# Ph/CS 219B: Quantum Computation
## (Winter 2023)

**Class meetings:** Monday and Wednesday 2:30pm–4:00pm 103 Downs.

**Instructor:**

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Office hours: Monday 4:15pm–5:15pm.

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## Tentative list of topics

**Quantum error-correcting codes:** Error models. Classical linear codes (Hamming, Reed-Muller). Quantum error correction conditions. Shor's 9-qubit code; CSS codes; Steane's 7-qubit code. Symplectic (stabilizer) codes; the 5-qubit code. Upper and lower bounds.

**Topologically protected qubits:** Toric code. Anyons. Surface codes with boundaries. Majorana modes.

**Fault-tolerant computation:** Logical gates. Fault-tolerant measurement of error syndrome. Error correction threshold. Distillation of magic ancillas.

**Continuous variables (GKP) codes.**

**References:**

Textbooks:
- John Preskill, *Lecture notes*
- A. Kitaev, M. Vyalyi, and A. Shen, *Classical and Quantum computation*

Other recommended books:
- Michael Nielsen and Isaac Chuang, *Quantum Computation and Quantum Information*

References to some original papers will be provided during the course.

**Grading and homework policy:** The course is pass-fail, based on homework. By default, the passing threshold is 60% of points (excluding extra credit problems). If many students find the homework problems too hard, the threshold may be lowered.

There will be 4 problem sets. You may have two automatic 4-day extensions. Additional extensions may be granted for legitimate reasons; please ask in advance.

Please submit your homework in the `pdf` format. You can either type your solutions in LaTeX or write and scan them. Or maybe you will prefer to type the text and include scanned figures. Please indicate on the first page of your solution if you are using an extension. There is a 25% penalty for missing a deadline. Late homework is generally accepted up to one week after the original due date. (Exceptions may be granted due to special circumstances.)

**Collaboration and academic integrity:** You may discuss homework problems with each other while you are trying to solve them, but you must write up your solutions on your own. Do not share complete solutions. Please mention your collaboration and give proper credit to the people whose ideas you are using. Most problems are not new. If you find a solution to an exact same problem on the web, please don't read it! But it's OK to read a research paper where the problem was solved in a slightly different form. In this case, please don't forget to cite the source.

**Security and privacy:** Only enrolled students and those given permission to audit have access to course materials. The Zoom passcode is included in the Canvas link (to be used for some lectures and office hours if the need arises.) Please do not share any course-related materials or web links outside the class.