CSC258H1 – Computer Organization

Course Syllabus for the 2023 Fall Semester

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1 Course details

Welcome to Computer Organization (CSC258H1)! By the end of this course, you should be able to explain how high-level code is translated into a language that instructs digital hardware what to do, and how the hardware decodes and operates on those instructions to produce the changes in memory that a programmer expects. Some of the key things you will learn include:

1. *Digital Design.* How to design combinational and sequential circuits from a specification (e.g., truth table, English description), analyze circuit behaviour, and evaluate circuits (e.g., in terms of performance).
2. *Instruction Set Architecture.* How to translate high-level programming constructs (like loops and procedure calls) into assembly and then machine instructions that a microprocessor understands.
3. *Microarchitecture.* How a microprocessor operates in terms of its datapath and control unit, and how a computer is (in essence) a state machine that decodes and interprets machine instructions.

For a high-level overview of the topics we will cover, see Table 1. Section 1.1 gives more information about lectures, tutorials, and labs. Section 1.3 discusses how you will be assessed and graded. To learn more about our course policies, see Section 2.

Table 1: A birds-eye view of the course.

Week of	Lab	Tutorial	Key topics
Sep. 4th			digital abstraction
Sep. 11th		Tutorial 1	binary arithmetic, transistors
Sep. 18th	Lab 1	Tutorial 2	combinational circuits
Sep. 25th	Lab 2	Tutorial 3	sequential circuits, finite state machines
Oct. 2nd	Lab 3	Tutorial 4	timing analysis, system timing
Oct. 9th	Lab 4	Tutorial 5	arithmetic circuits
Oct. 16th	Lab 5	Tutorial 6	sequential building blocks, memory
Oct. 23rd		Midterm	assembly language, machine instructions
Oct. 30th	Lab 6	Tutorial 7	branches, arrays
Nov. 6th			reading week
Nov. 13th	Lab 7	Tutorial 8	procedure calls
Nov. 20th	Lab 8	Tutorial 9	the single-cycle processor
Nov. 27th	Lab 9		exceptions, memory systems
Dec. 4th			caches

1.1 Logistics

All course announcements are posted on Quercus. You are responsible for reading all announcements made by the teaching team, as well as being familiar with the course syllabus. If you have a question related to course content, please use Piazza. As a courtesy to others (and the teaching team), please search to see if your question has already been posted. If your question is personal (i.e., the answer is only useful to you), please use csc258-2023-09@cs.toronto.edu and ensure that you share your UTORid in the body of your message.

The course offers you with three opportunities to learn synchronously and in-person: lectures, tutorials, and labs. All lectures, tutorials, and labs start at 10 minutes past the hour of the time specified on ACORN. The location of lectures and tutorials is on ACORN, but the location of your labs will be announced on Quercus. Some important dates you should note are:

- The first lecture is on Friday, September 8th, but after that lectures are on Mondays and Wednesdays.
- The first tutorial is on Friday, September 15th.
- The first lab is on Tuesday, September 19th (TUT5101) or Wednesday, September 20th (TUT5201), depending on your section.

It is very important to be enrolled in a lab section (TUT5101 or TUT5201). It is also very important that you attend your assigned lab section. Labs are discussed in more detail in Section 1.1.3.

1.1.1 Lectures

You should prepare for lectures by reading the textbook (Section 1.2). Which readings to complete for the week will be posted on the course website. Most of the material from the readings will not be covered in lecture but can be assessed; the expectation is that you have completed, and made an effort to understand, the reading before the lecture.

Lectures present new material that build on content covered in previous weeks and the textbook readings. The lecture is meant to be interactive, which means that student activities are interleaved between presented materials. Your attendance in lectures is recommended, but not mandatory.

If the lecture hall supports it, lecture and tutorial recordings will be made available on Quercus. You may access these recordings through the "OCCS Student App". You can find a link to the app on the course website. Please see Section 2.3.1 for our policy on lecture recordings.

1.1.2 Tutorials

Tutorials reinforce material from lectures and demonstrate how to use software to design and analyse circuits and assembly programs. You will get a lot out of the tutorials if you come prepared, briefly reviewing the week's lecture material beforehand. Your attendance in tutorials is recommended, but not mandatory.

1.1.3 Labs

You must prepare for labs by completing the "pre-lab" exercises, which are graded. The pre-lab exercises will require you to analyse, extend, design, and test digital circuits and assembly code. This is where a lot of your learning will happen.

Your pre-labs will result in a lab report and one or more circuits and/or assembly programs. You work on, and submit, these pre-labs individually on MarkUs **before attending the lab** (see also Section 2.2.1). In our opinion, students who truly understand the lab material get the most out of this course. So be sure to dedicate enough time each week to prepare for the labs.

Lab demonstrations are completed in person during your lab session and are graded. During the lab itself, you work in pairs at a specific work station (you may not work individually). Your partner must be from the same section as you, and you will work on all lab demonstrations together at the same workstation. However, the demonstrations are assessed individually by your TA based on your answers to their questions. Labs allow you to demonstrate your mastery of the material from the previous week.

