Carleton UNIVERSITY | Department of Systems and Computer Engineering

SYSC 2006
Foundations of Imperative Programming
Fall 2023

Instructor

TA name(s)

Course Description and requirements

1) Course description

The imperative programming paradigm: assignment and state, types and variables, static and dynamic typing. Memory management and object lifetimes: static allocation, automatic allocation in activation frames, dynamic allocation. Function argument passing. Recursion. Data structures: dynamic arrays, linked lists. Encapsulation and information hiding.

Includes: Experiential Learning Activity

Lectures three hours a week, laboratory two hours a week.

http://calendar.carleton.ca/undergrad/courses/SYSC/

2) Prerequisites

Second-year status in Engineering.

Precludes additional credit for COMP 2401, SYSC 4006.

3) Prior Knowledge

Students should:

- know the fundamental concepts of procedural programming, using Python as the programming language.

- have gained practical experience using some lightweight, modern software engineering practices in a team environment to design and implement small-scale programs.
- have developed a "mental model" of computation; in other words, learned how to reason about and visualize the execution of program code.
- understand the use of software experiments as an aid to learning.
- have a basic understanding of unit testing.

4) Course Objectives

The objective of this course is to learn the concepts that underlie most imperative programming languages, and understand how these concepts are supported by the C programming language. By the end of the course, students should be able to apply this knowledge to learn new programming languages. The course will also introduce students to the design, implementation, and application of data structures; specifically, dynamic arrays and linked lists.

This course prepares students to undertake a course that provides a thorough introduction to object-oriented programming principles. It also prepares students to undertake a course that provides a comprehensive introduction to abstract data types and data structures.

5)Accreditation Units

For more information about Accreditation Units, please visit:

https://engineerscanada.ca/.

The course has 49 AUs divided into:

Math	Natural Science	Complementary Studies	Engineering Science	Engineering Design
			35%	65%

6) Learning outcomes / Graduate Attributes

By the end of this course, students should be able to:

1. Produce well-tested, readable, and maintainable C code that demonstrates their understanding of control flow, memory management, and code and data structuring constructs provided by an imperative programming language.
2. Trace short programs written in C; explain what happens, step-by-step, as the computer executes each statement; and visualize how code execution changes the program's state; in other words, draw diagrams that depict the program's global

variables, its activation frames (containing function arguments and local variables) and memory that has been allocated from the heap and is accessed through pointers.
3. Design, code, test, and debug functions that operate on two fundamental data structures: the dynamic (resizable) array and the pointer-based singly-linked list.
4. Describe, from a client-side perspective, the operations provided by some abstract data types (ADTs): e.g., lists, queues, and stacks.
5. Given the specification of an ADT and a description of its underlying data structure, implement the data structure and the functions that provide the required operations.
6. Specify simple recursive algorithms, convert these algorithms into recursive functions, and draw memory diagrams to explain their execution.

The Canadian Engineering Accreditation Board requires graduates of undergraduate engineering programs to possess 12 attributes. Courses in all four years of our programs evaluate students' progress towards acquiring these attributes. Aggregate data (typically, the data collected in all sections of a course during an academic year) is used for accreditation purposes and to guide improvements to our programs. Some of the assessments used to measure GAs may also contribute to final grades; however, the GA measurements for individual students are not used to determine the student's year-to-year progression through the program or eligibility to graduate.

This following list provides the GAs that will be measured in this course, along with the learning outcomes that are intended to develop abilities related to these attributes.

GA - Indicator	Assessment Tool
1.4.S: Knowledge Base: Developed: Programming and algorithms	All
5.1: Use of Engineering Tools: Introductory: Diagrams and engineering sketches	2, 3, 5
5.3: Use of Engineering Tools: Introduced: Tools for design, experimentation, simulation, visualization, and analysis	1, 2, 3, 5, 6
7.1: Communication Skills: Introduced: Instructions	all

7) Texts

required, supplementary, other

8) List of Topics

- Fundamental elements of imperative programming languages using C as the implementation language: types, variables, expressions, control flow: conditional statements, iteration (loops), functions.

- Function calls and parameter-passing mechanisms. Visualizing the program state by drawing memory diagrams containing activation frames (activation records) that depict function parameters and local variables.
- Structuring data: arrays and structures
- Motivation for modular programming. Modules: interface vs. implementation:
- Modules in C: header (.h) and implementation (.c) files. The C preprocessor. Compiling and linking C programs comprised of several modules. A brief overview of the standard C library.
- C pointers:
- The & and * operators. Passing pointers to local variables as function arguments.
- Relationship between arrays and pointers.
- Pointers to structures as function arguments. The -> operator.
- Drawing memory diagrams to explain how pointers, pointers to arrays, and pointers to structures are passed as function arguments.
- C character strings.
- Introduction to dynamically-allocated memory and the heap:
- Heap management in C: malloc and free. Drawing memory diagrams to explain how parameters and local variables in activation frames can point to memory blocks allocated on the heap. Memory leaks. Dynamically allocated structs.
- Dynamically-allocated arrays, dynamic arrays:
- Case study: C implementation of a list collection using a dynamic array.
- Linked lists:
- Implementing linked lists in C using structs and pointers.
- Drawing memory diagrams to understand the fundamental operations on singly-linked lists.
- Applications of linked lists. Abstract data types (ADTs). Examples may include stacks, queues, and hash tables.
- Introduction to recursion.

