

Course Syllabus

EEL4930/EEL 5934: Introduction to Quantum Computing

Class Periods: MWF, Period 5 (11:45-12:35), CHE0316

Academic Term: Fall 2022

Instructor

- Name: Jing Guo
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- Office: NEB 551

Course Description

This course introduces quantum computing concepts and the hardware implementations in a self-contained manner to ECE students. The first part of the course discusses fundamentals of quantum mechanics and introduces important concepts of superposition and entanglement. The second part of the course focuses on hardware realization of quantum computing technologies. The third part of the course discusses several examples of quantum computing algorithms that takes advantage of the concepts discussed in the first and second parts. 3 credit hours.

Course Pre-Requisites / Co-Requisites

Linear Algebra (required)

Course Objectives

The students are expected to learn and develop in-depth understanding on (1) fundamentals of quantum mechanics, (2) physical implementation of quantum computing, and (3) examples of quantum computing algorithms.

Class Web site: UFL elearning canvas website

Office Hours

9-10am, Wed. (Zoom: <https://ufl.zoom.us/j/9976443936> (Links to an external site.)Links to an external site. Meeting ID: 997 644 3936)

Materials and Supply Fees

N/A

Professional Component (ABET)

This course consists of 1.5 credits of Engineering Design and 1.5 credits of Engineering Science

Relation to Program Outcomes (ABET)

Engineering Criteria

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
5. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Required Textbooks and Software

- Title: An Introduction to Quantum Computing (Required)
- Author: P. Kaye, R. Lafamme, and M. Mosca
- Publication date, edition, and publisher: Oxford University Press, 2007
- Title: Quantum Computation and Quantum Information (Recommended)
- Author: M. Nielsen and I. Chuang
- Publication date, edition, and publisher: Cambridge University Press, 2010
- ISBN number: 10: 9781107002173

- Software: None
(if course notes derived from various published sources are used, provide information above for each source) (if course notes are developed by the instructor, so state)

Recommended Materials

- Title: Quantum Computation and Quantum Information (Recommended)
- Author: M. Nielsen and I. Chuang
- Publication date, edition, and publisher: Cambridge University Press, 2010
- ISBN number: 10: 9781107002173

Course Schedule

Week 1: Linear algebra and operators

Week 2-3: Introduction to quantum mechanics in matrix form

Week 4: Superposition and entanglement

Week 5: Quantum gates and quantum circuits

Week 6: Superconducting technology for quantum computing

Week 7-8: Semiconductor technology for quantum computing

Week 9: midterm project

Week 10: Optical technology for quantum computing

Week 11: Introduction to Deutsch-Jozsa algorithm and Grover's algorithm

Week 12: Quantum Fourier transform and Shor's algorithm

Week 13: Quantum variational algorithm and its application

Week 14-15: Final project and presentation

Evaluation of Grades:

Assignment	Percentage of Final Grade
Homework Sets	10%
Midterm project	15%
Exam	35%
Final project	40%

- 15% Midterm project: Research paper presentation: Each student will choose a research paper, preferably related to their term project, in the field of quantum computing, and present it in class. The presentations will be graded based on 1) the presenter's ability to clearly describe the problem, explain the solution, and evaluate the (experimental or simulation) results, 2) the quality of answers provided to the questions, and 3) the content of the slides.
- The final project shall be on the topics of quantum computing learned throughout the course, and consist of the following parts (i) Motivation (ii) Background, (iii) Technical Approach (iv) Results, (v) Discussions, and (vi) conclusions. It will be graded according to the following percentages: 30% for parts (i) and (ii), 45% for parts (iii) and (iv), 25% for parts (v) and (vi). Parts (i), (ii) and (v) shall discuss relations and comparisons between various quantum computing technologies in the course which need to be comprehensive, and parts (ii) and (iv) can focus specifically on one quantum computing technology.

The schedules of the presentations will be available in the course e-learning website.

Half of the project presentation should be overview of the research field for the project, and the other half shall clear identify a problem, perform calculation, modeling, or simulation, and reach YOUR OWN conclusion on the memory device studied in the project.

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting [https://disability.ufl.edu/students/get-started/Links to an external site.](https://disability.ufl.edu/students/get-started/Links%20to%20an%20external%20site) It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at [https://gatorevals.aa.ufl.edu/students/Links to an external site.](https://gatorevals.aa.ufl.edu/students/Links%20to%20an%20external%20site) Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via

[https://ufl.bluera.com/ufl/Links to an external site.](https://ufl.bluera.com/ufl/Links%20to%20an%20external%20site.). Summaries of course evaluation results are available to students at [https://gatorevals.aa.ufl.edu/public-results/Links to an external site.](https://gatorevals.aa.ufl.edu/public-results/Links%20to%20an%20external%20site.).

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>)[Links to an external site.](#) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate

personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html> [Links to an external site.](#)

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>[Links to an external site.](#), and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the [Office of Title IX Compliance](#)[Links to an external site.](#), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>[Links to an external site.](#)

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <https://lss.at.ufl.edu/help.shtml>[Links to an external site.](#)

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling;
<https://career.ufl.edu>Links to an external site..

Library Support, <http://cms.uflib.ufl.edu/ask>Links to an external site.. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>Links to an external site..

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>Links to an external site..

Student Complaints Campus: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>Links to an external site.;<https://care.dso.ufl.edu>Links to an external site..

On-Line Students Complaints: <https://distance.ufl.edu/state-authorization-status/#student-complaint>Links to an external site..