

COURSE SYLLABUS

CMPT 215: INTRODUCTION TO COMPUTER ORGANIZATION AND ARCHITECTURE

Catalogue Description

An introduction to the design of contemporary computer systems, focusing on the hardware-software interface and the upper hardware levels. Topics include machine and assembly language, computer arithmetic, the processor datapath and control, pipelining, memory hierarchies, and I/O systems.

Prerequisite: CMPT 214 and one of MATH 104, MATH 110, MATH 121, MATH 123, MATH 125, or STAT 245 (or equivalent)

Note: A student cannot receive credit for more than one of CMPT 215, EE 331, or CME 331.

Class Time & Location: M W F, 12:30-13:20, Arts 241

Tutorials: M, 16:30-17:50, Spinks 320
T, 10:00-11:20, Spinks 311
T, 1:00-2:20, Spinks 320
Th, 11:30-12:50, Spinks 320
Th, 14:30-15:50, Spinks 311
F, 14:30-15:50, Spinks 320

Website: Moodle

Instructor Information

Instructor: Derek Eager

Contact: Email: eager@cs.usask.ca
Office Phone: 4899

Office Hours: Location: Thorv 281.2
Hours: feel free to drop by my office anytime, or make appointment via email

Course Objectives and Overview

Most students will enter this class with familiarity with computer systems as end-users and as high-level language programmers. This class is designed to provide an introduction to a portion of what lies below the application programming interface, namely, the basic organization and architecture of contemporary computer systems.

By the time you complete this course, you should be able to:

- Describe the basic hardware organization of a computer system and the hardware/software interface
- Use the factors of clock rate, instruction count, and CPI to evaluate performance
- Describe how data and instructions are represented in a computer system, and convert among different representations
- Develop and debug MIPS assembly language programs
- Describe the main characteristics and design principles of MIPS machine language
- Explain how assembly language programs are assembled and linked
- Design simple digital logic circuits
- Describe how the basic arithmetic operations can be implemented in an ALU
- Describe, and analyze the operation of, simple processor datapath and control designs
- Describe, and analyze the operation of, processor pipelining, including techniques for dealing with pipeline hazards
- Describe, and analyze the operation of, processor caching and virtual memory management techniques

- Explain how I/O is performed, and describe the basic characteristics of SSD and magnetic disk storage systems
- Compare and contrast the main approaches to parallel computing

Student Evaluation

There will be 5 equally weighted assignments (likely approximate due dates – late January, early February, early March, mid-March, and early April). Four of these assignments will involve both programming and non-programming exercises, with programming to be done in MIPS assembly language using the *spim* simulator. The other assignment will serve as review for the midterm exam and will not require programming using *spim*. Due dates for the assignments are strict – if you require an extension for some special reason (e.g. medical), you must contact the instructor as soon as feasible. An in-lab programming exam and a midterm exam will be held early in March. The midterm exam and the three-hour final exam will be closed book, with no electronic devices permitted.

Grading Scheme

Assignments (5)	25 %
Midterm Exam	15 %
In-Lab Programming Exam	10 %
Final Exam	50 %
Total	100%

Final Exam Scheduling:

The Registrar schedules all final examinations, including deferred and supplemental examinations. Students are advised not to make travel arrangements for the exam period until the official exam schedule has been posted.

Note: All students must be properly registered in order to attend lectures and receive credit for this course.

Textbook Information

Required Text

Computer Organization and Design MIPS Edition: The Hardware/Software Interface (5th edition), David A. Patterson and John L. Hennessy, Morgan Kaufmann/Elsevier, 2014.

Software

The programming work for this course requires use of the *spim* (specifically, *qtspim*) simulator for the MIPS assembly language. This has been installed in the Computer Science Department laboratories. It can also be downloaded from <https://sourceforge.net/projects/spimsimulator/files/>.

Lecture Schedule

1. Computer Systems and Performance (1 week)
 Overview of computer systems organization, factors determining performance, performance metrics, benchmarking, energy consumption.
Readings: Chapter 1.

2. Machine and Assembly Language (3.5 weeks)
MIPS machine and assembly language, integer representations, addressing methods, instruction sets, procedures, implementing assembly language – assembly and linking.
Readings: Chapter 2, portions of Appendix A.
3. Arithmetic (2 weeks)
Basics of digital logic circuits, implementing arithmetic operations, floating point number representation and operations.
Readings: Chapter 3, portions of Appendix B.
4. Processor Implementation (2.5 weeks)
Datapath and control, a single clock cycle implementation of a MIPS subset, pipelining, multiple issue.
Readings: Chapter 4, portions of Appendix B.
5. Memory (2 weeks)
Memory hierarchies, temporal and spatial locality, caches, virtual memory, virtual machines, coherence and consistency.
Readings: Chapter 5.
6. Selected Topics from I/O and Parallel Computing (1 week)
Controlling I/O, solid-state drives (SSDs) and magnetic disks, RAID, parallel computing approaches.
Readings: Section 5.11, Chapter 6, portions of Appendix A.

Policies

Recording of Lectures

Students may record lectures if desired.

Late Assignments

Due dates for assignments are strict – if you require an extension for some special reason (e.g. medical), you must contact the instructor as soon as possible.

