PHYS/ACS 2102: Scientific Computing in C++

University of Winnipeg – Winter 2026

Course Information

Instructor:	Joe Hrzich
Email:	jo.hrzich@uwinnipeg.ca
Lectures:	Friday 2:30–5:30 PM
Classroom:	2L14
Office:	2C31
Office Hours:	By Appointment

Important Dates

Jan 9	Our First Class
Feb 15–21	Reading Week
Feb 26	Midterm
Mar 13	Withdraw Date
Apr 3	Good Friday
Apr 7	Last Class (makeup for Good Friday)
Apr 9–22	Final Exams

Course Description

Many problems arising in science are too difficult to solve analytically and require computational approaches. This course introduces fundamental C++ programming concepts specifically designed for physics and computer science students. Starting with variables and control structures, students progress through functions, arrays, strings, and scientific computing applications including numerical methods and data visualization. The course emphasizes hands-on learning through extensive code examples, practice problems, and scientific applications. Students develop practical programming skills essential for computational physics, numerical analysis, and data processing.

Overview

This course provides a comprehensive introduction to C++ programming with applications to scientific computing and computational physics. Designed for physics and computer science students with basic mathematics background, no prior programming experience is required. Beginning with fundamental programming concepts, students progress through three integrated phases:

- **Fundamentals (Weeks 1–6)** establishing core skills in variables, operators, control structures, functions, arrays, and strings
- **Scientific Applications (Weeks 8–11)** applying programming to real problems through numerical methods and data visualization, while learning memory management, structures, and object-oriented programming
- **Integration (Week 12)** exploring file operations and synthesizing concepts for scientific data analysis

Topics include: variables, data types, operators, control structures, loops, functions, arrays, strings, pointers, structures, classes, file I/O, numerical analysis techniques, and program organization.

Software: VS Code, g++ compiler, and Gnuplot.

By the end of this course, students will be able to write, compile, and debug C++ programs; apply numerical methods to scientific problems; and organize code for readability and reuse. The course balances theoretical understanding with practical application through weekly coding demonstrations, hands-on exercises, and assignments based on physics and computational science problems.

Course Material

Reference Texts

- Pitt-Francis, J., & Whiteley, J. (2017). *Guide to Scientific Computing in C++* (2nd ed.). Springer. ISBN 978-3-319-73131-0 (Available as eBook through UW Library)
- Press, W. H., Teukolsky, S. A., Vetterling, W. T., & Flannery, B. P. (2007). *Numerical Recipes: The Art of Scientific Computing* (3rd ed.). Cambridge University Press. ISBN 978-0521880688
- Stroustrup, B. (2014). *Programming: Principles and Practice Using C++* (2nd ed.). Addison-Wesley.
- Lippman, S. B., Lajoie, J., & Moo, B. E. (2012). *C++ Primer* (5th ed.). Addison-Wesley.

Online Resources

- **W3Schools:** https://www.w3schools.com/cpp/
- **Gnuplot:** http://www.gnuplot.info
- **cppreference.com:** https://en.cppreference.com/ (The definitive C++ reference)
- **cplusplus.com:** https://www.cplusplus.com/ (User-friendly tutorials and reference)
- **LearnCpp.com:** https://www.learncpp.com/ (Free, comprehensive step-by-step tutorial)

Evaluation

This course employs an interactive learning model combining instructor-led coding demonstrations with hands-on practice.This in-class work directly informs weekly assignments, with many assignment problems extending concepts practiced during class time. Examinations are designed to assess mastery of material covered in lectures and assignments: students will encounter problems similar or identical to those practiced in class. Success in this course correlates strongly with consistent attendance and active participation.

Grading Scheme

Component	Weight	Details
Assignments	20%	10 total, nearly weekly Posted/submitted via Nexus Zero if late – no exceptions
Midterm	30%	Friday, February 26, 2026 In-class, closed-book examination No cheat sheets permitted Simple calculator allowed No personal electronic devices Photo ID required
Final Exam	50%	Same criteria as Midterm

NB: If the Midterm is missed for valid reasons, that Midterm's weight will be added to the Final Exam.

Grading System

The percentage to letter grade conversion guidelines are as follows:

Letter	Percentage	Letter	Percentage
A+	90.00 – 100.00	C+	61.00 – 66.99
A	84.00 – 89.99	C	55.00 – 60.99
A-	80.00 – 83.99	D	50.00 – 54.99
B+	74.00 – 79.99	F	0.00 – 49.99
B	67.00 – 73.99		

Note: These are guidelines, wherein the final grades shall be approved by the Department Review Committee (DRC), and so are subject to change.

