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, MATH 176 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, Biol 106
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

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• 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 – mid/late January, early February, late February, 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

<table>
<thead>
<tr>
<th>Assignments (5)</th>
<th>25 %</th>
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<tbody>
<tr>
<td>Midterm Exam</td>
<td>15 %</td>
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<tr>
<td>In-Lab Programming Exam</td>
<td>10 %</td>
</tr>
<tr>
<td>Final Exam</td>
<td>50 %</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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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 (April 9th through April 29th inclusive) 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**


**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/](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 an extension is required for some special reason (e.g. medical) the instructor must be contacted 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. "If a student is absent from a final examination due to an extenuating circumstance, they may be eligible to apply for a deferred exam. Students in the College of Arts and Science must contact the Undergraduate Student Office within three business days of the missed exam to be considered."
   (http://artsandscience.usask.ca/undergraduate/advising/strategies.php)

Incomplete Course Work and Final Grades
"When a student has not completed the required class 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 percentage grade for the class which factors in the incomplete class work 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 percentage grade but the instructor has indicated in the class syllabus that failure to complete the required class work will result in failure in the class, 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 class on the basis of work completed in the class provided that any incomplete class work has not been deemed mandatory by the instructor in the class syllabus as per 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 Policy on 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.


For more information on what academic integrity means for students see the Student Conduct & Appeals section of the University Secretary Website at: https://secretariat.usask.ca/student-conduct-appeals/index.php

**Access and Equity Services (AES) for Students**

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/.

Teaching, Learning and Student Experience
The Teaching, Learning and Student Experience Unit (TLSE) focuses on providing developmental and support services and programs to students and the university community. For more information, see https://students.usask.ca.

College Supports
Students in Arts & Science are encouraged to contact the Undergraduate Student Office and/or the Trish Monture Centre for Success with any questions on how to choose a major; understand program requirements; choose courses; develop strategies to improve grades; understand university policies and procedures; overcome personal barriers; initiate pre-career inquiries; and identify career planning resources. Contact information is available at: (http://artsandscience.usask.ca/undergraduate/advising/)