University of Victoria
HEAT Course Outline

ECE596C: Selected Topics in Electrical and Computer Engineering, Advanced Program Techniques for Robust/Efficient Computing

Territory Acknowledgement

We acknowledge and respect the Lək̓ʷəŋən (Songhees and Esquimalt) Peoples on whose territory the university stands, and the Lək̓ʷəŋən and W̱SÁNEĆ Peoples whose historical relationships with the land continue to this day.

Course Dates

CRN(s):	Section A01 CRN: 30362
Term:	2024
Course Start:	2024-05-08
Course End:	2024-08-17
Withdrawal with 100% reduction of tuition fees:	2024-05-20
Withdrawal with 50% reduction of tuition fees:	2024-06-09
Last day for withdrawal (no fees returned):	2024-07-03

Cross-listed With

Cross-Listed Course(s): SENG475

Scheduled Meeting Times (M=Mon, T=Tue, W=Wed, R=Thu, F=Fri)

Section:	Location:	Classes Start:	Classes End:	Days of week:	Hours of day:	Instructor:
A01	MAC D207	2024-05-08	2024-08-02	TWF	11:30-12:20	Michael Adams
T01	ELW B238	2024-05-08	2024-08-02	W	13:30-14:50	Michael Adams

Instructor(s)

Name: **Michael Adams**
Office: EOW 311
Phone: (250) 721-6025
Email: frodo at uvic dot ca
Office Hours: **TBD**

Course Pre- & Co-requisites

Prerequisites

This course is a selected-topics course. Entrance is restricted to students who meet the prerequisites specified for the topic to be offered. In the case of this course, permission of the instructor is required.

Specification of Dates/Times

Unless explicitly indicated otherwise, all dates and times are specified using local time in Victoria, BC, Canada (i.e., Pacific Time). This statement applies in totality to all written and verbal communication for the course, including but not limited to: assignment and project submission deadlines, lecture and tutorial times, office hours, and any dates/times specified on handouts, the course website, or the Brightspace site.

Instructor

Name: Michael Adams
Office: EOW 311
Email: mdadams at ece dot uvic dot ca (or frodo at uvic dot ca)
Web: https://www.ece.uvic.ca/~mdadams
YouTube: iamcanadian1867
GitHub: mdadams
Twitter: mdadams16

Course Website

Home Page: https://www.ece.uvic.ca/~mdadams/courses/cpp
Username: cpp
Password: as announced on Brightspace site at
https://bright.uvic.ca/d2l/le/news/350695/281412/view

The course website is the **primary online source of information** for the course.

Brightspace Site

Home Page: https://bright.uvic.ca/d2l/home/350695

Although the course has a Brightspace site, the primary online source of information for the course is the course website (introduced above), **not the Brightspace site**. The Brightspace site is mainly intended to be used for:

1. posting certain types of announcements and other information related to the course, such as the username and password to be used for accessing password-protected areas of the course website; and
2. providing students with a means to review their grades in the course.

Students are responsible for reading all announcements posted on the Brightspace site in a timely fashion. For this reason, it is strongly recommended that **students enable notifications (via email) for new announcements and other events on the Brightspace site**.

Teaching Assistants (TAs)

The teaching assistants (TAs) are listed on the course website along with their contact information. In particular, this information can be found in the section of the course website titled "Teaching Assistants".

General Teaching Strategy

This course employs a **flipped classroom** approach to teaching. With this approach, students are first introduced to the course materials through prerecorded video lectures prepared by the instructor. Then, students are given the opportunity to engage with the course materials in interactive lecture sessions held by the instructor during the lecture time slots. For more details on how the lecture sessions will be run, see the section of this document titled "Lecture Sessions".

Pandemic Contingency Plan

This document has been prepared on the assumption that face-to-face meetings will be feasible for the course. In the event that face-to-face meetings turn out not to be feasible (e.g., due to public health measures resulting from a pandemic), the following changes to this course outline will apply:

- any lecture sessions that would normally be held face-to-face in the lecture time slots will instead be offered online (during those same time slots); and
- any tutorial sessions that would normally be held face-to-face in the tutorial time slots will instead be offered online (during those same time slots).

