

Quantum Computing and Information

COMP 4114 (August 18, 2026)

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1 DELIVERY METHOD

Lectures will be held in person. Homework, assignments and other activities will be completed outside of class and submitted in Brightspace. Students are expected to be available during class times.

2 CONTACTS

- Evangelos Kranakis, Office 5366 HP,
Office hrs Tue 1-2:30 pm (via Zoom Link in Brightspace)
- Teaching Assistants (Email) See office hours in Brightspace.

– TBA

3 COURSE DESCRIPTION

Introduction to the ideas and principles of quantum computing and information. Review of mathematical foundations. Discussion of quantum theory, architecture and quantum gates. Basic algorithms in quantum computing. Theoretical computer science and computation. Applications of quantum computing to cryptography. Quantum information and error correction.

Prerequisite(s): COMP 2804.

CONTENTS OF LECTURES/IMPORTANT DATES

1. Week 01: Sep 14 **Quantum Systems, Vectors**
2. Week 02: Sep 21 **Quantum States, Hermitian Operators**
3. Week 03: Sep 28 **Axioms of QM**
4. Week 04: Oct 05 **Time & Change, Uncertainty, Light**
Oct 12: Thanksgiving Holiday

5. Week 05: Oct 19 **Entanglement, Combining Systems**
Oct 26-30: FALL BREAK
6. Week 06: Nov 02 **MidTerm Exam**
7. Week 07: Nov 09 **Classical to Quantum, Architectures and Quantum Gates**
8. Week 08: Nov 16 **Communication Principles**
9. Week 09: Nov 23 **Quantum Algorithms**
10. Week 10: Nov 30 **Testing Coins, Boolean Functions**
11. Week 11: Dec 07 **Periodicity, Search, Factoring**
12. Week 12: Dec 11 **Information, Crypto, Bell's Inequality**

NB: Three assignments to be handed out approximately on Weeks 02, 04, 08. Material covered in lectures and assignment dates may vary depending on time available. Lecture Notes (labeled LEC) in PDF will be posted in Brightspace before the lectures in a timely manner.

4 ASSESSMENT AND REQUIREMENTS

Following are evaluation details and requirements for the course.

Grading and Course Work

Type of Test	#	% Each	% Total	Where
Assignments	3	4%	12%	Homework
Mid-Term (60 min)	1	34%	34%	TBA
Final (90 min)	1	54%	54%	TBA

Quizzes and Assignments

The purpose of **Exams** is to help you review the material covered in class in a timely manner. Questions are based on everything that we covered in class up to and including the last lecture prior to this exam. You should be familiar with all the material covered from the beginning of the course. Exam questions are generally simpler than assignment questions.

The purpose of **Assignments** is to understand deeper material related to issues discussed in class. Assignments are homework based. From the day an assignment is handed out, you will have about ten days time to complete and submit them.

Additional Details

- **Academic Integrity**

1. Students are expected to uphold the values of academic integrity, which include fairness, honesty, trust, and responsibility. Examples of actions that that

compromise these values include but are not limited to plagiarism, accessing unauthorized sites for assignments or tests, unauthorized collaboration on assignments or exams, and using Generative Artificial Intelligence (GenAI) tools when course assessment instructions indicate such use is not permitted.

2. Misconduct in scholarly activity will not be tolerated and will result in consequences as outlined in Carleton University's Academic Integrity Policy.

- **Assignments**

1. All assignments are compulsory and must be uploaded to the course web site in Brightspace on the due date and time. **Submit only in pdf format and/or the programming code separately, if required** (DO NOT SUBMIT zip, wordperfect, etc.) It is preferable for the assignments to be typed. Late assignments will not be accepted. Assignments will be submitted through Brightspace's course web site. Missing assignments are worth 0%.
2. You are expected to work on your assignments consistently in a timely manner once they are released. As a result, the instructor does not grant exemptions for the assignments. Under extenuating circumstances, if you are seeking additional accommodations for your assignments (perhaps due to an ongoing medical issue, for instance), you may petition the Associate Dean's office.
3. You must always write up the solutions to assignment problems on your own based on methodologies explained and/or developed in lectures. You must acknowledge your sources in case you used library material, Generative AI, etc. Plagiarism will not be tolerated. On the first occasion, plagiarizing an assignment will result in assigning a 0 to all the students involved and continuation of this practice may have severe repercussions for the student(s) involved.
4. Avoid posting code and/or solutions of assignments online on github and other places in the cloud. Other students have found that code and plagiarized their assignments and projects. Students posting their code and/or solutions assignments online are making themselves a potential party to plagiarism.

