

PHYS 7810

Quantum Error Correction

Fall 2026

OVERVIEW

Lectures: Tu/Th 2:00-3:15 PM: Duane G1B31

Instructor: Andrew Lucas (andrew.j.lucas@colorado.edu); Duane D137.
Office hours: Tu 1-2 PM

Canvas: <https://canvas.colorado.edu/courses/144469>

Books and References: N/A

Recommended prerequisites: PHYS 4230 and PHYS 5260, or equivalent.

COURSE THEMES

- ▶ **quantum codes** protect logical qubits by encoding them redundantly in entangled states of multiple physical qubits; **Knill-Laflamme conditions** are necessary and sufficient for error correction
- ▶ the Ising model is a classical **parity-check code**
- ▶ **surface codes**, inspired by high energy physics, are a leading candidate for experimental QEC; they represent the simplest example of a quantum phase of matter with **topological order**
- ▶ detecting and correcting errors in quantum codes is itself a noisy process, requiring **fault tolerance**
- ▶ **low-density parity-check (LDPC) codes** are natural candidates for fault-tolerant computation
- ▶ a primary challenge for realizing scalable quantum computation is obtaining a **universal gate set** in a fault-tolerant manner
- ▶ **bosonic codes** are an alternative to qubit codes that are desirable for certain experimental platforms, e.g. superconducting circuits

COURSE POLICIES

- ▶ All documents are found by clicking appropriate links on the homepage of Canvas.
- ▶ Lectures are held in-person. There will be no recording of in-person lectures. Lecture notes will be posted before each lecture.
- ▶ If the instructor is traveling, lectures will be pre-recorded via Zoom.
- ▶ You are allowed to collaborate with and consult humans and AI on take-home assignments. It is considered cheating, as opposed to collaboration, when you turn in something that you did not write in your own words, and/or that you could not explain independently, without acknowledging the steps that you are borrowing from elsewhere.
- ▶ Standard university policies regarding appropriate conduct on campus also apply to this class, and can be found in writing on the course website.

GRADES

- ▶ **100% homework:** Homework can be found on the course website, and on Canvas. Homework is **due at or before 11:59 PM on the due date**. Solutions will be posted on Canvas on the third day after the due date. You must upload every homework assignment electronically into Canvas. We anticipate 6 homework assignments in this class.

Late/drop policies: Every student starts with 2 extensions, which can be tracked in the ungraded “Extensions Left” assignment in Canvas. Extensions can be used as follows:

- ▶ To receive a no penalty 48 hour extension on the due date for a homework assignment.
- ▶ To drop a homework which was not turned in, *or* a homework which was turned in late but is (at the end of the class) below your average homework score.
- ▶ To drop a low score. (Remaining extensions will be used this way at the end of the class.)

Assuming no apocalypse, I will not give more extensions or push back deadlines. I apply these rules automatically, in the order above, so you do not need to ask for permission to use these extensions.

Grade cutoffs will be chosen to avoid students being just below a cutoff. The cutoff for A-range grades will be $\leq 80\%$.

Each homework will be graded out of 100 points. The numbers besides each (sub)problem denote the number of points it is worth. If a (sub)problem is worth $5k$ points, you’ll receive 0, k , $2k$, $3k$, $4k$ or $5k$ points according to a holistic grading scheme. Points are deducted for conceptual/“big picture” issues, not minor algebra/calculational mistakes (as long as they did not lead to an absurd answer that you should have noticed was wrong!). If you quote something without sufficient explanation or justification, even if it is correct, this may lead to points being deducted. The number of points earnable on an assignment may exceed 100 points, in which case you can earn “extra credit” by completing the entire assignment.

Consequences for cheating will, at minimum, include receiving a 0 on the assignment(s) in question and a university-required referral to the Honor Code board. Further consequences may occur, at the discretion of the course instructors and graders.