Online Meetings

Some meetings in the course may be held online. For details on how to attend online meetings, refer to the section of the course website titled "Online Meetings".

Lecture Sessions

Time/Location: The time/location of the lecture sessions is given in the information provided at the beginning of this document.

The lecture time slots will be used by the instructor to hold interactive lecture sessions that are intended to assist students in learning the course materials more effectively. The lecture sessions will employ one of the following two formats:

1. face-to-face with provisions for online attendance;
2. face-to-face only (i.e., no provisions for online attendance).

If the instructor has the hardware and software necessary in order to accommodate online attendance, the first of these formats will be used. Otherwise, the second format will be employed as a fallback. (If online attendance is supported, details on how to attend online meetings can be found in the section of this document titled "Online Meetings".) How exactly the lecture sessions

will be utilized will depend on the needs, interests, and preferences of the students. Some potential uses of these sessions include (but are not limited to):

- discussing aspects of the course materials that are typically more problematic for students and addressing common misunderstandings;
- answering student questions about the course materials;
- giving software demonstrations; and
- discussing some extra topics not officially covered by the course that may be helpful to students when seeking employment.

The first lecture session will be used to provide an overview of the course and address numerous administrative matters. **All students are required to attend the first lecture session.**

Since the core instructional content is delivered through prerecorded video lectures, students are **not required** to attend the lecture sessions, **except when explicitly indicated by the instructor**. This said, however, each student is **strongly encouraged** to attend at least some of the lecture sessions, as this will very likely lead to an improved understanding of the course materials.

Students are responsible for all material covered in lecture sessions for which the instructor has indicated attendance is mandatory. If a student is unable to attend a mandatory-attendance lecture session due to illness or some other reason, the student is responsible for any information missed (including any course-related announcements).

Normally, **the lecture sessions will not be recorded**. There are several important reasons for this:

- the main objective of the lecture sessions is to provide an opportunity for the instructor and students to engage with one another interactively in real time, and recording the lecture sessions would run completely contrary to this objective;
- recording any interactions with students raises many privacy concerns which are best avoided whenever possible;
- some students are much less likely to participate (or may not participate at all) in lecture sessions if they are being recorded; and
- all of the core instructional content for the course is already available in video format so none of the material covered in the lecture sessions is essential for the course.

For more information on lecture sessions, see the section of the course website titled "Lecture Sessions".

Office Hours

Office-hour sessions will be held by the instructor in order to provide extra help with the course materials as well as discuss other course-related matters with students. These sessions will be offered **online only**.

For more information regarding office-hour sessions, including the schedule for these sessions, refer to the section of the course website titled "Office Hours". (For details on how to attend online meetings, see the section of this document titled "Online Meetings".)

Tutorial Sessions

Time/Location: The time/location of tutorial sessions is given in the information provided at the beginning of this document.

The tutorial time slots will be used by the instructor to hold interactive tutorial sessions that are intended to assist students in learning the course materials more effectively. Each of the tutorial sessions will be held in one of two formats:

1. face-to-face in the computer lab used by the course (with no provision for online attendance);
2. online only.

Which of these formats will be used for a particular tutorial session will depend on the specific manner in which the session is being used. The precise manner in which the tutorial sessions are to be used will be driven by the needs and preferences of the students taking the course. Some potential uses of these sessions include (but are not limited to):

- discussing aspects of the course materials that are typically more problematic for students and addressing common misunderstandings;
- answering student questions about the course materials;
- giving software demonstrations; and
- conducting student interviews regarding code submitted for programming assignments (to guard against plagiarism).

Normally, only a subset of the available tutorial time slots will be used to hold tutorial sessions. The number and frequency of tutorial sessions will depend on the needs of students in the course. Any tutorial time slots that are not used for tutorial sessions are reserved for other purposes (such as additional office hours) as needed during the term.

Students are required to attend all tutorial sessions, except for those for which the instructor explicitly indicates that attendance is optional. Students are responsible for all material covered in tutorial sessions for which the instructor has indicated attendance is mandatory. If a student is unable to attend a mandatory-attendance tutorial session due to illness or some other reason, the student is responsible for any information missed (including any course-related announcements).

