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

The course will be adopting a mixed remote delivery mode. Class meetings will be held during the scheduled class time (M W F, 12:30-13:20), using Zoom. The Zoom meeting invitation will be posted on Moodle. Zoom sessions will be recorded and posted on Moodle, together with detailed lecture notes. Both the midterm exam and the final exam will be synchronous. The midterm exam will be held during our scheduled class time (12:30-13:20), tentatively on Monday March 8th. The final exam will be held during a three-hour time slot that will be assigned in the University final exam schedule.

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

Tutorials will be held during their scheduled times, using Discord. You are free to participate in any tutorial session(s) you wish, regardless of which tutorial section you are registered in. Tutorials will begin the week of January 18th.

Website:
Moodle

Instructor Information
Instructor: Derek Eager
Contact: Email: eager@cs.usask.ca

Feel free to email me at any time. I am usually able to respond to emails received during the day (9:00 am to 5:00 pm) on weekdays (Monday to Friday) within a few hours, depending on other commitments. Emails received during the evening may not be responded to until the following morning.

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 – early February, late February, end of second week of March, late March, and early April). These assignments will involve both programming and non-programming exercises, with programming to be done in MIPS assembly language using the spim simulator. 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. A midterm exam will be held, using Moodle, during our scheduled class time (12:30-13:20), tentatively on Monday March 8th. A three-hour final exam will be held, using Moodle, during a time slot that will be assigned in the University final exam schedule.

Grading Scheme

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments (5)</td>
<td>40%</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>20%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>40%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

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 14th through April 30th inclusive) until the official exam schedule has been posted.

Note: All students must be properly registered in order to participate in 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/.

Lecture Schedule (all timings approximate)
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.

University of Saskatchewan Grading System (for undergraduate courses)

Exceptional (90-100) A superior performance with consistent evidence of
  • a comprehensive, incisive grasp of the subject matter;
  • an ability to make insightful critical evaluation of the material given;
  • an exceptional capacity for original, creative and/or logical thinking;
  • an excellent ability to organize, to analyze, to synthesize, to integrate ideas, and to express thoughts fluently.

Excellent (80-90) An excellent performance with strong evidence of
  • a comprehensive grasp of the subject matter;
  • an ability to make sound critical evaluation of the material given;
• a very good capacity for original, creative and/or logical thinking;
• an excellent ability to organize, to analyze, to synthesize, to integrate ideas, and to express thoughts fluently.

**Good (70-79)** A good performance with evidence of
• a substantial knowledge of the subject matter;
• a good understanding of the relevant issues and a good familiarity with the relevant literature and techniques;
• some capacity for original, creative and/or logical thinking;
• a good ability to organize, to analyze and to examine the subject material in a critical and constructive manner.

**Satisfactory (60-69)** A generally satisfactory and intellectually adequate performance with evidence of
• an acceptable basic grasp of the subject material;
• a fair understanding of the relevant issues;
• a general familiarity with the relevant literature and techniques;
• an ability to develop solutions to moderately difficult problems related to the subject material;
• a moderate ability to examine the material in a critical and analytical manner.

**Minimal Pass (50-59)** A barely acceptable performance with evidence of
• a familiarity with the subject material;
• some evidence that analytical skills have been developed;
• some understanding of relevant issues;
• some familiarity with the relevant literature and techniques;
• attempts to solve moderately difficult problems related to the subject material and to examine the material in a critical and analytical manner which are only partially successful.

**Failure <50** An unacceptable performance

**Policies**

**Recording of Lectures**
The instructor will be posting recordings of lectures on the course Moodle site. These recordings are protected by copyright. Do not download, copy, or share recordings without the explicit permission of the instructor.

For questions about recording and use of sessions in which you have participated, including any concerns related to your privacy, please contact your instructor. More information on class recordings can be found in the Academic Courses Policy [https://policies.usask.ca/policies/academic-affairs/academic-courses.php#5ClassRecordings](https://policies.usask.ca/policies/academic-affairs/academic-courses.php#5ClassRecordings).

