NANO*4700/MATH*4150/PHYS*4910 Course Outline

Course Title: Concepts in Quantum Computing

Prerequisite: MATH*1160 and PHYS*3230 or CHEM*3860 (or Instructor Consent)

Credit Weight: 0.5

Academic Department: Mathematics & Statistics

Campus: University of Guelph

Semester Offering: Fall 2024

Instructor Information

Instructor Name:

Instructor Email:

Office hours via Zoom:

Teaching Assistant Information

TA Name:

TA Email:

Office hours via Zoom:

Course Content and Delivery

Class Schedule and Method of Delivery:

Course Materials:

- **Course textbook (required)**: P. Kaye, R. Laflamme, M. Mosca, *"An Introduction to Quantum Computing,"* Oxford University Press, Toronto, 2007. This textbook is widely available online.
- **Lecture notes**: hand-written lecture notes will be posted on Courselink before each class.
- **Lecture videos:** Some of the class material will be posted as recorded videos on Courselink and announced in class.
- **Other course materials:** such as assignments, practice tests, and solutions will be announced in class or via group email and will be posted on Courselink. Additionally, there are many introductory quantum

computing textbooks and articles available in the Library and online, if you are interested in broadening your introduction to the subject beyond the course materials.

Calendar Description: This course introduces concepts in quantum computation and quantum information. Following an introduction to the basics of linear algebra, quantum mechanics, and computer science, presented from the viewpoint of quantum information theory, topics covered will include a selection from quantum computation, quantum algorithms, quantum error correction, quantum cryptography and quantum communication.

Course Description, Learning Outcomes and Alignment of Assessments: The intent of this course is to give an in-depth introduction to the modern topic of quantum computing, which brings togethers aspects of physics, computer science and mathematics. The emphasis of the course delivery will be on the foundational underlying mathematics of the subject, and it will include a selection of important topics and applications in quantum computing. Students will be exposed to and learn about a relatively new and interdisciplinary subject at the forefront of modern science and technological development, and at the same time students will learn aspects of higher-level mathematics and numerical literacy used in this and many other subjects. The assessments described below (including the two written assignments and two term tests) will be aligned to test for these learning outcomes.

Lecture Content: The specific lecture content will be announced in class and adjusted as needed through the semester. The course will cover the material from chapters 1 to 6 of the course textbook, and then a selection of topics from the rest of the textbook.

Attendance: Lecture notes will be posted and some of the course material will also be posted in recorded videos on Courselink. It will still be necessary to attend class, as the notes and videos will not capture the surrounding discussions on the material during class, and so you are strongly encouraged to attend class. Beyond this, if you are unable to attend class, it is your responsibility to find out what you missed from your classmates.

Email Etiquette: Although I try to respond to all email messages, please don't ask me math questions by email (instead come and see me or our TA during our online office hours listed above). Please keep your messages to the point, polite, and clearly state your question.

Course Homework and Grading Policies

Homework: The textbook has a variety of homework exercises that can be completed as we move through the course material. You are encouraged to work through these problems and review examples and theory covered in class.

Tests and Written Assignments: Tests and assignment questions are based primarily on material from examples and theory covered in class and in the homework problems.

- 25% Term Test 1: Wednesday, October 2.
- 35% Written Assignment 1: Announced in class and via email, and due Friday, October 25 at 11:59pm.
- 25% Term Test 2: Wednesday, November 20.
- 15% Written Assignment 2: Announced in class and via email, and due Tuesday, December 3 at 11:59pm.

Assignment and Test Grading and Corrections: Collaboration is allowed on the written assignments, up to a maximum of groups of 3 students, but you must write up your assignment in your own words. The TA will grade most of the assignments and tests and can be contacted via email or during office hours for corrections and answering questions about grading. If you have corrections please contact the TA to have your score adjusted. If you find errors in grading and you miss the office hours offered by the TA then email the TA to schedule an appointment. However, as our TA is only paid for a limited number of hours, IF YOU MISS THE TA OFFICE HOURS THERE IS NO GUARANTEE THAT THE TA WILL BE ABLE TO SEE YOU TO MAKE ASSIGNMENT OR TEST CORRECTIONS. CORRECTIONS CANNOT BE MADE AFTER THE END OF CLASSES. It is in your best interests to check through your assignments and tests in a timely manner with the solutions provided.

Submission and Picking up of midterm tests and assignments: Midterm tests will be handed back in class, and written assignments will be submitted and returned electronically through the Dropbox tool on Courselink – ASSIGNMENTS MUST BE SUBMITTED AS PDF'S.

Academic Consideration:

- There will be NO MAKE-UP MIDTERM EXAMS. If you miss a Midterm exam due to serious illness of yourself or a death in your immediate family, or due to personal grounds, please contact me by email ASAP explaining the reason for missing the test. You do not need to get a doctor's note. If consideration is granted I will readjust the weight of assessed material, as described in the next section. However, once you have taken an exam no accommodations can be granted (it is general University of Guelph procedure to not grant accommodations retroactively). For further details concerning Academic Consideration see https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml
- Under no circumstances will any exam be re-scheduled at a different time and/or date, with the possible exception of exams taken in SAS.

Procedure used to re-adjust the weight of assessed material: If consideration is given to miss a test (note that at most one can be missed for legitimate reasons), the percentage of missed material (25%) is divided evenly amongst the other test (12.5%) and the written assignment component of the course (12.5%). Please DO NOT ASK FOR ALTERNATE ARRANGEMENTS AS FOR REASONS OF FAIRNESS TO OTHER STUDENTS IT WILL NOT BE GRANTED.

Regulations regarding a grade-reassessment: If you believe that an error has been made in the determination of your final grade then you must write to the chair of the department (by the 10th class day of the new semester) requesting a grade re-assessment. This can lead to the grade staying the same, a grade increase, or a grade decrease. Please note that this should not be used as a means of 'trying to get a few extra marks', but for situations where you have grounds for believing that mistakes have been made in the determination of your final grade. For further information see:
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

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University Standard Statements

Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy is outlined in the Undergraduate Calendar.

Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required, however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to make a booking at least 10 business days in advance, and no later than the first business day in November, March or July as appropriate for the semester. Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

More information: www.uoguelph.ca/sas.

Accommodation of Religious Obligations

If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements.

See the Academic calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations.

Copies of Out-Of-Class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

Drop Date

Courses that are one semester long must be dropped by the end of the last day of classes; two-semester courses must be dropped by the last day of classes in the second semester. The regulations and procedures for Dropping Courses are available in the Undergraduate Calendar.

Email Communication

As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

Health and Wellbeing

The University of Guelph provides a wide range of health and wellbeing services at the Vaccarino Centre for Student Wellness. If you are concerned about your mental health and not sure where to start, connect with a Student Wellness Navigator who can help develop a plan to manage and support your mental health or check out our mental wellbeing resources. The Student Wellness team are here to help and welcome the opportunity to connect with you.

Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g., final exam or major assignment).

Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.

When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. See the Undergraduate Calendar for information on regulations and procedures for Academic Consideration.