For more information on tutorial sessions, see the section of the course website titled "Tutorial Sessions".

Video Lectures

The core instructional content for the course will be delivered in the form of prerecorded video lectures. Information about these video lectures can be found in the section of the course website titled "Video Lectures".

Students are responsible for all material covered in the prerecorded video lectures.

Required Texts/Materials

The following references are required for the course:

1. Lecture Slides

    - Michael D. Adams, Lecture Slides for Programming in C++ — The C++ Language, Libraries, Tools, and Other Topics (Version 2021-04-01), 2021, ISBN 978-0-9879197-4-8 (PDF).
2. Textbook (C++ Exercise Book)
    - Michael D. Adams, Exercises for Programming in C++ (Version 2021-04-01), 2021, ISBN 978-0-9879197-5-5 (PDF).

The above textbook has a corresponding website, whose URL is:

- https://www.ece.uvic.ca/~mdadams/cppbook

The textbook and lecture slides can be obtained in PDF format (free of charge) from this website.

Optional Texts/Materials

There are no optional texts/materials for this course.

Computer and Software Requirements

Each student is required to have access the following software installed on their own computer:

- Zoom. The Zoom software is required for participating in any online meetings held in the course.
- Secure Shell (SSH) Client with support for X11 tunnelling. A SSH client is needed in order to remotely login to the computers in the lab used for the course.
- X11 Server. The X11 server is used in conjunction with X11 tunnelling to facilitate remote execution of programs with graphical user interfaces.

Each student is also required to have access to a 64-bit x86 machine with hypervisor software installed (such as VirtualBox, VMware Workstation, or Gnome Boxes) in order to be able to utilize the virtual machine (VM) disk image containing a software development environment that can be used for most of the work in the course.

Course Announcements and Other Important Course Information

Important course announcements are often sent to students via email. Therefore, **students are responsible for checking their email regularly**.

Many important documents for the course are available from the course website. Some of these documents include the following:

- Online Meetings Handout (See section titled "Online Meetings")
- Course Video-Lecture Handout (See section titled "Video Lectures")
- Course Video-Lecture Information Package (See section titled "Video Lectures")
- Assignment-Assessment Handout (See section titled "Assignments")
- Assignment Handouts (See section titled "Assignments")
- Project Handout (See section titled "Project")
- Course-Materials Bug-Bounty Program Handout (See section titled "Course-Materials Bug-Bounty Program")
- Course-Materials Errata Handout (See section titled "Course-Materials Bug-Bounty Program")

Description and Objectives

Advanced programming techniques for robust efficient computing are explored in the context of the C++ programming language. These techniques are applied to solving a variety of engineering-related problems.

Topics

The topics covered in the course are as follows:

1. Software development tools
    - C++ compiler (i.e., GCC and Clang)
    - linker, build tools (i.e., CMake)
    - version control systems (i.e., Git)
    - code sanitizers (e.g., ASan, UBSan, LSan, and TSan)
    - code coverage tools (e.g., Gcov and Lcov)
    - test frameworks (e.g., Catch2)
2. Data structures and algorithms
    - time and space complexity
    - asymptotic complexity
    - abstract data types (ADTs)
    - containers, iterators
    - implementations of ADTs
    - trade offs between different implementations of ADTs
    - intrusive and nonintrusive data structures
3. Compile-time versus run-time computation
    - mechanisms for compile-time computation and their limitations
    - compile-time polymorphism
4. Error handling
    - exceptions
    - exception safety
    - exception guarantees
    - exception-safe resource management
    - resource acquisition is initialization (RAII) idiom
5. Memory management
    - memory allocation
    - memory-leak avoidance
    - smart pointers
    - move semantics
    - intrusive and nonintrusive containers
    - iterators
6. Computer arithmetic
    - finite-precision arithmetic
    - floating-point arithmetic
    - interval arithmetic
    - rational arithmetic
    - exact arithmetic
    - advantages and disadvantages of various approaches to arithmetic
7. Cache-efficient code
    - memory hierarchy and caches
    - cache-aware and cache-oblivious algorithms

