University of Saskatchewan
Department of Computer Science
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Course Syllabus
CMPT 215: the Magic of Computation (*Lower Half*)

Catalogue Description

CMPT 215.3 (3L–2P)
Introduction to Computer Organization and Architecture

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(s):	CMPT 214	
	A student cannot receive credit for more than one of CMPT 215, EE 331, or CME 331.	
Class Time and Location:	lectures:	MWF, 12:30–13:20 in Arts 134
	tutorials:	R, 14:30–15:50 in Thorv S320
		F, 14:30–15:50 in Thorv S320
		M, 16:30–17:50 in Thorv S320
Website:	CS Moodle:	https://moodle.cs.usask.ca
	TSoCM:	https://app-ca.tophat.com/e/724248

Instructor Information

Instructor	Christopher Dutchyn
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Office Hours:	Location: Thorv 281.10,
	Hours: W, 14:00–15:00

Course Overview

- Tutorials will be hands-on software practice and problem-solving sessions [worked example, then small group, then individual effort], and exam preparation and review.
- The last tutorial will examine (meaning test) computer-based/supported skills: writing machine code, converting floating-point numbers, etc. in a practical exam on computer. **The first tutorial session begins January 9.**
- Credit is not given for attendance. To motivate attendance and in-class participation at lectures and tutorials, and self-study, students will have an opportunity to accumulate *bonus points* which may be redeemed to yield benefits such as assistance on the midterm and/or final, the right to use crib-sheets, or the opportunity to rewrite the midterm exam. Details will be given at the first lecture. **This is an optional and experimental feature: it may be withdrawn at any time**–the benefits realized from the increased learning would remain.

Course Objectives

Computers are magical[1] devices; and this course aims to remove (the lower half of) that mystery. As a result of learning what lies below the *application programming interface*, namely the basic organization and architecture of computer systems, you should be able to

1. Describe the basic hardware organization of a computer system and the hardware/software interface;
2. Use the factors of clock-rate, instruction-count, and cycles-per-instruction to evaluate performance;
3. Describe how data and instructions are represented in a computer system, and convert among different representations;
4. Develop and debug (simplified) ARM assembly language programs;
5. Describe the main characteristics and design principles of ARM machine language;
6. Explain how assembly language programs are assembled and linked;
7. Design simple digital logic circuits;
8. Describe how the basic arithmetic operations can be implemented in an arithmetic-logic-unit;
9. Describe and analyze the operation of a simple processor datapath and control designs;
10. Describe and analyze the operation of processor pipelining, including techniques for dealing with pipeline hazards;
11. Describe and analyze the operation of processor caching and virtual memory management techniques;
12. Explain how input/output is performed, and describe the basic characteristics of disk storage systems;
13. Compare and contrast the main approaches to parallel computing.

Student Evaluation

Intangibles may count in the determination of your grade. The relative weights of different course activites are shown in Table 1.

Grading Scheme

Table 1: Course Work and Grades

Item	*Description*	*Weighting*
Preparation Quiz	(30 minutes, in-class)	5%
Assignments	six (one per chapter) @ 2%	12%
Chapter Examinations	five (one per chapter, except last) @ 10%	50%
Skills Examination	(80 minutes, in-lab)	13%
Final Examination	(180 minutes)	20%
	Total	100%

[1] *Any sufficiently advanced technology is indistinguishable from magic.* Arthur C. Clarke

Tasks

In response to student requests, and as allowed for by the "all dates are approximate" comment, these dates have changed from the Syllaus availabel at start of class. Please reschedule any DSS appointments.

There are five in-class chapter exams, anticipated for Jan. 16 (ch. 1), Feb. 13 (ch. 2), Mar. 13 (ch. 3), Mar. 29 (ch. 4), Apr. 3 (ch. 5); chapter 6 will only be tested on the final exam.

Each chapter has an assignment, to provide an opportunity for you to practice the skills you need for the exam. The due dates are Jan. 15, Feb. 5, Mar. 5, Mar. 19, and Mar. 26.

There is a final exam, centrally scheduled for sometime in the usual span of Apr. 7–29. Once the date is determined, it will be announced in class.

The last tutorial period is a practical skills exam: Monday tutorials will write Mar. 27, Thursday tutorials will write Mar. 30, and Friday tutorials will write Mar. 31.

For clarity, tutorials will be held on the following days:

Table 2: Tutorials

Days	*Topic*	*Days*	*Topic*
Jan. 4, 6	**no tutorial**	Jan. 9, 11, 13	prep-quiz answers and chapter 1
Jan. 16, 19, 20	exam-1 answers and chapter 2	Jan. 23, 26, 27	chapter 2
Jan. 30, Feb. 2, 3	chapter 2	Feb. 6, 9, 10	assn-2 answers and chapter 3
Feb. 13, 16, 17	exam-2 answers and chapter	Feb. 20, 22, 24	**no tutorial**
Feb. 27, Mar. 2, 3	chapter 3 and chapter 4	Mar. 6, 9, 10	assn-3 answers and chapter 4
Mar. 13, 16, 17	exam-3 answers, chapters 4 and 5	Mar. 20, 23, 24	assn-4 answers and chapter 5
Mar. 27, 29, 31	skill examination	Apr. 3, 6	**no tutorial**

All dates are approximate, and may be adjusted as the term progresses.

