**Computer Science 434x/534x**

**Quantum Information and Complexity**

**Fall, 2021**

**Instructor**

Jack Lutz

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Office Hours:

**Prerequisites**

Com S 331 or Phys 422 or Phys 522; Math 207 or 317.

**Course Objectives**

By the end of the course students should have a *working knowledge* (ability to solve problems with rigorously justified reasoning) of quantum information and complexity, including the following.

1. Ability to analyze entangled quantum systems.  
2. Ability to solve problems in quantum information theory.  
3. Ability to design and analyze quantum circuits.  
4. Ability to reason about quantum computational complexity.

Graduate students should also demonstrate knowledge of the research frontier of one of the course topics.

**Lectures**

The primary resource for course material is the course lectures. You are encouraged to take careful notes.

Recording or photography of lectures without written permission is prohibited and constitutes academic misconduct.

**Grading**

**434x.** Three components, weighted as follows, will determine grades.

Homework 40%

Exam 1 30%

Exam 2 30%

**534x.** Four components, weighted as follows, will determine grades.

Homework 30%

Exam 1 20%

Exam 2 20%

Term paper 30%

**Homework Guidelines**

When doing homework, you are allowed to collaborate with others and consult books, journals, notes, etc.

(*excluding* Chegg and other websites devoted to providing homework solutions for specific courses), subject to the following restrictions.

1. You should write the final solutions alone, without the aid of such sources, and understand them fully.
2. Your solutions should include written acknowledgment of books, articles, and individuals who have helped you achieve them. (It is promised that such acknowledgment will *never* adversely affect any student's grade.)

Part of knowing something is knowing whether you know it. For each problem in this course, *on homework and exams*, blank space or a clear statement that you do not know how to solve it will receive 30% credit. If you do submit a solution, you will receive 0% - 100% credit, per the usual criteria for awarding partial credit when answers are partially correct.

When proofs are required, try to make them both clear and rigorous. Even when proofs are not required, you should justify your answers and explain your work.

*Nullius in verba*.

(*Nothing upon another's word*.)

Motto of the Royal Society

*In questions of science the authority of a thousand is not worth the humble reasoning of a single individual*.

        Galileo Galilei

**Academic Integrity**

From the university catalog: “Academic dishonesty occurs when a student uses or attempts to use unauthorized information in the taking of an exam or assignment; or submits as their own work themes, reports, drawings, laboratory notes, or other products prepared by another person; or knowingly assists another student in such acts; or plagiarism. Such behavior is abhorrent to the university and students found responsible for academic dishonesty face expulsion, suspension, conduct probation, or reprimand. Instances of academic dishonesty ultimately affect all students and the entire university community by degrading the value of diplomas when some are obtained dishonestly, and by lowering the grades of students working honestly.”

Computer science has become a vital component of human welfare, and it must maintain the highest standards of integrity and ethics. Students found responsible for *any* instance of academic dishonesty in this course receive an F grade for the entire course and are subject to any additional penalties that may be imposed by the office of the Dean of Students. Clear discussions of academic misconduct and its adjudication appear on the web pages of the Dean of Students office.

**Iowa State University Syllabus Statements**

**Academic Integrity**

Academic Integrity, based on the values of honesty, trust, fairness, respect, and responsibility, is a fundamental principle of scholarship in higher education. Iowa State’s Academic and Research Misconduct Policy prohibits: plagiarism (using another person’s writing or copying any work without proper citation); falsification; unauthorized collaboration during a test or on an assignment or substitution for another student to take an exam, course or test; and other forms of academic dishonesty. If you are to benefit from this class and be properly evaluated for your contributions, it is important for you to be familiar with and follow Iowa [State’s Academic Dishonesty and Research Misconduct policies](http://www.policy.iastate.edu/policy/SDR#4.2.1). Students are also encouraged to review these [Student Resources](https://www.studentconduct.dso.iastate.edu/academic-misconduct-new). Work that violates this policy will not be tolerated. Students who are found responsible for a violation of the Academic Misconduct Policy will have both a university process sanction and an academic outcome that could include a failing grade on the assignment or exam, or a failing grade for the course.

**Accessibility**

Iowa State University is committed to assuring that all educational activities are free from discrimination and harassment based on disability status. Students requesting accommodations for a documented disability are required to work directly with staff in Student Accessibility Services (SAS) to establish eligibility and learn about related processes before accommodations will be identified. After eligibility is established, SAS staff will create and issue a Notification Letter for each course listing approved reasonable accommodations. This document will be made available to the student and instructor either electronically or in hard-copy every semester. Students and instructors are encouraged to review contents of the Notification Letters as early in the semester as possible to identify a specific, timely plan to deliver/receive the indicated accommodations. Reasonable accommodations are not retroactive in nature and are not intended to be an unfair advantage. Additional information or assistance is available online at [www.sas.dso.iastate.edu](http://www.sas.dso.iastate.edu), by contacting SAS staff by email at accessibility@iastate.edu, or by calling 515-294- 7220. Student Accessibility Services is a unit in the Dean of Students Office located at 1076 Student Services Building.

