CSCI 2122: Systems Programming: Winter 2023

Instructor Information

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Office Hours:	Mon 11:30 - 1:00 Thurs 11:30 - 1:00.
Class Time/LOc: Sec 1: MW 2:35 - 4:00 Chem 125	Sec 2 T, Th 2:35 - 4:00 Dentistry 3156
Course Mail List	`ll-cs2122@cs.dl.ca` (not yet active)

Teaching Assistants

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Required Texts and Resources

Text: *Computer Systems: A Programmer's Perspective. 3rd Ed.*; Bryant & O'Hallaron (2016) Pearson. Available electronically (rent/buy): `https://tinyurl.com/yg94dq36`.
A C reference is useful to have at hand: A good online ref is at:
`https://en.wikibooks.org/wiki/C_Programming`
A concise guide to C: `http://cslibrary.stanford.edu/101/EssentialC.pdf`.
A commented list of C books (some free), available online: `https://tinyurl.com/puqwlqq`.
(the list is only a suggestion.)

Evaluation Criteria

Assignments	$\sim 5\times$ 4% = %20	04/01, 18/01
Quizzes (4)	12%	20/01, 07/02, 10/03, 31/03
Labs	8%	Must pass file structure test (Schedule TBA)
Practicums	8%, 14%, 14%	Week of: 06/02, 06/03, 03/04*
Final:	24%	scheduled by the Registrar

In the case of Quizzes or of the Final being on-line, the instructor reserves the right to request an interview with selected students about their exam answers, before issuing a grade

* Subject to room availability - schedule for quizzes/Assignments etc will be adjusted accordingly

Important Dates

- Last day to drop w/o financial implications: 20 January.
- Last day to drop without a "W": 6 February.
- Munro Day: 3 Feb.
- Winter Study Break: 20 - 24 February.
- Friday Classes: 10 April (Monday)
- Friday Classes: 11 April (Tuesday)
- Break Before Exams: 12 April
- Exam period: 13 - 25 April.

Course Description

The course has two interconnected components. One component provides a low level view of computer. This includes tool and techniques for *systems* programming. To this end, students will be introduced to **C** and x86-64 assembly. which will also serve as a tool for exploring the computer at a low level. The course also discusses data representations, memory hierarchy and its effects on performance.
The second component of the course is a thorough, practical introduction to C, via the labs.

Learning Outcomes

- *Data Representation and Assembly:* Describe the internal representation of numeric/non-numeric data. (*i.e.* ints, floats, chars, strings, records, and arrays); Convert numerical data from one format to another; Explain different instruction formats; Explain how subroutine calls are handled at the assembly level; Show how fundamental high-level programming constructs are implemented at the machine-language level.
- *(ii) C Programming:* Explain the C build cycle (preprocess, compile, assemble, link); Use pointers in C and manage memory; Describe the various kinds of software errors that can occur and their causes; Write a program in C to solve a problem of moderate complexity given a problem specification; Use a debugger to debug an executable program.
- *(iii) Memory Hierarchy:* Learn about the effects of the memory hierarchy on program performance. Be able to analyze program performance, given details of memory hierarchy (cache-aware programming).
- *(iii) Low-Level Systems: Use software tools to profile and measure program performance; Describe the structure and types of memory inside a computer. Explain the basic concepts of interrupts and I/O operations. Explain the basic concepts of processes, system calls, and process control.*