Academic Integrity

You are expected to take academic integrity very seriously and be mindful of your own activities and the requests/offers you may receive from others. In addition to the guidelines in the Academic Calendar (Regulations and Policies, Subsection 8a), for all assessment items in this course, the following are considered cheating, plagiarism, or academic misconduct:

- Copying from another student's work and submitting it as your own (group or collaborative work approved by the instructor is not considered cheating).
- Uploading the assignment questions on file-sharing websites (such as Chegg.com, Quizlet, ChatGPT, or any other "Help" sites) in order to receive help or solutions.
- Copying from any sources, including, but not limited to: the Internet; any AI tools, online calculators and graphing tools; assignments or tests/exams from previous years or from other courses; solutions provided by a third party (purchased or otherwise).
- Asking questions from another student or any unauthorized person during the exams and tests.
- Talking or communicating with other student(s), during the exams/tests (in-person or on Zoom), in any language, for any reason or purpose.
- Using or having in one's possession any unauthorized sources and devices during the tests and exams.
- Soliciting and obtaining solutions to the assignments, tests, and exams via any means of communication.
- Providing test or exam questions and/or solutions to another student, uploading them to a file-sharing website, or otherwise sharing them outside the course.

It is your responsibility to know the policies and guidelines, and to be aware of the academic misconduct procedures. For more information, please see the Academic Calendar, Regulations and Policies, Subsection 8a: https://uwinnipeg.ca/academics/calendar/docs/regulationsandpolicies.pdf

AI Text-generating Tools

Students must follow principles of academic integrity (e.g., honesty, respect, fairness, and responsibility) in their use of material obtained through AI text-generating tools (e.g., ChatGPT, Bing, Notion AI). Suspected misuse of AI may result in a report to the Senate Academic Standards and

Misconduct Committee. If AI tools are used, students must cite them. According to the MLA (https://style.mla.org/citing-generative-ai/), you should cite a generative AI tool whenever you paraphrase, quote, or incorporate into your own work any content that was created by it; acknowledge all functional uses of the tool in a note, your text, or another suitable location; and take care to vet the secondary sources it cites. If students are not sure whether or not they can use AI tools, they should ask their professor.

University of Winnipeg Regulations and Policies

Course Outline Changes

A permitted or necessary change in mode of delivery may require adjustments to important aspects of course outlines, like class schedule and the number, nature, and weighting of assignments and/or exams.

COVID-19

Students can find answers to updates and frequently asked questions related to COVID-19 here: https://www.uwinnipeg.ca/covid-19/index.html

Winter Term 2026

- Lectures begin on January 5
- Reading week is February 15 to 21
- Voluntary withdrawal is March 13
- Lectures end on April 3
- Evaluation period is April 9 to 22

Class Cancellation

When it is necessary to cancel a class due to exceptional circumstances, every effort will be made to inform students via UWinnipeg email.

Communication

Students have the responsibility to regularly check their University of Winnipeg email addresses to ensure timely receipt of correspondence from the University and/or their course instructors. Students are also responsible for regularly checking Nexus for announcements, notes/slides updates, assignments (downloads/uploads), etc. This will be the primary source for the dissemination of information pertaining to this course. Nexus has email alerts that can be set. Should technical difficulties arise with Nexus, communication shall default to email. Do not use the Nexus email tool, as it is not checked.

Voluntary Withdrawal

The Voluntary Withdrawal (VW) date, without academic penalty, is Wednesday, March 13, 2026. Please note that withdrawing before the voluntary withdrawal date does not necessarily result in a fee refund. A minimum of 20% of the work on which the final grade is based will be evaluated and available to the student prior to the voluntary withdrawal date. Students are encouraged to contact their instructor prior to withdrawing in case they can help in any way.

University Closures 2026

The dates the University is closed for holidays:

- February 16, 2026 (Louis Riel Day)
- April 3, 2026 (Good Friday)
- April 5, 2026 (Easter Sunday)

Religious Holy Days

Students may choose not to attend classes or write examinations on holy days of their religion, but they must notify their instructors at least two weeks in advance. Instructors will then provide opportunity for students to make up work examinations without penalty. A list of religious holidays can be found in the Undergraduate Academic Calendar: https://www.uwinnipeg.ca/academics/calendar/docs/important-notes.pdf

Regulations, Policies, and Academic Integrity

Students are encouraged to familiarize themselves with the Regulations and Policies found in the 2025–26 Academic Calendar. Particular attention should be given to subsections 8 (Student Discipline, including Academic Misconduct Policies and Procedures), 9 (Senate Appeals), and 10 (Grade Appeals). Please be mindful of the importance of maintaining academic integrity and the potential consequences of engaging in plagiarism, cheating, and other forms of academic misconduct. Even unintentional plagiarism is a form of academic misconduct.

