



Faculty of Engineering
COURSE OUTLINE



SENG 475 & ECE 596C— Advanced Programming Techniques for Robust Efficient Computing
Summer 2020

Specification of Dates/Times:

Unless explicitly indicated otherwise, all dates and times are specified using Pacific Daylight Time (i.e., local time in Victoria, BC, Canada). 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 web site, or Coursespaces.

Instructor:

Dr. Michael Adams
Office: EOW 311
Email: mdadams@ece.uvic.ca
Web: <https://www.ece.uvic.ca/~mdadams>

Course Web Site:

Home Page: <https://www.ece.uvic.ca/~mdadams/courses/cpp>
Username: `cpp`
Password: as announced on UVic Coursespaces at <https://coursespaces.uvic.ca/mod/forum/discuss.php?id=824226#p2252489>

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

UVic Coursespaces:

Home Page: <https://coursespaces.uvic.ca/course/view.php?id=79219>

Note: Although the course has a Coursespaces site, the primary online source of information for the course is the course web site (introduced above), not Coursespaces. Coursespaces is mainly intended to be used for providing the username and password that is required for accessing password-protected areas of the course web site.

Office Hours:

As posted on the course web site.

Lectures:

Sections: SENG 475 A01 (CRN 30780), SENG 475 A02 (CRN 30781), and ECE 596C A01 (CRN 30354)
Time/Location: Tuesdays, Wednesdays, and Fridays 11:30–12:20 in online meeting room

Note: The main lecture content is to be delivered via prerecorded videos that are available on YouTube. The first lecture time slot will be used for a live course introduction (using either Zoom or Blackboard Collaborate), while the remaining time slots are reserved for other purposes (such as office hours) as needed during the term. The URLs and passwords needed to access any online meetings held in the lecture time slots will be made available via email to the class list and/or posting in a password-protected area of the course web site.

Tutorials:

Section(s): SENG 475 B01 (CRN 30782) and ECE 596C B01 (CRN 30355)
Time/Location: Wednesdays 13:30–14:50 in online meeting room

Note: At the time of this writing, the main tutorial content is planned to be delivered via prerecorded videos that will be made available on YouTube. In the event that the some content cannot be recorded in advance, the

tutorial time slot will be used for live delivery of the material (using either Zoom or Blackboard Collaborate). Any tutorial time slots that are not used for live content delivery are reserved for other purposes (such as office hours) as needed during the term. The URLs and passwords needed to access any online meetings held in the tutorial time slots will be made available via email to the class list and/or posting in a password-protected area of the course web site.

Teaching Assistants:

Contact information for each of the teaching assistants (TAs) for the course can be found on the course web site.

Online Course Delivery:

As the course will be conducted online during this term, students will need to complete assignments/projects online. The students will require access to a computer that can be used to remotely login to the machines in the lab used for the course. Some parts of the course work may be performed directly on a student's own computer provided some additional software is installed. For more details regarding remote lab access and recommended additional software for the course, refer to the course web site.

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:

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), and test frameworks (e.g., Catch2).
2. Very accelerated review of rudimentary C++ (focusing almost exclusively on common misunderstandings about the language)
 - classes, templates, lambda expressions, C++ standard library
3. 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 non-intrusive data structures
4. Compile-time versus run-time computation
 - mechanisms for compile-time computation and their limitations, compile-time polymorphism
5. Error handling
 - exceptions, exception safety, exception guarantees, exception-safe resource management, resource acquisition is initialization (RAII) idiom
6. Memory management
 - memory allocation, memory-leak avoidance, smart pointers, move semantics, intrusive and nonintrusive containers, iterators
7. Computer arithmetic
 - finite-precision arithmetic, floating-point arithmetic, interval arithmetic, rational arithmetic, exact arithmetic, advantages and disadvantages of various approaches to arithmetic
8. Cache-efficient code
 - memory hierarchy and caches, cache-aware and cache-oblivious algorithms
9. Concurrency
 - multithreading, sequential consistency, data races, thread safety, threads, mutexes, condition variables
10. 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)

Learning Outcomes:

Upon completion of the course, students should be able to:

- identify many of the factors that can impact the performance and robustness of code

- select data structures and algorithms that are appropriate for solving a given problem and justify the choices made
- 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, and concurrency
- develop software to meet a detailed set of specifications
- recognize the importance of thoroughly testing code
- demonstrate an intermediate-level competency in the C++ programming language
- demonstrate a basic competency with the C++ standard library as well as several other libraries, such as Boost and CGAL
- make effective use of the tools available in a typical C++ software development environment, such as: a compiler, linker, and tools for building software, version control, debugging, testing, and performance analysis

Required Texts/Materials:

The following references are required for the course:

Lecture Slides (print-on-demand book; available from University Bookstore):

M. D. Adams, *Lecture Slides for Programming in C++ — The C++ Language, Libraries, Tools, and Other Topics (Version: 2020-02-29)*, University of Victoria, Victoria, BC, Canada, 2020, ISBN 978-1-55058-663-3 (paperback).

The above lecture slides can be obtained in PDF format (free of charge) from <https://www.ece.uvic.ca/~mdadams/cppbook>.

Optional Texts/Materials:

For students wanting an additional reference on C++, the following book is recommended:

B. Stroustrup, *The C++ Programming Language, Fourth Edition*, Addison-Wesley, Upper Saddle River, NJ, USA, 2013, ISBN 978-0-321-56384-2 (paperback). On Amazon: <https://www.amazon.ca/dp/0321563840>.

This book is available from the University Bookstore as well as many online book retailers (e.g., Amazon).

Video Lectures:

Video lectures are available for the main course content as well as some supplementary content. Information about these video lectures can be found on the course web site.

Other Important Documents Available from the Course Web Site:

1. Course Video-Lecture Handout (See section titled “Video Lectures”)
2. Course Video-Lecture Information Package (See section titled “Video Lectures”)
3. Assignment-Assessment Handout (See section titled “Assignments”)
4. Assignment Handouts (See section titled “Assignments”)
5. Project Handout (See section titled “Project”)
6. Supplemental Video-Lecture Handout (See section titled “Video Lectures”)
7. Textbook-Exercises Handout (See section titled “Assignments”)
8. Course-Materials Bug-Bounty Program Handout (See section titled “Course-Materials Bug-Bounty Program”)
9. Course-Materials Errata Handout (See section titled “Course-Materials Bug-Bounty Program”)

Importance of Email:

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

Lecture and Tutorial Attendance:

Students are responsible for all material covered in live and prerecorded lectures and tutorials. If a student is unable to attend a live lecture/tutorial due to illness or some other reason, the student is solely responsible for any information missed (including any course-related announcements).

Assessment:

SENG 475	ECE 596C
80% Assignments [†]	80% Assignments [†]
20% Project [§]	20% Project [§]

SENG 475 and ECE 596C: Course-Materials Bug-Bounty Program Bonus*: 2% (of course mark)

***Note:** See the handout titled “Course-Materials Bug-Bounty Program” for more details.

[†]**Note:** The submission deadlines for assignments will be posted on the course web site. The assignments are to be done independently by each student. Assignments are not necessarily equally weighted. The relative weighting of assignments will be posted on the course web site.

[§]**Note:** The submission deadlines for the project will be posted on the course web site. See the handout titled “Project” for more details.

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.**

Maintenance of Marks:

Course marks are maintained (securely) on a server external to the University. Typically, a service like Google Docs/Sheets is used. Only the instructor and markers for the course are given access to this information. If a student has any concerns about this practice, they should contact the instructor as soon as possible during the first week of the term so that alternative arrangements for the maintenance of marks can be made.

Use of GitHub for Assignment Submission:

Private Git repositories hosted by GitHub (<https://github.com>) 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.

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.

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/calendar2020-05/undergrad/index.php#/policy/S1AAgoGuV?bc=true&bcCurrent=14%20-%20Grading&bcItemType=policies> in the Undergraduate Calendar and <https://www.uvic.ca/calendar2020-05/grad/index.php#/policy/B13jeiMdE?bc=true&bcCurrent=07%20-%20Grading&bcItemType=policies> in the Graduate Calendar.

Supplemental Exams:

There will be no supplemental examination for this course.

Note to Students (Regarding Handling Concerns About Course):

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 Secretary to set up an appointment.

Course Withdrawal Deadlines:

- May 16, 2020. Withdrawal with 100% reduction of tuition fees.
- June 6, 2020. Withdrawal with 50% reduction of tuition fees.
- July 1, 2020. Last day for withdrawal (no fees returned).

Accommodation of Religious Observance:

See <https://www.uvic.ca/calendar2020-05/undergrad/index.php#/policy/rlq0gofdN?bc=true&bcCurrent=10%20-%20Accommodation%20of%20Religious%20Observance&bcItemType=policies> in the Undergraduate Calendar and <https://www.uvic.ca/calendar2020-05/grad/index.php#/policy/SkmigiMOV?bc=true&bcCurrent=17%20-%20Accommodation%20of%20Religious%20Observance&bcItemType=policies> in the Graduate Calendar.

Policy on Inclusivity and Diversity:

- Faculty of Engineering. <https://www.uvic.ca/engineering/about/equity/index.php>.
- Undergraduate Academic Calendar. <https://www.uvic.ca/calendar2020-05/undergrad/index.php#/policy/HkQ0pzdAN>.
- Graduate Academic Calendar. <https://www.uvic.ca/calendar2020-05/grad/index.php#/policy/HkQ0pzdAN>.

Standards of Professional Behaviour:

You are advised to read the Faculty of Engineering document *Standards for Professional Behaviour*, which contains important information regarding conduct in courses, labs, and in the general use of facilities. See <https://www.uvic.ca/engineering/assets/docs/professional-behaviour.pdf>.

Academic Integrity:

Cheating, plagiarism and other forms of academic fraud are taken very seriously by both the University and the Department. You should consult the entry in the current Undergraduate/Graduate Calendar for the UVic policy on academic integrity. See https://www.uvic.ca/calendar2020-05/undergrad/index.php#/policy/Sk_0xsM_V?bc=true&bcCurrent=08%20-%20Policy%20on%20Academic%20Integrity&bcItemType=policies in the Undergraduate Calendar and https://www.uvic.ca/calendar2020-05/grad/index.php#/policy/BJujesM_E?bc=true&bcCurrent=02%20-%20Policy%20on%20Academic%20Integrity&bcItemType=policies in the Graduate 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 (CAL) located in the Campus Services Building. The CAL web site can be found at <https://www.uvic.ca/services/cal>. 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.

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.

Sexualized Violence Prevention and Response at UVic:

UVic takes sexualized violence seriously, and has raised the bar for what is considered acceptable behaviour. We encourage students to learn more about how the University defines sexualized violence and its overall approach by visiting <https://www.uvic.ca/svp>. If you or someone you know has been impacted by sexualized violence and needs information, advice, and/or support, please contact the Sexualized Violence Resource Office in Equity and Human Rights (EQHR). Whether or not you have been directly impacted, if you want to take part in the important prevention work taking place on campus, you can also reach out:

- Where: Sexualized Violence Resource Office in EQHR; Sedgewick C119
- Phone: 250-721-8021
- Email: svpcoordinator@uvic.ca
- Web: <https://www.uvic.ca/svp>

Office of the Ombudsperson:

The Office of the Ombudsperson is an independent and impartial resource to assist with the fair resolution of student issues. A confidential consultation can help you understand your rights and responsibilities. The Ombudsperson can also clarify information, help navigate procedures, assist with problem solving, facilitate communication, provide feedback on an appeal, investigate and make recommendations.

- Phone: 250-721-8357
- Email: ombuddy@uvic.ca
- Web: <https://uvicombudsperson.ca/>