8. Concurrency
    - multithreading
    - sequential consistency
    - data races
    - thread safety
    - threads, mutexes, condition variables
9. Applications
    - signal processing (e.g., fast Fourier transform, filter design)
    - numerical analysis (e.g., interval arithmetic, matrix transposition, matrix multiplication)
    - computational geometry (e.g., robust geometric predicates, Delaunay triangulations)
10. Vectorization (time permitting)
    - SIMD
    - fast Fourier transform (FFT)

Learning Outcomes

Upon completion of the course, a student should be able to:

1. identify many of the factors that can impact the performance and robustness of code
2. select data structures and algorithms that are appropriate for solving a given problem and justify the choices made
3. demonstrate a detailed understanding of a variety of concepts related to:
    - data structures
    - algorithms
    - compile-time computation
    - error handling
    - resource management
    - memory management
    - computer arithmetic
    - cache-efficient algorithms
    - concurrency
4. develop software to meet a detailed set of specifications
5. recognize the importance of thoroughly testing code
6. demonstrate an intermediate-level competency in the C++ programming language
7. demonstrate a basic competency with the C++ standard library as well as several other libraries, such as Boost and CGAL
8. make effective use of the tools available in a typical C++ software development environment, such as:
    - compiler
    - linker
    - build tools
    - version control tools
    - tools for testing and debugging
    - performance analysis tools
9. analyze the complexity of algorithms and identify the trade offs between different choices of data structures

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Assessment (SENG475 and ECE596C)

Weight (%)	Component
80	Assignments (†)

Weight (%)	Component
20	Project (‡)

Course-Materials Bug-Bounty Program Bonus (★): 2% (of course mark)

(†) Note: The submission deadlines for assignments will be posted on the course website. The assignments are to be done independently by each student. Assignments are **not equally weighted**. **The relative weighting of assignments is specified in the document titled "Assignment-Assessment Handout"** available on the course website.

(‡) Note: The submission deadlines for the project will be posted on the course website. See the handout titled "Project" for more details.

(★) Note: See the handout titled "Course-Materials Bug-Bounty Program" for more details.

Grading Appeals

If a student would like to appeal the grade assigned for a particular graded item in the course (such as a midterm exam or assignment), the student is required to do so in a timely manner. Unless an alternative deadline is explicitly stated (in writing) by the instructor, an appeal of a grade must be made within 10 calendar days of the grade being released to the student. An appeal must be made in writing. The reconsideration of a grade may result in the grade being raised, lowered, or remaining unchanged.

Plagiarism, Cheating, and Other Forms of Academic Misconduct

Plagiarism, cheating, and other forms of academic misconduct are taken very seriously by the instructor. Due to the nature of the course, the instructor is particularly sensitive to the issue of plagiarism in the context of programming assignments. The instructor and teaching assistants may, at any time, question a student regarding any aspect of their submitted work in order to ensure that this work is the student's own. Furthermore, the instructor and teaching assistants may employ plagiarism detection tools in the review and grading of some or all student work. **All incidents of plagiarism will be reported to the Department Chair.**

Plagiarism Detection Tools

Plagiarism detection software may be used to aid the instructor and/or teaching assistants in the review and grading of some or all student work.

Use of GitHub for Assignment Submission

Private Git repositories hosted by GitHub are used for the submission of assignments in the course. Only the instructor and teaching assistants for the course are given access to these repositories. If a student has any concerns about placing their assignment submissions in Git repositories that are stored on servers external to the University, they should contact the instructor as soon as possible during the first week of the term so that alternative arrangements for assignment submission can be made.

Use of Source-Code Submissions for Research Purposes

The instructor (of this course) conducts research in software-related areas. Some of this research involves the analysis of source code for various purposes, including (but not limited to):

- developing better methods for teaching programming;
- studying how programming languages and libraries are used in practice; and
- detecting bugs or bad programming practices.

Source code submitted for assignments and/or projects in the course may be used for the purposes of this research. Any such use will not publicly divulge source code or the identities of individuals whose code was used. Only the instructor and the members of his research team would have access to the source code. If a student has any concerns of their assignment and/or project submissions being used in this way, please inform the instructor so that he can exclude your work from any such research.