9) Course Schedule

Topics, (assignments, lab report, project report) due dates, exam/test dates, lab/PA schedule

10) Evaluation and Marking Scheme

All the elements that will contribute to the cumulative grade earned and the overall approximate grade breakdown for the course.

a) Final Exam:

i) Include the following statement

Final exams are for evaluation purpose and will not be returned to students.

ii) Include any exam condition (eg. Closed-book, type of calculator …) and requirement (eg. Minimum grade on final exam to pass the course)

iii) Final exam weight [Fall 2022/Winter 2023/Summer 2023]

1 - In any course that assigns less than 50% to a proctored final exam, the professor will notify the department of the revised grading scheme with a description of how the marking scheme ensures that the final grade is reflective of each individual student's abilities and understandings.

2 - The proctored exam (except where an exception has been granted) will be worth a minimum of 25% of the final grade.

3 - A minimum of 50% of the final grade will be justifiably based on individual student work

iv) Deferred Final Examinations

Students who are unable to write the final examination because of a serious illness/emergency or other circumstances beyond their control may apply for accommodation by contact the Registrar’s office. Consult the Section 4.3 of the University Calendar (https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/examinations/)

c) Additional requirement(s):

Please consult Section 5 of the undergraduate regulations (https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/grading/)

If additional requirements beyond the cumulative grade earned in the course (for example, a requirement that students complete/pass certain assignments, examinations, lab, project components, or attend a minimal number of lab/PA sessions in order to pass the course), this should be clearly identified in the course outline.

d) Exam format and e-proctoring statement

Engineering Courses shall have on campus and proctored final examinations. The final exam may be in electronic format (ie. Student will write the exam on campus and use either their computer or a university-owned computer).

If you intend to have the electronic format exam, then it must use an e-proctoring option provided by the university and the following note must be added to the course outline:

e-Proctoring: Please note that tests and examinations in this course will use a remote proctoring service provided by Scheduling and Examination Services. You can find more information at https://carleton.ca/ses/e-proctoring/.

e) Self-Declaration form and Deferred Term work

Calendar language (Section 4.4 https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/examinations/#deferred-term-work):

Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for making alternate arrangements with the instructor and in all cases this must occur no later than three (3) days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule.

Instructors can require (or not) the student to submit the self-declaration form. Include the following statement if you require the student to submit a completed self-declaration form:

Consult with the instructor no later then 3 days after any missed course work or midterm examination.

or

Contact the instructor with the completed self-declaration form no later than 3 days after the date/deadline of term work including test/midterm, labs, assignments.

Copyright

Advising and Counselling services

a) Engineering Academic Advising

The Engineering Academic Support Service : https://carleton.ca/engineering-design/current-students/undergrad-academic-support/ assists undergraduate engineering students with course selection, registration, and learning support from first-year through to graduation.

Academic Advisors Contact : https://carleton.ca/engineering-design/current-students/undergrad-academic-support/undergraduate-advisors/

b) Student Mental Health Service

As a University student you may experience a range of mental health challenges that significantly impact your academic success and overall well-being. Carleton's Wellness Services Navigator https://wellness.carleton.ca/navigator/ is designed to help students connect with mental health and wellness resources. If you need to talk to someone, please reach out for assistance: https://carleton.ca/health/emergencies-and-crisis/.

Learning and Working Environment

The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the Department of Equity and Inclusive Communities at equity@carleton.ca

We will strive to create an environment of mutual respect for all through equity, diversity, and inclusion within this course. The space which we work in will be safe for everyone. Please be considerate of everyone's personal beliefs, choices, and opinions.

Academic Integrity and Plagiarism

a) Please consult the Faculty of Engineering and Design information page about the Academic Integrity policy and our procedures: https://carleton.ca/engineering-design/current-students/fed-academic-integrity Violations of the Academic Integrity Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension or, expulsion.

b) One of the main objectives of the Academic Integrity Policy is to ensure that the work you submit is your own. As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as "presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one's own." This includes reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source.

Examples of violations of the policy include, but are not limited to:
· any submission prepared in whole or in part, by someone else;

· using another's data or research findings without appropriate acknowledgement;

· submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own;

· failing to acknowledge sources of information through the use of proper citations when using another's work and/or failing to use quotations marks; and

· unless explicitly permitted by the instructor in a specific course, the use of generative AI and similar tools to produce assessed content (such as text, code, equations, images, summaries, videos, etc.).

Academic Accommodations

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For accommodation regarding a formally-scheduled final exam, you must complete the Pregnancy Accommodation Form (click here).

Religious obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details click here.

Academic Accommodations for Students with Disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable).

Survivors of Sexual Violence: As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: https://carleton.ca/equity/sexual-assault-support-services

Accommodation for Student Activities: Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation will be provided to students who compete or perform at the national or international level. Write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist.

https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf