



Faculty of Engineering
COURSE OUTLINE



SENG 475 & ECE 596C— Advanced Programming Techniques for Robust Efficient Computing
Summer 2019

University Calendar Entry for Course:

SENG 475: <https://web.uvic.ca/calendar2019-05/CDs/SENG/475.html>
ECE 596C: <https://web.uvic.ca/calendar2019-05/CDs/ECE/596C.html>

Instructor:

Dr. Michael Adams
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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 during lectures

Office Hours:

As announced during the lectures and posted on the course web site.

Lectures:

Sections: SENG 475 A01 (CRN 30761), SENG 475 A02 (CRN 30762), and ECE 596C A01 (CRN 30334)
Time/Location: Tuesdays, Wednesdays, and Fridays 11:30–12:20 in ECS 108

Tutorials:

Tutorial attendance is mandatory.

Section(s): SENG 475 B01 (CRN 30763) and ECE 596C B01 (CRN 30335)
Time/Location: Wednesdays 13:30–14:50 in ELW B238

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: 2019-02-04)*, University of Victoria, Victoria, BC, Canada, 2019, ISBN 978-1-55058-640-4 (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:

Numerous video lectures are available on topics related to the course materials. Information about this video-lecture content can be found on the course web site.

Other Important Documents Available from the Course Web Site:

1. Course-Materials Bug-Bounty Program Handout (See section titled “Course-Materials Bug-Bounty Program”)
2. Course-Materials Errata Handout (See section titled “Course-Materials Bug-Bounty Program”)
3. Video Lectures Handout (See section titled “Video Lectures”)
4. Assignment Handouts (See section titled “Assignments”)
5. Project Handout (See section titled “Project”)

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 required to attend all lectures and tutorials in the course. If a student is unable to attend a lecture/tutorial due to illness or some other reason, the student is solely responsible for any information missed (including any course-related announcements). Any student who does not attend lectures/tutorials regularly places themselves at a **very serious disadvantage and a very greatly increased risk of failure** in the course.

Assessment:

SENG 475	ECE 596C
50% Assignments [†]	50% Assignments [†]
50% Final Exam [‡]	10% Project [§]
	40% Final Exam [‡]

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. The instructor reserves the right to, 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 reserves the right to use plagiarism-detection software in the review and grading of student work. Assignments are not necessarily equally weighted. The relative weighting of assignments will be posted on the course web site.

[‡]**Note:** All exams are closed book. Calculators are not permitted in exams.

[§]**Note:** 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://web.uvic.ca/calendar2019-05/undergrad/info/regulations/grading.html> (in the Undergraduate Calendar) and <https://web.uvic.ca/calendar2019-05/grad/academic-regulations/grading.html> (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.

Accommodation of Religious Observance:

See <https://web.uvic.ca/calendar2019-05/undergrad/info/regulations/religious-observance.html> (in the Undergraduate Calendar) and <https://web.uvic.ca/calendar2019-05/grad/registration/Registration.1.17.html> (in the Graduate Calendar).

Policy on Inclusivity and Diversity:

See <https://web.uvic.ca/calendar2019-05/general/policies.html>.

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>.

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://web.uvic.ca/calendar2019-05/undergrad/info/regulations/academic-integrity.html> (in the Undergraduate Calendar) and <https://web.uvic.ca/calendar2019-05/grad/academic-regulations/academic-integrity.html> (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 located in the Campus Services Building. 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: svpcordinator@uvic.ca
- Web: <https://www.uvic.ca/svp>