Supplemental Exams

There will be **no supplemental examination** for this course.

Percentage to Letter-Grade Conversion

The final grade obtained from the above marking scheme for the purpose of GPA calculation will be based on the percentage-to-grade point conversion table as listed in the current Undergraduate/Graduate Calendar. See https://www.uvic.ca/calendar/archives/202405/undergrad/#/policy/S1AAgoGuV in the Undergraduate Calendar and https://www.uvic.ca/calendar/archives/202405/grad/#/policy/B13jeiMdE in the Graduate Calendar.

General Information

Note to students: Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the Chair of the Department by email, or the Chair's Assistant to set up an appointment.

Course Lecture Notes: Unless otherwise noted, all course materials supplied to students in this course have been prepared by the instructor and are intended for use in this course only. These materials are NOT to be re-circulated digitally, whether by email or by uploading or copying to websites, or to others not enrolled in this course. Violation of this policy may in some cases constitute a breach of academic integrity as defined in the UVic Calendar.

Equality: This course aims to provide equal opportunities and access for all students to enjoy the benefits and privileges of the class and its curriculum and to meet the syllabus requirements. Reasonable and appropriate accommodation will be made available to students with documented disabilities (physical, mental, learning) in order to give them the opportunity to successfully meet the essential requirements of the course. The accommodation will not alter academic standards or learning outcomes, although the student may be allowed to demonstrate knowledge and skills in a different way. It is not necessary for you to reveal your disability and/or confidential medical information to the course instructor. If you believe that you may require accommodation, the course instructor can provide you with information about confidential resources on campus that can assist you in arranging for appropriate accommodation. Alternatively, you may want to contact

the Centre for Accessible Learning. The University of Victoria is committed to promoting, providing, and protecting a positive, and supportive and safe learning and working environment for all its members.

Academic Integrity requires commitment to the values of honesty, trust, fairness, respect, and responsibility. It is expected that students, faculty members and staff at the University of Victoria, as members of an intellectual community, will adhere to these ethical values in all activities related to learning, teaching, research and service. Any action that contravenes this standard, including misrepresentation, falsification or deception, undermines the intention and worth of scholarly work and violates the fundamental academic rights of members of our community. This policy is designed to ensure that the university's standards are upheld in a fair and transparent fashion.

Attendance: Students are expected to attend all classes in which they are enrolled. An academic unit may require a student to withdraw from a course if the student is registered in another course that occurs at the same time.

An Instructor may refuse a student admission to a lecture, laboratory, online course discussion or learning activity, tutorial or other learning activity set out in the course outline because of lateness, misconduct, inattention or failure to meet the responsibilities of the course set out in the course outline. Students who neglect their academic work may be assigned a final grade of N or debarred from final examinations.

Students who do not attend classes must not assume that they have been dropped from the course by an academic unit or an instructor. Courses that are not formally dropped will be given a failing grade, students may be required to withdraw and will be required to pay the tution fee for the course.

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Resources for Students:

- UVic Learn Anywhere
- Library resources
- Indigenous Student Services (ISS)
- Centre for Academic Communication (CAC)
- Math & Stats Assistance Centre
- Learning Strategies Program (LSP)
- Community-Engaged Learning (CEL)
- Academic Concessions
- Academic Concessions & Accomodations
- Centre for Accessible Learning (CAL)
- Academic Accommodation & Access for students with disabilities - Policy AC1205
- Student Groups & Resources
- Student Wellness
- Office of the Ombudsperson

University Statements & Policies

- Information for all students
- Attendance
- Creating a respectful, inclusive and productive learning environment (general policies)
- Accommodation of Religious Observance
- Student Conduct
- Academic Integrity
- Non-academic Student Misconduct
- Standards of Professional Behaviour (Faculty of Engineering and Computer Science)
- Academic Accommodations and Accessibility
- Accessibility
- Diversity & Inclusion Supports (Faculty of Engineering and Computer Science)
- Diversity / EDI (VPAC's Commitment

- Equity statement
- Sexualized Violence Prevention and Response
- Discrimination and Harassment Policy
- Graduate Supervision Policy