

# PHYS 2601X – An Introduction to Quantum Computation and Information Spring 2024

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**Class information:**

**Call number:** 12205

**Class Location:** Gordy Hall 109

**Class times:** T-Th 9:30-10:50 AM

**Credit Hours:** 3

**Office Hours:** TBD.

## **Description**

The course will provide an overview of the basic principles of quantum computing and quantum information science.

## **Required textbooks.**

- *Quantum Computing: An Applied Approach*  
J. D. Hidary. Springer, 2<sup>nd</sup> Ed. 2021  
<https://github.com/jackhidary/quantumcomputingbook>
- *An Undergraduate Course on Quantum Computing*  
P. Young.  
[https://young.physics.ucsc.edu/150/phys\\_150\\_all.pdf](https://young.physics.ucsc.edu/150/phys_150_all.pdf)

## **Recommended other materials.**

- *Qiskit Textbook*.  
Available online at: <https://qiskit.org/textbook/preface.html>
- *Quantum Computation and Quantum Information*  
M. A. Nielsen and I. I. Chuang. 10<sup>th</sup> Anniversary Edition. 2010. Cambridge University Press.

## **Course outline**

During the semester, we will cover the following (tentative) schedule:

Week 1: Superposition, entanglement, and reversibility – basic quantum concepts. Ch. 1 and 2.

Week 2-3: Mathematical tools for quantum computing – aka linear algebra. Ch. 11. (Toolkit)

Week 4-6: Qubits, operators, and measurement. Ch. 3.

Week 7: Basic notions of complexity theory. Ch. 4.

Week 8: Project assignment.

Week 9: Spring break.

Week 10: How do you build a quantum computer? Different physical realizations. Ch. 5.

Week 11-12: Review of different computer libraries. Qiskit, Cirq, ... Ch. 6.

Week 12-13: Teleportation, Bell's inequality. Ch. 7.

Week 13-15: Fundamental quantum algorithms. Ch. 8.

## **List of other recommended references (printed and online)**

- Quantum Computer Science. An introduction. N. D. Mermin. Cambridge Univ. Press. (2007).
- Quantum Processes, Systems, and Information. B. Schumacher and M. Westmoreland. Cambridge Univ. Press. (2010).
- Lecture notes by John Preskill (available at <http://theory.caltech.edu/~preskill/ph219/index.html#lecture>)
- Quantum Country: A free introduction to quantum computing and quantum mechanics. A. Matuschak and M. Nielsen. <https://quantum.country>
- Feynman Lectures on Computation. R. P. Feynman. Addison-Wesley. (1996)

Some suggested references that may come in handy as we work through different topics are:

- *Quantum Mechanics for Tomorrow's Engineers*. J. Kono (Cambridge Univ. Press)
- *Introduction to Quantum Mechanics. Second Edition*. D. Griffiths (Pearson)
- *Introduction to Linear Algebra. Fifth Edition*. G. Strand (Wellesley Cambridge Press)

### **Homework and in-class participation policy**

We follow the philosophy 'you learn by doing': therefore, we consider assignments and active class participation essential parts of your learning process. Homework sets will be handed out typically on a biweekly schedule and will be due two weeks later in class. We will give partial credit for attempted solutions to incomplete problems. For full credit, solutions to problems should be legible and show details of your work. We strongly encourage you to discuss homework problems and lectures with your peers but remember to present your solutions. **Late homework will not be accepted.**

### **Midterm and Final exams:**

There will be two midterms and one final examination (see below).

Midterms: there will be two in-class midterm exams. These one-hour examinations are scheduled at 11:50 a.m. on Monday, February 5<sup>th</sup>, and Friday, March 1<sup>st</sup>.

Final: The final exam will consist of in-class presentations to be delivered during the last week of classes and extended to Wednesday, May 1<sup>st</sup>, at 10:10 a.m. as needed.

### **Project Assignment**

Midsemester, you will be required to start working on a project draft based on a topic chosen from a list provided in class. The draft will consist of a two-page single-spaced paper and should include a bibliography and tables/graphics (on a separate page) as needed. The project may include a code you develop for a particular problem, or a review of a topic not covered in the course.

This assignment will be due on Monday March 18<sup>th</sup>, during class and it will be graded and returned with suggestions/comments.

At the end of the semester, you will be required to complete the paper and give a 10' in-class presentation during the last week of classes.

### **Grading:**

The final grade will be tentatively based on the following:

|                                   |     |
|-----------------------------------|-----|
| Homework + in-class participation | 30% |
| Project assignment                | 10% |
| Midterms (2 x 15% each)           | 30% |
| Final project and presentation    | 30% |

**Academic misconduct policy**

We are required to remind you that academic misconduct is a Code A violation of the Ohio University Code of Student Conduct. If you are found to be involved in academic misconduct regarding this course, you will receive F on the pertinent work and possibly for the entire course and/or a referral to the Director of Judicials. Procedures for judicial actions will be invoked as described in the Student and Faculty Handbooks. Examples of academic misconduct include *plagiarism* (copying other person’s work and or results without proper acknowledgment) and *copying during exams*.

**Diversity and Inclusion Statement**

Ohio University is committed to supporting inclusion of diverse people and populations within and beyond our campus community. It is crucial that we commit to learning from one another in our classroom and provide an environment where if something is occurring that prevents us from being able to succeed, we talk about and address it. Discrimination has a negative impact on one’s learning, and my hope is that we can create a classroom environment in which all are able to learn and succeed.

**Special Accommodations**

If you need special accommodations, we urge you to contact [Accessibility Services](#). They provide us with the required authorizations to incorporate any needed change during the semester. Analogously, let us know if homework deadlines and exams date present conflicts with religious beliefs and practices. We will work together to find alternative solutions.

**Pronouns and Names**

It is our desire that we, and your fellow students, will honor the name and pronoun that you would like used when addressing you. We will create space within the classroom for you to notify us of your name and pronoun, but you may also contact any of us privately. We also understand that this may change throughout the semester, as students become more comfortable or as one’s experience changes.