Attendance Expectation

All students are expected to attend lectures and the tutorial session they are registered for. If you miss a lecture, contact other students to obtain lecture notes.

If you cannot attend a tutorial session, please attend another in the same week (the content will be the same), but recognize that seating is limited and you can be denied access to a lab computer or even asked to leave if space is required for students properly registered in that session. You cannot switch skills examination times without prior approval of the instructor.

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 and Software

- Patterson, David A. and John L. Hennessy, *Computer Organization and Design: the hardware/software interface* **ARM EDITION**, Morgan Kaufmann (Elsevier), 2016.

Note: Questions will be assigned from the textbook: earlier editions may not suffice.

Recommended Texts

- Hennessy, John L. and David A. Patterson, *Computer Architecture: a quantitative approach* 5ed., Morgan Kaufmann (Elsevier), 2015.
- Petzold, Charles, *Code: the hidden language of computer hardware and software*, Microsoft Press, 2000.

Lecture Schedule

The order is fixed, but the the lengths of each section are approximate schedule, subject to change. The associated readings are also given.

Abstractions (4.5 lectures): overview of computer systems organization, performance factors, performance metrics, benchmarking, and power consumption.

Chapter 1.

Instructions (9.5 lectures): machine and assembly language, integer representations, addressing methods, instruction sets, procedures and recursion, assembly and linking.

Chapter 2 and portions of appendix A.

Arithmetic (7 lectures): basics of digital logic circuits, implementing arithmetic operations, floating-point representation and operations.

Chapter 3, portions of appendix B.

Processor (4.5 lectures): datapath and control, single-clock cycle implementation, pipelining and hazards, multiple issue.

Chapter 4, rest of appendix B.

Memory (4 lectures): memory hierarchies, temporal and spatial locality, caches (including coherence and consistency), virtual memory, virtual machines.

Chapter 5.

Parallel (4 lectures): controlling IO, SSDs and magnetic disks, RAID, parallel computing approaches.

Chapter 6, rest of appendix A.

Policies

Disabled Students

As far as possible, disabled students will be accommodated; although this may delay access to assignment solutions. In accordance with DSS policy, you must submit notice to me as early as possible: certainly no later than the January 18 registration deadline. Otherwise, accommodations may not be provided.

Recording of Lectures

Lecture capture is available for the classroom; and depending on demand (especially disabled students), access may be granted to those recordings. Personal recording is not permitted.

Late Assignments

Late assignments (unless supported by DSS request) will neither be accepted nor graded. Late assignments receive a grade of zero (0). Singular, extenuating circumstances (requiring written declaration) will be negotiated individually. The moodle courseware system permits re-submission of assignments: therefore submit regularly as you progress toward completion of an assignment.

Server outages in the 24-hours preceding an assignment due date will be handled on ad-hoc but across-the-board basis, depending on the length and severity of the problem. Typically, any outage lasting less than 4 hours will not grant extensions: submit regularly as your progress toward completion of an assignment.

Missed Assignments

Missed assignments are simply terribly late, and are handled in accordance with that policy.

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."
(http://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" (http://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 subsection of the University Secretary Website and avoid any behaviour 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, as well as the Standard of Student Conduct in Non-Academic Matters and Procedures for Resolution of Complaints and Appeals. Academic honesty is also defined and described in the Department of Computer Science statement on Academic Honesty.

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

http://www.usask.ca/university_secretary/pdf/dishonesty_info_sheet.pdf

Collaboration Policy

Please note that you may not share any work (rough drafts, finished answers, or graded assignments) with another student at any time during the course: **before or after** assignments are due. Study groups and group discussion are encouraged; but if you plan to discuss how to solve problems or to learn how to solve them, then you must adhere to the ***no recording*** policy:

> Collaboratively, you may discuss and sketch on a non-permanent surface (e.g. white board), but no written-on-paper and no typed-into-computer activities are allowed. Every student must leave the discussion without a record (no written notes or document, no computer file, no photograph, and no audio/video recording) and must reproduce the result from their own memory. The impermanent surface must be erased.

One student's possession of other students' work (even after the due date) is *prima facia* evidence of academic dishonesty on the part of both students.

Examinations with Disability Services for Students (DSS)

Students who have disabilities (learning, medical, physical, or mental health) are strongly encouraged to register with Disability Services for Students (DSS) if they have not already done so. Students who suspect they may have disabilities should contact DSS for advice and referrals. In order to access DSS programs and supports, students must follow DSS policy and procedures. For more information, check http://www.students.usask.ca/disability/, or contact DSS at 966-7273 or `dss@usask.ca`.

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

01/03/2017 : initial 2017-T2 version

01/23/2017 : revised schedule to meet student requests