Fall 2025 CS 593 / MA 595
Intro to Quantum Computing

Welcome to the course homepage for Fall 2025 CS 593/MA595 Intro to Quantum Computing (CS CRN: 13994, MA CRN: 27855). This webpage is our syllabus, so please read the whole thing.

- **Schedule and location:** MWF 2:30-3:20PM in Biochemistry Building (BCHM) 105
- **In-class Midterm 1 exam date:** Monday, October 6.
- **In-class Midterm 2 exam date:** Friday, November 7.
- **In-class final exam date:** TBD by registrar.
- **Course webpage:** https://www.math.purdue.edu/~esampert/IQC/
- **Detailed course calendar:** https://www.math.purdue.edu/~esampert/IQC/cal
- **Modality:** Face-to-Face
- **Gradebook, announcements, course discussion forum and homework submission are all handled via Brightspace (Purdue login required):** https://purdue.brightspace.com/d2l/home/1360201
- **Boilercast stream and recording archive:** available on Brightspace
- **Instructors:** Eric Samperton and Yuxiang Peng
- **Eric's contact info**
  - **Email:** first name followed by AT purdue.edu
  - **Office hour:** TBA in MATH 706
  - **Office phone:** 41937 (Purdue dialing plan)
- **Yuxiang's contact info**
  - **Email:** yxpeng followed by AT purdue.edu
  - **Office hour:** tba
- **TA:** Eduardo Bejar Espejo
  - **Email:** ebejares followed by the usual
  - **Office hour:** tba

Course description

An introduction to quantum computation focused primarily on foundations and algorithms. We will begin with a linear algebra review, then introduce the axioms of quantum mechanics and the usual formalization of quantum computation based on quantum circuits. The core of the course will focus on the most common primitives in quantum algorithms, including Grover search, quantum Fourier transforms, phase estimation, and Trotterization. A highlight will be Shor's factoring algorithm, but along the way we will see some of the more curious aspects of quantum information facilitated by quantum entanglement, such as Grover search, quantum teleportation, superdense coding, and Bell violations. The last third of the course will develop Hamiltonian simulation and complexity, as well as some other more advanced topics.

Prerequisites

First- and second-year graduate students in CS, physics or mathematics are our intended audience, but some advanced undergrads should also be comfortable in the class. Familiarity with at least one of the following at the level of a first year graduate student will be expected of all students: CS theory, quantum mechanics, linear algebra. Please inquire with Eric if you have any questions about whether this course is appropriate for you.

Learning outcomes

After completing this course, successful students should be able to do the following:

1. Formulate the axioms of quantum mechanics, and all relevant mathematical definitions.
2. Explain what it means for a quantum computer to solve a problem, as well as what it means for a quantum computer to *efficiently* solve a problem.
3. Appreciate the essential role that measurement plays in quantum computation.
4. Describe several examples of impressive things that quantum computers can do when compared to classical computers.
5. Discern some of the limitations of quantum computers, both theoretical and practical.
6. Code quantum algorithms using the Qiskit language.

Reading

Required textbook (unfortunately not available online through Purdue library, but it's a classic book that is probably worth owning):

- *Quantum computation and quantum information* by Nielsen, Chuang

Further recommended reading, with links to free online access:

- Quantum computing science Democritus by Aaronson
- Classical and quantum computation by Kitaev, Shen, Vyalyi
- A concise introduction to quantum probability, quantum mechanics, and quantum computation, by Kuperberg
- The Theory of Quantum Information>, by Watrous

Assignments & grading

Grades will be based on Theoretical Homework (32%), Coding Homework (18%), two in-class midterm exam (12.5% each), and an in-class final exam (25%).

- **Theoretical Homework (THW):** it will be assigned once every week or two, for a total of 9 assignments or so. You should expect the assignments to be longer and more frequent at the beginning of the course as we work through essential foundational material. THW will be posted on the detailed course calendar page. We will strive to make THW available on Wednesdays, and due the following Wednesday. You will turn it in via Brightspace. Each assignment will be worth 4 points, with a combined 32 total points possible (so it is possible, for example, to skip one assignment entirely yet still earn the maximum number of points.)
- **Coding Homework (CHW):** there will be 3 CHW assignments, each worth 10 points. You will get at least 2 weeks for each assignment. The purpose of these assignments is to make you familiar with the Qiskit programming language. More details TBA.
- **In-class midterm exams:** they will happen during the usual class, on Monday, October 6, and Friday, November 7. You can expect them both to be "pen and paper" exams, with roughly 3 long response questions on them.
- **In-class final exam:** the schedule has yet to be determined by the Purdue registrar. Details TBD.

Individual assignments will not receive letter grades or curves. Final course letter grades will be computed using a scale that is at least as generous as the usual 10 point scale.