- **Exams**

1. Make-up exams are not possible. In case you miss an exam the grade will be averaged, but to qualify you must submit (within two weeks from the date the exam was held) a detailed critical analysis (about 20 pages long typewritten) of all the topics covered for that exam and get a passing grade; this may be accompanied by an oral exam. (This includes any absences for medical reasons.) Failing to do so you get 0% grade. This rule applies to the mid-term but not the final exam.

- **Attendance**

1. Class attendance and participation is encouraged and highly recommended because additional material is being discussed and clarified in class.

2. Office hours are held by the instructor and the TAs on a regular basis and students are encouraged to make use of them.

5 USEFUL BOOKS

Your study should be based on the lecture notes (labeled LEC) and additional material provided. Although I will not follow any of the books below you can use them as a guide for supplementary material and further study. Additional material on each topic can also be found on the internet.

1. Aaronson-Quantum - Computing since Democritus, Cambridge University Press, 2013 (**Not Required**)
2. Berera-Del Debbio - Quantum Mechanics-Cambridge University Press, 2022 (**Not Required**)
3. Feynman - QED The Strange Theory of Light and Matter, Princeton University Press, 2006 (**Not Required**)
4. Feynman - Lectures On Computation, CRC Press, 2018, First Published 1996 (**Not Required**)
5. Nielsen-Chuang-Quantum Computation and Quantum Information, Cambridge University Press, 2010 (**Not Required**)
6. Susskind-Friedman-Quantum Mechanics The Theoretical Minimum, Basic Books, 2014 (**Not Required**)
7. Yanofsky-Mannucci - Quantum Computing for Computer Scientists, Cambridge University Press, 2008 (**Not Required**)
8. Vedral - Decoding Reality: The Universe as Quantum Information, Oxford University Press, 2012 (**Not Required**).
9. Vedral - Portals to a New Reality: Five Experiments to Unlock the Future of Physics, Basic Books, 2025 (**Not Required**).
10. Zeilinger, Dance of the Photons: From Einstein to Quantum Teleportation, Farrar, Straus and Giroux, Oct 12, 2010 (**Not Required**).

There is no requirement to buy any of the books above! However, if you would like to buy a single book that is worth having, then I would recommend the classic by Nielsen-Chuang-Quantum Computation and Quantum Information, Cambridge University Press, 2010 (Price:152.77 CAN \$). If you need to, you can purchase books from any commercial bookstore. Use also information available in the internet or in numerous other books.

6 Undergraduate Academic Advisor

The Undergraduate Advisor for the School of Computer Science is available in Room 5302C HP; or by email at scs.ug.advisor@cunet.carleton.ca. The undergraduate advisors can assist with information about prerequisites and preclusions, course substitutions/equivalencies,

understanding your academic audit and the remaining requirements for graduation. The undergraduate advisors will also refer students to appropriate resources such as the Science Student Success Centre, Learning Support Services and Writing Tutorial Services. SCS Computer Laboratory

SCS students can access one of the designated labs for your course. The lab schedule can be found at: <https://carleton.ca/scs/tech-support/computer-laboratories/>. All SCS computer lab and technical support information can be found at: <https://carleton.ca/scs/technical-support/>. Technical support is available in room HP5161 Monday to Friday from 9:00 until 17:00 or by emailing SCS.Tech.Support@cunet.carleton.ca.

7 University Policies

For information regarding Carleton's Academic Accommodation, Student Support Services, and University Policies see relevant links in this course's web-page in Brightspace. For information regarding Carleton's academic year, including registration and withdrawal dates, see Carleton's Academic Calendar.