**Discrimination and Harassment**

Iowa State University does not discriminate on the basis of race, color, age, ethnicity, religion, national origin, pregnancy, sexual orientation, gender identity, genetic information, sex, marital status, disability, or status as a U.S. Veteran. Inquiries regarding non-discrimination policies may be directed to Office of Equal Opportunity, 3410 Beardshear Hall, 515 Morrill Road, Ames, Iowa 50011, Tel. 515-294-7612, Hotline 515-294-1222, email [eooffice@iastate.edu](mailto:eooffice@iastate.edu).

**Free Expression**

Iowa State University supports and upholds the First Amendment protection of [freedom of speech](https://www.studentconduct.dso.iastate.edu/know-the-code-resources/resources-for-students/harassment-and-free-speech/free-speech) and the principle of [academic freedom](https://www.iowaregents.edu/plans-and-policies/board-policy-manual/39-academic-freedom) in order to foster a learning environment where open inquiry and the vigorous debate of a diversity of ideas are encouraged. Students will not be penalized for the content or viewpoints of their speech as long as student expression in a class context is germane to the subject matter of the class and conveyed in an appropriate manner.

**Prep Week**

This class follows the Iowa State University Prep Week policy, as noted in the ISU Policy Library and section 10.6.4 of the Faculty Handbook. Visit the [ISU Policy Library website](http://www.policy.iastate.edu/) for policy wording.

**Religious Accommodations**

Iowa State University welcomes diversity of religious beliefs and practices, recognizing the contributions differing experiences and viewpoints can bring to the community. There may be times when an academic requirement conflicts with religious observances and practices. If that happens, students may request reasonable accommodation for religious practices. In all cases, you must put your request in writing. The instructor will review the situation in an effort to provide a reasonable accommodation when possible to do so without fundamentally altering a course. For students, you should first discuss the conflict and your requested accommodation with your professor at the earliest possible time. You or your instructor may also seek assistance from the [Dean of Students Office](http://dso.iastate.edu) at 515-294-1020 or [the Office of Equal Opportunity](https://www.eoc.iastate.edu) at 515-294-7612.

**Contact Information for Academic Issues**

If you are experiencing, or have experienced, a problem with any of the above issues, email [academicissues@iastate.edu](mailto:academicissues@iastate.edu)

**COVID-19 health and safety requirements (likely to be updated before course begins)**

Students are responsible for abiding by the university’s [COVID-19 health and safety expectations](https://bit.ly/guidance-covid-19). All students attending this class in-person are required to follow university policy regarding health, safety, and face coverings:

* wear a cloth face covering in all university classrooms, laboratories, studios, and other in-person instructional settings and learning spaces. Cloth face coverings are additionally required to be worn indoors in all university buildings, and outdoors when other people are or may be present where physical distancing of at least 6 feet from others is not possible. Students with a documented health or medical condition that prevents them from wearing a cloth face covering should consult with [Student Accessibility Services](https://sas.dso.iastate.edu) in the Dean of Students Office.
* ensure that the cloth face covering completely covers the nose and mouth and fits snugly against the side of the face.
* practice physical distancing to the extent possible.
* assist in maintaining a clean and sanitary environment.
* not attend class if you are sick or experiencing symptoms of COVID-19.
* not attend class if you have been told to self-isolate or quarantine by a health official.
* follow the instructor’s guidance with respect to these requirements. Failure to comply constitutes disruptive classroom conduct. Faculty and teaching assistants have the authority to deny a non-compliant student entry into a classroom, laboratory, studio, conference room, office, or other learning space.

These requirements extend outside of scheduled class time, including coursework in laboratories, studios, and other learning spaces, and to field trips. These requirements may be revised by the university at any time during the semester.

In accordance with university policy, instructors may use a face shield while they are teaching as long as they are able to maintain 8 feet of physical distance between themselves and students during the entire instructional period. Some form of face covering must be worn at all times in learning spaces regardless of the amount of physical distancing.

Faculty may refer matters of non-compliance to the Dean of Students Office for disciplinary action, which can include restrictions on access to, or use of, university facilities; removal from university housing; required transition to remote-only instruction; involuntary disenrollment from one or more in-person courses; and other such measures as necessary to promote the health and safety of campus.

It is important for students to recognize their responsibility in promoting the health and safety of the Iowa State University community, through actions both on- and off-campus. The university’s faculty asks that you personally demonstrate a commitment to our [Cyclones Care campaign](https://www.care.iastate.edu/). Iowa State University’s faculty support the Cyclones Care campaign and ask you personally to demonstrate a commitment to our campaign. Your dedication and contribution to the campaign will also protect your family, classmates, and friends, as well as their friends and families. Our best opportunity for a successful semester with in-person learning and extramural activities requires all of us to collaborate and fully participate in the Cyclones Care campaign.