▾ Click to see usual 10 point grading scale

>=97%	A+
93%-97%	A
90%-92.99%	A-
87%-89.99%	B+
83%-86.99%	B
80%-82.99%	B-
77%-79.99%	C+
73%-76.99%	C
70%-72.99%	C-
67%-69.99%	D+

63%-66.99%	D
60%-62.99%	D-
<60%	F

Please try to resolve any grading issues within one week after the return of the graded work. Enrollment in this course is quite high, and so we do not expect to be able to be too generous with homework extensions. *If you ask ahead of time*, then we should be able to give a 2 day extension, no questions asked; however, if you ask for an extension too many times, then we reserve the right to refuse unless you have a good explanation of your need for one.

Attendance

Regular attendance is expected but not mandatory, except on the days of the exams. If you can not regularly attend class in-person, then you should probably not enroll. On the other hand, if you are feeling unwell with something contagious, please consider using the Boilercast recordings.

Academic integrity (click for more info on each topic)

▾ **Homework.**

When it comes to solving homework problems, an information source is generally allowed if it is legal, free, public, and passive. *Legal* means that your access to the information does not involve the violation of any law (e.g. copyright law); *free* means you do not pay for the information (the required textbook is the only exception to this policy); *public* means the information is available to any Purdue student without having to create an account or register for a service that is not provided by Purdue; and *passive* means that the information is prerecorded and not created in response to your input.

The use of almost any calculator or computer program is disallowed a priori, as it fails to meet the "passive" requirement. However, common programs such as a TI-87 calculator, MatLab or GeoGebra that do not use AI are exempted from this. If you are unsure if a specific computer program is allowed, please ask Professor Samperton or Professor Peng.

Similarly, the use of other people is generally disallowed when it comes to getting help on homework problems, since asking another person a question fails to generate an answer in the form of passive information. However, any individual that is officially associated with this course (that is, your instructor, your classmates or your TA) is exempt from this.

In fact, *you are encouraged to collaborate with your classmates when solving homework problems*, and you are generally welcome to use any textbooks, research papers, or other notes to solve homework problems, as long as the sources are legal, free, public and passive as explained above. However, you must use your own words and understanding when writing up your solutions (you can not just copy or quote), and you must cite any sources you use.

Examples of allowed resources: textbooks from the Purdue library; answers to questions that you yourself did not post on public online discussion forums such as CS Stack Exchange; publicly available YouTube videos. Of course, the use of any such source must be accompanied with a proper citation.

Examples of disallowed resources: typing a homework question directly into an online search engine or artificial intelligence program such as ChatGPT or WolframAlpha; posting a homework question on a forum such as StackOverflow or Chegg.

Violation of these expectations will typically result in a 0 for the offending assignment and the filing of an Academic Dishonesty Report with the Office of Student Rights and Responsibilities.

Finally, the use of "homework help services" (that is, professional cheating companies) such as Chegg, CourseHero, etc, is disallowed for help on any homework problems unless I give you my explicit permission. Any un-authorized use we discover will result in an F for the course and the filing of an Academic Dishonesty Report.

▾ **General studying.**

All of the above also applies when it comes to studying the recommended practice problems for the exams. However, for other studying, you are free to use whatever technologies or people you want as long as you do not violate the other policies. For example, if you want to use an AI to create a summary of your textbook and self-written homework solutions, then have at it. Of course, you should also feel free to talk to whomever you want about quantum computing generally (just not the specifics of assigned problems if they are not in our class).

▾ **Exams.**

The in-class midterm and final exams are of course not to be done in collaboration with anyone or using any reasons other than your brain.

Privacy

All of the regularly scheduled course meetings will be recorded and made available for viewing by your classmates on Brightspace and the Purdue Mediaspace. If you have privacy concerns, please let us know.

Accessibility

Purdue University strives to make learning experiences accessible to all participants. If you anticipate or experience physical or academic barriers based on disability, you are encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247, as soon as possible.

If the Disability Resource Center (DRC) has determined reasonable accommodations that you would like to utilize in this class, you must send your Course Accommodation Letter to the instructor. Instructions on sharing your Course Accommodation Letter can be found by visiting:

https://www.purdue.edu/drc/students/course-accommodation-letter.php. Additionally, you are strongly encouraged to contact the instructor as soon as possible to discuss implementation of your accommodations.

Non-discrimination statement

A hyperlink to Purdue's full Nondiscrimination Policy Statement is included in the Academic Resources table on your Brightspace homepage.

Mental health statement

Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS offices in West Lafayette or Indianapolis.

Other boilerplate

In extraordinary circumstances, this syllabus may be amended or changed as necessary in order to facilitate fair learning and grading. Any changes will be announced well in advance both in class and via Brightspace announcements.