1.2 Textbook and software

A lot of your learning will happen outside of lectures, tutorials, and labs. The course textbook, which can be accessed online for free using your UTORid (Mirror 1, Mirror 2), will serve as an excellent resource:

> Harris, David, and Sarah L. Harris. Digital design and computer architecture. Morgan Kaufmann, 2007.

The course also uses two different software applications for learning and assessment. Logisim Evolution is used to design, analyse, simulate, and test digital circuits at the transistor and gate level. Another application (e.g., Mars, Saturn) is used to assemble, run, and debug programs written in assembly. For more information on installing and using the software applications, please see the course website.

1.3 Assessment and grading

The course assesses you through labs and examinations. Lab assessments are each worth 5% of your grade and are further broken down into a preparation and demonstration. Your lab preparations are submitted online on MarkUs on Mondays before 4:00 PM. Your lab demonstration will then be assessed that same week, on Tuesday or Wednesday from 6:00 to 9:00 PM depending on your section (TUT5101 or TUT5202). The breakdown in grade between your preparation and demonstration varies from one lab to another. Overall, nine labs will account for 45% of your grade.

A midterm examination will be held on Friday, October 27th during lecture time. You must attend midterm examination for the lecture section you are enrolled in. The location of the midterm, and additional instructions, will be announced on Quercus closer to the date. The midterm examination is worth 10% of your overall grade.

A three-hour final examination will be scheduled by the Faculty of Arts and Science during the final assessment period (December 9th to 20th). The final examination is worth 44% of your overall grade. In addition, **you must get at least 30% on the final exam to pass the course.** That is, if your final exam mark is less than 30%, then your final mark in the course will be reduced (if necessary) to no more than 45%.

The final 1% of your grade will be based on the completion of a research survey. The due date will be announced on Quercus and you will have one week to complete the survey. Completing the survey should take (approximately) 10 to 15 minutes of your time.

2 Course policies

The University of Toronto is committed to equity, human rights and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. The University of Toronto does not condone discrimination or harassment against any persons or communities.

In the rest of this section, we detail our course policies related to academic integrity, accommodations, and intellectual property.

2.1 Academic integrity

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, please reach out. Note that you are expected to seek out additional information on academic integrity from me or from other institutional resources (for example, the University of Toronto website on Academic Integrity).

2.1.1 Helpful guidelines

Here are a few guidelines to help you maintain academic integrity:

- Never look at another student's or group's assignment solution or idea for a solution, whether it is on paper or on the computer screen, and don't allow your solution to be viewed by or come into the possession of another student. Maintain absolute control of your work, including notes and partial solutions, at all times.
- We encourage you to discuss course concepts and to study for exams with other students, but any work that is submitted should be your own. The easiest way to avoid plagiarism is to only show work to a TA or instructor.
- An academic offence may significantly slow your progress through your degree. It is better to submit a partially completed assignment and receive a low mark than to face an academic offence on your record.
- While it might be tempting to look for ideas and solutions in public repositories like GitHub, remember that using someone else's work and ideas without without attribution, even if making some changes, is considered plagiarism. Keep in mind that plagiarism detection software may detect such cases.

2.1.2 Generative artificial intelligence

In this course, you may use generative artificial intelligence (AI) tools, including ChatGPT and GitHub Copilot, as learning aids and to help complete assignments. You will not be permitted to use generative AI on the midterm test or final exam. While some generative AI tools are currently available for free in Canada, please be warned that these tools have not been vetted by the University of Toronto and might not meet University guidelines or requirements for privacy, intellectual property, security, accessibility, and records retention. Generative AI may produce content which is incorrect or misleading, or inconsistent with the expectations of this course. They may even provide citations to sources that do not exist—and submitting work with false citations is an academic offense. These tools may be subject to service interruptions, software modifications, and pricing changes during the semester.

Generative AI is not required to complete any aspect of this course, and we caution you to not rely entirely on these tools to complete your coursework. Instead, we recommend treating generative AI as a supplementary tool only for exploration or drafting content. Ultimately, you (and not any AI tool) are responsible for your own learning in this course, and for all the work you submit for credit. It is your responsibility to critically evaluate the content generated, and to regularly assess your own learning independent of generative AI tools. Overreliance on generative AI may give you a false sense of how much you have actually learned, which can lead to poor performance on the midterm test or final exam, in later courses, or in future work or studies after graduation.

2.2 Accommodations

The majority of assessments in this course are labs, which include a synchronous in-person component. Moreover, subsequent labs build upon the previous ones. As a result, missing one lab can make it challenging to complete the next. But we understand that circumstances during the semester may impose challenges that you cannot overcome without special consideration.