An updated and expanded University of Winnipeg library site outlining principles of Academic Integrity can be found at: https://library.uwinnipeg.ca/use-the-library/help-with-research/academic-integrity.html

Important information is outlined in the Academic Misconduct Policy and Procedures:

- https://www.uwinnipeg.ca/policies/docs/policies/academic-misconduct-policy.pdf
- https://www.uwinnipeg.ca/policies/docs/procedures/academic-misconduct-procedures.pdf

Respectful Learning Environment

Students are expected to conduct themselves in a respectful manner on campus and in the learning environment irrespective of platform being used. Behaviour, communications, or acts that are inconsistent with a number of UW policies could be considered non-academic misconduct.

See the following policies:

- Respectful Working and Learning Environment Policy: https://www.uwinnipeg.ca/respect/respect-policy.html
- Acceptable Use of Information Technology Policy: https://www.uwinnipeg.ca/policies/docs/policies/acceptable-use-of-information-technology-policy.pdf

More detailed information is outlined in the Non-Academic Misconduct Policy and Procedures:

- https://www.uwinnipeg.ca/policies/docs/policies/student-non-academic-misconduct-policy.pdf
- https://www.uwinnipeg.ca/policies/docs/procedures/student-non-academic-misconduct-procedu
pdf

Scent Policy

In order to ensure a safe and comfortable learning environment for everyone, we kindly ask that all students refrain from wearing or using scented products while attending class.

Copyright and Intellectual Property

Course materials are the property of the instructor who developed them. Examples of such materials are course outlines, assignment descriptions, lecture notes, test questions, and presentation slides, irrespective of format. Students who upload these materials to file-sharing sites, or in any other way share these materials with others outside the class without prior permission of the instructor/presenter, are in violation of copyright law and University policy. Students must also seek prior permission of the instructor/presenter before, for example, photographing, recording, or taking screenshots of slides, presentations, lectures, and notes on the board (or computer). Students found to be in violation of an instructor's intellectual property rights could face serious consequences pursuant to the Academic Misconduct or Non-Academic Misconduct Policy; such consequences could possibly involve legal sanction under the Copyright Policy: https://copyright.uwinnipeg.ca/basics/copyright-policy.html

Research Ethics

Students conducting research interviews, focus groups, surveys, or any other method of collecting data from any person, including a family member, must obtain research ethics approval before commencing data collection. For submission requirements and deadlines, see: https://www.uwinnipeg.ca/research/ethics/human-ethics.html

Privacy

Students should be reminded of their rights in relation to the collecting of personal data by the University, especially if Zoom is being used for remote learning and testing/proctoring:

- Admissions Privacy Notice: https://www.uwinnipeg.ca/privacy/admissions-privacy-notice.html
- Zoom Privacy Notice: https://www.uwinnipeg.ca/privacy/zoom-privacy-notice.html
- Zoom Test and Exam Proctoring: https://www.uwinnipeg.ca/privacy/zoom-test-and-exam-proctorin
  html

Sexual Violence and Human Rights Advisor (SVHRA)

Students who have experienced Sexual Violence can access support from the SVHRA. The SVHRA receives disclosures and can support students with on and off-campus reporting. In collaboration with the Sexual Violence Response Team (SVRT), the SVHRA also provides fast-track referrals to Student Wellness, academic accommodations, security support, and other on and off campus supports. The SVHRA and SVRT operate within a confidential, survivor-centered, and trauma-informed framework.

Disclosures may be made in-person, email, by text, by phone, or Zoom/Teams.

- 5Ri55, 5th Floor (Rice Centre)
- 204.230.6660 – call or text (confidential line)
- svrt@uwinnipeg.ca
- https://uwinnipeg.ca/respect/sexual-violence

Accessibility Services

Students with documented disabilities, temporary or chronic medical conditions, requiring academic accommodations for tests/exams (e.g., private space) or during lectures/laboratories (e.g., note-takers) are encouraged to contact Accessibility Services at 204-786-9771 or https://www.uwinnipeg.ca/accessibility-services/ to discuss appropriate options. All information about a student's disability or medical condition remains confidential.

Land Acknowledgement

We acknowledge that we are gathered on ancestral lands, on Treaty One Territory. These lands are the heartland of the Métis people. We acknowledge that our water is sourced from Shoal Lake 40 First Nation.

https://www.uwinnipeg.ca/indigenous/land-acknowledgement.html