Tentative Schedule of Topics

1. **Data Representation 1** [Lectures 1 - 2, Text Ch.1]
   - Introduction: Basic Computer Organization, The need for a Memory Hierarchy.
   - Unsigned binary $\Longleftrightarrow$ Hexadecimal $\Longleftrightarrow$ Decimal.
   - Representing multi-byte data: Big & Little Endian.
   - Bit-wise Operators in C. Contrast with Logic Ops.
   - C language basics, Intro to use of pointers
2. **Data Representation 2: Representing Integers/Floats** [Lectures 3 - 5; Text: 2.4]
   - Representing Integers (Two's Complement), Arithmetic on Signed/Unsigned Ints
   - Arithmetic on signed and unsigned data.
   - IEEE-754 format for Floating Point
   - Rounding and Truncation
   - Casting in C, Use of pointers in C
3. **x-86-64 Assembly I: Basics & Control Flow** [Lectures 6 - 8; Text: 3.1- 3.5]
   - x86-64 Register Set, Operands and Addressing Formats.
   - Arithmetic & Logic Ops.
   - C-code $\Longleftrightarrow$ Assembly Code $\Longleftrightarrow$ Object Code.
   - Conditionals and Loops in Assembly
   - Dynamic Mem. Management in C
4. **x-86-64 Assembly II: Functions, Arrays, Structs** [Lectures 9 - 11; Text 3.6-3.9]
   - Procedures and the Program Stack.
   - Buffer Overflows
   - Function pointers in C
5. **x-86-64 Assembly II: Functions, Arrays, Structs** [Lectures 12 - 14; Text 3.6-3.9]
   - Procedures and the Program Stack.
6. **Memory Hierarchy: Cache Aware Programming I** [Lectures 15 - 18; Text 3.10, 6.1 - 6.6]
   - Heterogenous Data Structures and Pointer manipulation
   - Locality in programs
   - The Memory Hierarchy: Caching
7. **Linking; Exceptional Control Flow** [Lectures 19 - 22; Text; Ch 7,8 (summary)]
   - Static Linking; Symbol Resolution; Dynamic Linking
   - Interrupts

General Expectations:

⋆You will not necessarily understand the lecture notes unless you attend the lecture.
⋆ Assignments are designed to provoke questions, so start well before the assignment due date.
⋆ If you don't understand something, **please ask**, either in the lecture, after/before the lecture or on the **Lecture & Assignment Questions** channel in the class Team.
⋆ Labs form a significant part of the course (see Eval!). To be able to understand and do the labs, you **must** attend/watch the lab presentation.
⋆The schedule of labs and due dates is available in the **Lab Technical Document. (LTD)**
⋆ There will be a TA available for answering questions and helping with difficulties **every day** of the week, **except the day the lab is due**. There is no last minute help.
⋆ Each component of each lab is marked 0/1 (no partial credit). Programs **must** work to earn points.
⋆ It is your responsibility to be aware of the university Plagiarism Policy[1] and Culture of Respect[2]. **Submissions will be run through a plagiarism detector**. ⋆ Each assignment has a due date (see LTD)
⋆ Each assignment is submitted through 'Brightspace'. Late assignments can be up to 4 days late, but experience a penalty of 10% per 24hr period. No assignments will be accepted after the 4 day period.[3]
⋆ Each student has 2 SDA's for the term. Use them wisely. SDA's are **not** applicable for certain components of the course (*e.g.* Final.
⋆ The instructor must be informed of any absence, with reasons **before** a quiz. In this case the weight of the test will be shifted to the final exam. Missing a quiz and informing the instructor after, will result in a zero on the quiz.

Student Declaration of Absence

The Student Declaration of Absence policy shall apply (to a limited extent - details with each asesment). `https://www.dal.ca/campus_life/safety-respect/student-rights-and-respo`
`academic-policies/student-absence.html`

Notes

- A minimum C grade is required in this course if it is core to your FCS degree, or if it will be used as a prerequisite for a subsequent CSCI course.
- As of 2019, students who receive a grade lower than C in the same required CS course twice, will be dismissed.
- Grade conversion is by the Dalhousie Common Scale.
- **It is up to the discretion of the instructor to use remote proctoring in online testing**. Students may be required to download proctoring software onto their devices. Students who cannot meet system requirements for remote proctoring should contact the instructor for

[1] `https://www.dal.ca/dept/university_secretariat/academic-integrity.html`
[2] `https://www.dal.ca/faculty/computerscience/about/respect.html`
[3] Lateness is measured by Brightspace in terms of time beyond the original deadline, i.e. relative to midnight.

an alternate assessment. (Typical system requirements are: (i) Mac OS or Windows, (ii) a web-cam, and (iii) an internet connection.)
- **In the case of the Test or Final being on-line, The instructor reserves the right to interview selected students about their exam answers by video, before issuing a grade**

Midterm and Final Exam Requirements

- Photo ID is required.
- Closed book.
- No dictionaries, notes, calculators, cell phones, PDAs, talking slide rulers, or other electronic aids allowed.