**Late Assignments**
Due dates 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 it.

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)

Copyright
Course materials are provided to you based on your registration in a class, and anything created by your professors and instructors is their intellectual property, unless materials are designated as open education resources. This includes exams, PowerPoint/PDF slides and other course notes. Additionally, other copyright-protected materials created by textbook publishers and authors may be provided to you based on license terms and educational exceptions in the Canadian Copyright Act (see http://laws-lois.justice.gc.ca/eng/acts/C-42/index.html).
Before you copy or distribute others’ copyright-protected materials, please ensure that your use of the materials is covered under the University’s Fair Dealing Copyright Guidelines available at https://library.usask.ca/copyright/general-information/fair-dealing-guidelines.php. For example, posting others’ copyright-protected materials on the open web is not covered under the University’s Fair Dealing Copyright Guidelines, and doing so requires permission from the copyright holder.

For more information about copyright, please visit https://library.usask.ca/copyright/index.php where there is information for students available at https://library.usask.ca/copyright/students/rights.php, or contact the University’s Copyright Coordinator at mailto:copyright.coordinator@usask.ca or 306-966-8817.

Integrity in a Remote Learning Context

Although the face of teaching and learning has changed due to COVID-19, the rules and principles governing academic integrity remain the same. If you ever have questions about what may or may not be permitted, ask your instructor. Students have found it especially important to clarify rules related to exams administered remotely and to follow these carefully and completely.

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://secretariat.usask.ca/student-conduct-appeals/academic-misconduct.php) as well as the Standard of Student Conduct in Non-Academic Matters and Procedures for Resolution of Complaints and Appeals (https://secretariat.usask.ca/student-conduct-appeals/academic-misconduct.php/#IXXIIAPPEALS)

For more information on what academic integrity means for students see the Academic Integrity section of the University Library Website at: https://library.usask.ca/academic-integrity#AboutAcademicIntegrity.

You are encouraged to complete the Academic Integrity Tutorial to understand the fundamental values of academic integrity and how to be a responsible scholar and member of the USask community – https://library.usask.ca/academic-integrity.php#AcademicIntegrityTutorial.

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 at any time. Those students who are registered with AES with mental health disabilities and who anticipate that they may have responses to certain course materials or topics, should discuss course content with their instructors prior to course add / drop dates. In order to access AES programs and supports, students must follow AES policy and procedures. For more information or advice, visit 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.

For information on AES services and remote learning please visit https://updates.usask.ca/info/current/accessibility.php#AccessandEquityServices
Student Supports

Academic Help for Students

The University Library offers a range of learning and academic support to assist USask undergrad and graduate students. For information on specific services, please see the Learning page on the Library web site https://library.usask.ca/support/learning.php.

- Remote learning support information https://students.usask.ca/remote-learning/index.php
- Class and study tips https://students.usask.ca/remote-learning/class-and-study-tips.php
- Remote learning tutorial https://libguides.usask.ca/remote_learning
- Study skills materials for online learning https://libguides.usask.ca/studyskills
- A guide on netiquette, principles to guide respectful online learning interactions https://teaching.usask.ca/remote-teaching/netiquette.php

Teaching, Learning and Student Experience

The Teaching, Learning and Student Experience Unit (TLSE) provides developmental and support services and programs to students and the university community. For more information, see 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).

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/)

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, brining 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.

Land Acknowledgement

As we engage in Remote Teaching and Learning, I would like to acknowledge that the Saskatoon campus of the University of Saskatchewan is on Treaty Six Territory and the Homeland of the Métis. We pay our respect to
the First Nation and Métis ancestors of this place and reaffirm our relationship with one another. I would also like to recognize that some may be attending this course from other traditional Indigenous lands. I ask that you take a moment to make your own Land Acknowledgement to the peoples of those lands. In doing so, we are actively participating in reconciliation as we navigate our time in this course, learning and supporting each other.