

# Quantum Computing and Information

## COMP 4114 (August 15, 2024)

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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 W 1-3 pm (via Zoom Link in Brightspace)
- Teaching Assistants (Email) [Office Hours]
  - TBA
  - 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 1805 (with a minimum grade of C-), COMP 2804.

### CONTENTS OF LECTURES

- Quantum Systems;
- Quantum Experiments;
- Quantum States;
- Quantum Axioms and Principles;

- Time and Change;
- Complex Numbers; Linear Algebra;
- Classical to Quantum; Basic Quantum Theory;
- Architecture: Quantum Gates;
- Move, Copy, Teleport;
- Quantum Algorithms;
- Quantum Cryptography;
- Quantum Information;
- Error Correction;

## IMPORTANT DATES

- Four Assignments to be handed out approximately on Weeks 02, 04, 07, 09.
- Mid Term Exam (Oct 15)
- Fall Break is on Oct 21-25.
- Final Exam (TBA)

**NB:** Material covered in lectures and assignment dates may vary slightly 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	4	6%	24%	Homework
Mid-Term (60 min)	1	30%	30%	TBA
Final (90 min)	1	46%	46%	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

- **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 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. Plagiarism will not be tolerated. You must always write up the solutions to assignment problems on your own and acknowledge your sources in case you used library material. 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 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 TA 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 (**Recommended**)

If you need to, you can purchase the books either 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](mailto: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](mailto: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.