Missed Assignments

Students who do not submit anything for an assignment by the due date (possibly as extended by the instructor) will receive a grade of zero for the assignment.

Missed Examinations

1. Students who miss an exam should contact the instructor as soon as possible. If it is known in advance that an exam will be missed, the instructor should be contacted before the exam.
2. "A student who is absent from a final examination due to medical, compassionate, or other valid reasons, may apply to the College of Arts and Science Undergraduate Student's Office for a **deferred** exam. **Application must be made within three business days of the missed examination** and be accompanied by supporting documents." (<http://artsandscience.usask.ca/undergraduate/advising/strategies.php>)

Incomplete Course Work and Final Grades

"When a student has not completed the required course work, which includes any assignment or examination including the final examination, by the time of submission of the final grades, they may be granted an extension to permit completion of an assignment, or granted a deferred examination in the case of absence from a final examination."

Extensions past the final examination date for the completion of assignments must be approved by the Department Head, or Dean in non-departmentalized Colleges, and may exceed thirty days only in unusual circumstances. The student must apply to the instructor for such an extension and furnish satisfactory reasons for the deficiency. Deferred final examinations are granted as per College policy.

In the interim, the instructor will submit a computed percentile grade for the class which factors in the incomplete coursework as a zero, along with a grade comment of INF (Incomplete Failure) if a failing grade.

In the case where the student has a passing percentile grade but the instructor has indicated in the course outline that failure to complete the required coursework will result in failure in the course, a final grade of 49% will be submitted along with a grade comment of INF (Incomplete Failure).

If an extension is granted and the required assignment is submitted within the allotted time, or if a deferred examination is granted and written in the case of absence from the final examination, the instructor will submit a revised assigned final percentage grade. The grade change will replace the previous grade and any grade comment of INF (Incomplete Failure) will be removed.

A student can pass a course on the basis of work completed in the course provided that any incomplete course work has not been deemed mandatory by the instructor in the course outline and/or by College regulations for achieving a passing grade." (<https://policies.usask.ca/policies/academic-affairs/academic-courses.php>)

For policies governing examinations and grading, students are referred to the Assessment of Students section of the University policy "Academic courses: class delivery, examinations, and assessment of student learning" (<https://policies.usask.ca/policies/academic-affairs/academic-courses.php>)

Academic Honesty

The University of Saskatchewan is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Student Conduct & Appeals section of the University Secretary Website and avoid any behavior that could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

All students should read and be familiar with the Regulations on Academic Student Misconduct (<https://www.usask.ca/secretariat/student-conduct-appeals/StudentAcademicMisconduct.pdf>) as well as the Standard of Student Conduct in Non-Academic Matters and Procedures for Resolution of Complaints and Appeals (<https://www.usask.ca/secretariat/student-conduct-appeals/StudentNon-AcademicMisconduct.pdf>) Academic honesty is also defined and described in the Department of Computer Science Statement on Academic Honesty (<https://www.cs.usask.ca/students/academic-honesty/index.php>).

For more information on what academic integrity means for students see the Student Conduct & Appeals section of the University Secretary Website at:

<https://www.usask.ca/secretariat/student-conduct-appeals/forms/IntegrityDefined.pdf>

Examinations with Access and Equity Services (AES)

Students who have disabilities (learning, medical, physical, or mental health) are strongly encouraged to register with Access and Equity Services (AES) if they have not already done so. Students who suspect they may have disabilities should contact AES for advice and referrals. In order to access AES programs and supports, students must follow AES policy and procedures. For more information, check

<https://students.usask.ca/health/centres/access-equity-services.php>, or contact AES at 306-966-7273 or

aes@usask.ca.

Students registered with AES may request alternative arrangements for mid-term and final examinations. Students must arrange such accommodations through AES by the stated deadlines. Instructors shall provide the examinations for students who are being accommodated by the deadlines established by AES.

Student Supports

Student Learning Services

Student Learning Services (SLS) offers assistance to U of S undergrad and graduate students. For information on specific services, please see the SLS web site <https://library.usask.ca/studentlearning/>.

Student and Enrolment Services Division

The Student and Enrolment Services Division (SESD) focuses on providing developmental and support services and programs to students and the university community. For more information, see the students' web site <https://students.usask.ca>.

Financial Support

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact Student Central (<https://students.usask.ca/student-central.php>).

Aboriginal Students Centre

The Aboriginal Students Centre (ASC) is dedicated to supporting Aboriginal student academic and personal success. The centre offers personal, social, cultural and some academic supports to Métis, First Nations, and Inuit students. The centre is also dedicated to intercultural education, bringing Aboriginal and non-Aboriginal students together to learn from, with and about one another in a respectful, inclusive and safe environment. Students are encouraged to visit the ASC's Facebook page (<https://www.facebook.com/aboriginalstudentscentre/>) to learn more.

International Student and Study Abroad Centre

The International Student and Study Abroad Centre (ISSAC) supports student success in their international education experiences at the U of S and abroad. ISSAC is here to assist all international undergraduate, graduate, exchange and English as a Second Language students and their families in their transition to the U of S and Saskatoon. ISSAC offers advising and support on all matters that affect international students and their families and on all matters related to studying abroad. Please visit <https://students.usask.ca> for more information.