Prerequisites

CSCI 1120

Other Information: *i.e.* *The fine print* ↓

Responsible Computing Policy

Usage of all computing resources in the Faculty of Computer Science must be within the Dalhousie Acceptable Use Policies (`http://its.dal.ca/policies/`) and the Faculty of Computer Science Responsible Computing Policy. (`https://www.cs.dal.ca/downloads/fcs_policy_local.pdf`)

Use of Plagiarism Detection Software

All submitted assignment may be passed through a plagiarism detection software, such as the Moss Software Similarity Detection System (`https://theory.stanford.edu/~aiken/moss/`), or similar systems. If a student does not wish to have their assignments passed through plagiarism detection software, they should contact the instructor for an alternative. Please note, that code not passed through plagiarism detection software will necessarily receive closer scrutiny. `https://cdn.dal.ca/content/dam/dalhousie/pdf/dept/university_secretariat/policy-repository/OriginalitySoftwarePoli`
`pdf`

Culture of Respect

Every person has a right to respect and safety. We believe inclusiveness is fundamental to education and learning. Misogyny and other disrespectful behaviour in our classrooms, on our campus, on social media, and in our community is unacceptable. As a community, we must stand for equality and hold ourselves to a higher standard.

What we all need to do [4]:

1. **Be Ready to Act:** This starts with promising yourself to speak up to help prevent it from happening again. Whatever it takes, summon your courage to address the issue. Try to approach the issue with open-ended questions like "Why did you say that?" or "How did you develop that belief?"
2. **Identify the Behaviour:** Use reflective listening and avoid labeling, name-calling, or assigning blame to the person. Focus the conversation on the behaviour, not on the person. For example, "The comment you just made sounded racist, is that what you intended?" is a better approach than "You're a racist if you make comments like that."
3. **Appeal to Principles:** This can work well if the person is known to you, like a friend, sibling, or co-worker. For example, "I have always thought of you as a fair-minded person, so it shocks me when I hear you say something like that."
4. **Set Limits:** You cannot control another person's actions, but you can control what happens in your space. Do not be afraid to ask someone "Please do not tell racist jokes in my presence anymore" or state "This classroom is not a place where I allow homophobia to occur." After you have set that expectation, make sure you consistently maintain it.
5. **Find or be an Ally:** Seek out like-minded people that support your views, and help support others in their challenges. Leading by example can be a powerful way to inspire others to do the same.
6. **Be Vigilant:** Change can happen slowly, but do not let this deter you. Stay prepared, keep speaking up, and do not let yourself be silenced.

University Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and the Senate.
`https://academiccalendar.dal.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog&catalogid=69&chapterid=3457&loaduseredits=False`

Territorial Acknowledgement

Dalhousie University is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq. We are all Treaty people.

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders."
`https://www.dal.ca/about-dal/internationalization.html`

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect. As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member

[4]Source: Speak Up! ©2005 Southern Poverty Law Center. First Printing. This publication was produced by Teaching Tolerance, a project of the Southern Poverty Law Center. Full "Speak Up" document found at: `http://www.dal.ca/dept/dalrespect.html` Revised by Susan Holmes from a document provided April 2015 by Lyndsay Anderson, Manager, Student Dispute Resolution, Dalhousie University 902.494.4140 `lyndsay.anderson@dal.ca www.dal.ca/think`.

of the university community is required to follow to ensure academic integrity.
(read more: http://www.dal.ca/dept/university_secretariat/academic-integrity.html)

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion please contact: https://www.dal.ca/campus_life/academic-support/accessibility.html for all courses offered by Dalhousie with the exceptionof Truro.

Conduct in the Classroom — Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion — Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2).
(read more:http://www.dal.ca/cultureofrespect.html)

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution.
(read more: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html)

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. (read more: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html)

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the *Student Submission of Assignments and Use of Originality Checking Software Policy*. (read more: https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignm
html)

Student Use of Course Materials

These course materials are designed for use as part of the CSCI courses at Dalhousie University and

are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading material to a commercial third party website) may lead to a violation of Copyright law.

Learning and Support Resources

Please see `https://www.dal.ca/campus_life/academic-support.html`