other topics to be covered, as well as, are caching and storage system design.

4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Identify the task of a computer designer, technology and computer usage trends, cost and trends in cost, in addition to measuring and reporting performance of computer architectures.
2. Classify the instruction set architectures, and comprehend the instruction formats and semantics.

3. Identify and analyze basic pipeline operations, data and control pipeline hazards, and instruction-level parallelism.
4. Communicate effectively about advanced computer architectures and memory-hierarchy design; include cache design issues and performance evaluation techniques.
5. Comprehend and describe storage systems including types of storage devices, buses-connecting I/O devices to CPU/Memory, and the interfacing to an Operating System (OS).

4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

Graduate Attribute	Learning Objectives	Assessment
1. Knowledge Base for Engineering	1	Exams, Lab Experiments and Assignments
2. Problem Analysis	1, 2	Lab Experiments and Assignments
3. Investigation	3, 4, 5	Lab experiments
4. Design	1, 3, 4, 5	Lab experiments and exams
5. Use of Engineering Tools	1, 4	Lab experiments
6. Communication	4	Lab experiments
7. Individual and Teamwork	1, 4	Lab experiments
8. Professionalism	-	-
9. Impact on Society and Environment	-	-
10. Ethics and Equity	-	-
11. Environment, Society, & Project Management	4, 7	Exams
12. Life-Long Learning	-	-

4.5 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Course-link/D2L but these are not intended to be stand-alone course notes. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and project.

4.6 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

4.7 Relationships with other Courses

ENGG*3380: Internal bus structure, registers, control sequence design, microprogramming and memory organization.

5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:				
Tuesday		11:30 AM - 12:50 PM	CRSC 101	O. Ahmed
Thursday		11:30 AM - 12:50 PM	CRSC 101	O. Ahmed
Laboratory:				
Friday	Sec 01	3:30 PM - 5:20 PM	RICH 1532	S. Nazari

5.2 Lecture Schedule

Week	Lecture Topics	References	Learning Objectives
1	Introduction	Chapter 1	1
2	Instruction Set Principles	Appendix A	2
3	Pipelining: Basic and Intermediate Concepts	Appendix C	2
4	Super-scalar	Chapter 3	1,2
5	Very long Instruction Word (VLIW)	Chapter 3	1,2
6	Branch Predication	-	3
7	Memory Hierarchy	Appendix B	4
8	Advanced Caches	Chapter 2	4
9	Vector Machine	Chapter 4	2,5
10	SIMD Machine and GPGPU	Chapter 4	2,5
11	Multi-threading	Chapter 4	2,5
12	Review	-	-

5.3 Assignments

There will be 4 assignments throughout the term. **Solve all problems** and hand in your assignment to the instructor in the lecture.

Item	Handed In	Due Date	Topic
Assign #1	(Week #1)	Week #3	Computer Organization Review
Assign #2	(Week #3)	Week #6	Superscalar and VLIW
Assign #3	(Week #6)	Week #9	Branch Predication and Caches
Assign #4	(Week #9)	Week #12	Vector, SIMD, and Multi-threading machine

5.4 Lab Schedule

There will be 4-5 labs throughout the term. **Hand in** your reports to the teaching assistant in the lab. Below are the due dates:

Week	Topic	Report	Due
1	L0: Intro to Lab Equipment and Safety Training	No	-
2	L1: Simple Processor with one ALU	Yes	Week 3
3-4	L2: Pipelined Processor with one ALU	Yes	Week 5
5-6	L3: Multi core processor **(SIMD)** (Two ALUs)	Yes	Week 7
7-8	L4: Catch **Simulator**	Yes	Week 9
9-10	L5: Instruction Level Parallelism (ILP) **Simulation**	Yes	Week 11

5.5 Other Important Dates

1. **First Class**: Monday, January 11, 2016.
2. **Winter Break**: Monday, February 15 - February 19 2016
3. **Drop Date**: Friday March 11, 2016.
4. **Last Class**: Friday April 8, 2016.

---

6 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible. If the laboratory rules are not followed, consequences will include removing access to the lab. If this results in lab work not being completed, the student will receive a grade of 0.

---

7 Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community faculty, staff, and students to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offenses from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offense should consult with a faculty member.

7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:
http://www.academicintegrity.uoguelph.ca/

Please also review the section on Academic Misconduct in your Engineering Program Guide.

The School of Engineering has adopted a Code of Ethics that can be found at:
http://www.uoguelph.ca/engineering/undergrad-counselling-ethics

8 ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact the Centre for Students with Disabilities as soon as possible For more information, contact CSD at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.uoguelph.ca/csd/

9 RECORDING OF MATERIALS

Presentations which are made in relation to course work-including lectures-cannot be recorded or copied without the permission of the presenter, whether the instructor, classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

10 RESOURCES

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs:
http://www.uoguelph.ca/registrar/calendars/index.cfm?index