In this section, we describe accommodations that may be available to you and situations where you may request special consideration from us or the university. We also recommend you review the Faculty of Arts and Science policy on student absences, especially if you are experiencing an emergency that impacts multiple courses. In these cases, you should also contact your College Registrar for academic and/or personal advising.

2.2.1 Grace credits

We recognize that unexpected problems sometimes make it difficult to submit lab preparations on time. For this reason, we use grace credits to give you flexibility with lab

preparation deadlines. Each student will receive 21 grace credits; each grace credit can be used for a three-hour extension, up to a maximum of 24 hours (i.e., 7 grace credits) per lab preparation.

MarkUs automatically deducts grace credits when you submit work for an assignment late; you do not need to explicitly say you are using a grace credit, just submit your work within the grace credit three-hour periods. These periods round up: for example, **if you submit an assignment just two minutes after the actual assignment due date, this still uses up a grace credit.**

Grace credits serve both the role of allowing you some flexibility in how you plan your time, as well as an automatic cushion for when small things just go wrong. If you encounter a more serious problem during the term, please see Section 2.2.4.

2.2.2 Tests and exams

If you require accommodations to write the midterm, these accommodations are handled by Accommodated Testing Services. These types of accommodations include, but are not limited to, additional writing time and/or alternate print formats. If, however, you miss (or will miss) the midterm, please see Section 2.2.4. **Please note that accommodations for final exams are handled by your registrar.**

2.2.3 Disabilities

The University provides academic accommodations for students with disabilities in accordance with the terms of the Ontario Human Rights Code. This occurs through a collaborative process that acknowledges a collective obligation to develop an accessible learning environment that both meets the needs of students and preserves the essential academic requirements of the University's courses and programs. Students with diverse learning styles and needs are welcome in this course.

If you have a disability that may require accommodations, please contact the Accessibility Services on the St. George campus office as soon as possible. If you are registered with accessibility services, please let us know by emailing us your Letter of Academic Accommodation (csc258-2023-09@cs.toronto.edu). Alternatively, you may ask the accessibility office to send the letter. When you are in need of special consideration, please follow the process outlined in Section 2.2.4.

2.2.4 Emergencies

Students experiencing illness or other emergencies that prevent them from being able to complete homework on time, attend a lab, or write the midterm, can apply for special

consideration. You will be required to affirm that you are abiding by the Code of Behaviour on Academic Matters, in particular, to be aware that it is an offence:

> to engage in any form of cheating, academic dishonesty or misconduct, fraud or misrepresentation not herein otherwise described, in order to obtain academic credit or other academic advantage of any kind

That is, you must be truly experiencing an emergency, and acknowledge that to falsely claim so is an academic offence. Applying does not guarantee that you will be granted special consideration. To apply for special consideration,

1. Download the special consideration form from the course website.
2. Fill out every field of the form.
3. Email the form to us (csc258-2023-09@cs.toronto.edu) from your UofT email address.

Submit your request soon as possible if you find yourself in such a situation. It is easier to resolve situations earlier rather than later. If your emergency will affect your ability to complete coursework for more than a few days, or in multiple courses, we recommend you also talk to your registrar.

2.2.5 Religious observances

The University provides reasonable accommodation of the needs of students who observe religious holy days other than those already accommodated by ordinary scheduling and statutory holidays. Students have a responsibility to alert members of the teaching staff in a timely fashion to upcoming religious observances and anticipated absences. **Please reach out to us at least two weeks before the due date** to communicate any anticipated absences related to religious observances and to discuss any possible related implications for course work.

2.3 Copyright

Course materials prepared by the instructor are considered by the University to be an instructor's intellectual property covered by the Copyright Act, RSC 1985, c C-42. These materials are made available to you for your personal, and cannot be shared outside of the class or published (made publicly available) in any way. Posting course materials or any recordings you may make to other websites without the express permission of the instructor will constitute copyright infringement. This notice applies to all course materials, including (but not limited to): course notes, lecture slides, lecture recordings, lecture and tutorial handouts, sample solutions, and assessment handouts, starter files, and solutions.

2.3.1 Lecture recordings

This course, including your participation, may be recorded on video and made available to students in the course for viewing remotely after each session. Course videos and materials belong to your instructor, the University, and/or other sources depending on the specific facts of each situation and are protected by copyright. In this course, you are permitted to download session videos and materials for your own academic use, but you should not copy, share, or use them for any other purpose without the explicit permission of the instructor. For questions about the recording and use of videos in which you appear, please contact us.

2.3.2 Your course work

Work that you complete in this course may not be shared with other students or published. This policy is to both protect the intellectual property of course staff and to protect you from committing acts of academic dishonesty. For more information on this topic, see the Department of Computer Science website.

GitHub is a popular option for computer science students and professionals to both collaborate in teams and publish their work online, including to develop a portfolio for potential employers. As we said in the Academic Integrity section, you should not put your work publicly on GitHub. However, you may use GitHub's private repositories to store your own work (See GitHub's instructions for creating a repository and select "Private" in Step 4).