

ESE 512 Syllabus  
Spring 2020

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Learning Objective: To give students a broad introduction to quantum computing and information system including the underlying math and quantum circuits.

This is a **hybrid course** that is part online and part in class on Mondays from 4 to 5 PM. The **mandatory on campus midterm** is **Monday, March 30th** from 4 PM to 5:20 PM in the regular classroom. Please put date in your schedule.

Texts:

- (A) **Required:** Quantum Computing for Everyone by Chris Bernhardt, MIT Press, 2019. A very accessible book for the subject. Pretty inexpensive too.
- (B) **Optional:** Chapter 1 of Quantum Computation and Quantum Information by Michael Nielsen and Isaac Chuang, Cambridge University Press, 2000. At a higher level than the Bernhardt book but chapter 1 has similar coverage.

Week 1 (Week of Jan. 27<sup>th</sup>): Introduction (see Chuang videos Overview I, II and III).

Week 2 (Feb. 3): Chapter 2: Linear Algebra (use Bernhardt book and videos from this point)

Week 3 (Feb. 10): Chapter 2: Linear Algebra (continued). **Essay 1 due Feb. 10 (on some aspect of Quantum History).**

Week 4 (Feb. 17): Chapter 4: Entanglement.

Week 5 (Feb. 24): Chapter 4: Entanglement (continued).

Week 6 (March 2): Classical Gates and Circuits. **Essay 2 due March 2 (on some aspect of entanglement).**

Week 7 (March 9): Quantum Gates and Circuits.

Spring break (March 16-No class).

Week 8 (March 23): Quantum Gates and Circuits (continued)

Week 9 (March 30): **Midterm (in class) March 30<sup>th</sup>.**

Week 10 (April 6): Quantum Gates and Circuits (continued)

Week 11 (April 13): Quantum Algorithms. **Essay 3 due April 13<sup>th</sup> (on some aspect of quantum gates and circuits).**

Week 12 (April 20): Quantum Algorithms (continued). **Portfolio due April 20<sup>th</sup> (see below).**

Week 13: (April 27): IBM Architecture (and SWAP gates) and Quantum Computer Hardware. **Essay 4 due April 27<sup>th</sup> (on some aspect of quantum algorithms).**

Week 14 (May 4): Implementation (Ion Traps). **Self-final due May 4<sup>th</sup> (see below).**

Grading:

Midterm: 25%, Essays (four assignments at 6% each): 24%, Portfolio: 24%, Self-Final: 25% Total is 98 points.

Essays: For some topics specified by the professor you will write 500 words on some aspect of the chapter coverage that you find interesting or on a chapter related paper. Additional sources can be used but are not necessary. Please cite source(s) (any citation style is fine). A good place to find articles is Google Scholar. See syllabus for due dates.

Portfolio:

This is a collection of four original problems and solutions you submit involving **quantum related problems**. They should be math and/or circuit based. It is marked for neatness, coverage, correctness and to some extent for originality. Portfolio's can be hand written. Excessively complex problems should be avoided (it makes me think they were copied from somewhere). See syllabus for due date.

Self Final Exam:

Students create their own exam, consisting of qualitative problems. Create five questions and answers. Grading is based on choice of questions and reasonableness of answers. Questions should make one think a bit. See syllabus for due date.