SJSU SAN JOSÉ STATE UNIVERSITY

Charles W Davidson College of Engineering · Electrical Engineering

Introduction to Quantum Computing Section 02

EE 225

Fall 2023 3 Unit(s) 08/21/2023 to 12/06/2023 Modified 07/28/2023

Contact Information

Instructor:	Dr. Hiu Yung Wong
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Office Hours:	Mon: 9:00am-10:30am, Wed: 3:00pm-4:30pm, or by appointment In-person or zoom. (see Canvas or email instructor for zoom link)

Course Description and Requisites

Hardware implementation and algorithms for quantum computing. Essential quantum mechanics including Bra-Ket notation, spins, Hilbert Space, Simple Harmonic Oscillator, Block Sphere, Tensor Product, Density Operator. Implementation of Qubits including electron spins in quantum dots and Josephson junction. Qubits such as topological insulator, trapped ion and defect centers. Quantum gates, logics, circuits, and representative quantum computing algorithms (Deutsch's, Grove's and Shor's). Error correction. Quantum computing simulation and experiment through IBM Q Experience.

Prerequisite(s): Graduate standing or instructor approval.

Letter Graded

Classroom Protocols

Students are required to be in class on time and no use of cell phone during the class.

Course Learning Outcomes (CLOs)

Upon successful completion of this course, students will be:

CLO1: Able to describe the differences between quantum computing and classical computing

CLO2: Able to construct quantum circuits and perform simulations

CLO3: Able to trace and explain the evolution of each qubit in a quantum circuit

CLO4: Able to explain the underlying construction of the common quantum algorithms

Course Materials

Textbook

- Introduction to Quantum Computing: From a Layperson to a Programmer in 30 Steps. Hiu Yung Wong, Springer International Publishing, 2022.

Other Readings

Quantum Mechanics:

- Modern Quantum Mechanics, J. J. Sakurai and J.J. Napolitano, Cambridge University Press, 2017 (available as a print book in SJSU library).

Quantum Computing Theory and Algorithms:

- Quantum Computer Science: An Introduction, N.D. Mermin, 2016.
- Elements of Quantum Computing, Seiki Akama, Springer, 2015.(available as a multi-user e-book in SJSU Library)
- Quantum Computation and Quantum Information: 10th Anniversary Edition, M. Nielson and I. Chang, Cambridge University Press, 2011 (available as a print book in SJSU library).

Liaison librarian: Jane Dodge: jane.dodge@sjsu.edu

Course Requirements and Assignments

Prerequisites:	Graduate standing or instructor approval

Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. on Canvas Learning Management System course login website. You are responsible for regularly checking with the messaging system through MySJSU on Spartan App Portal (or other communication system as indicated by the instructor) to learn of any updates. For help with using Canvas see Canvas Student Resources page.

Course Requirements and Assignments

Students are expected to attend all classes and participate actively in the seminar, submit the assignments and project reports on time and attend the mid-term and final exams. Assignments and Project Reports must be submitted on time to receive full credit. Late submission of Assignments and Project Reports within 3 days after the due date will only receive half of the credits. No credits will be given after the late submission due date.

Review the following policy about your responsibility:

- Office of Graduate and Undergraduate Programs' Syllabus Information web page at http://www.sjsu.edu/gup/syllabusinfo/

"Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally three hours per unit per week) for instruction, preparation/studying, or course related activities, including but not limited to internships, labs, and clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus."

Course Project

Students need to use python to write a quantum computer simulator.

Seminar Reports

Students need to attend 5 quantum computing seminars (specified by the lecturer) and write a 100-word summary for each.

✔ Grading Information

Final Examination or Evaluation

Exams will be closed book. However, students are allowed to bring a calculator and a page of aid sheet. There will be no make-up exam and those absent will receive no credit. Students must write their answers clearly in an organized fashion. Further instructions will be provided during exams. The course is based on letter grading and grading percentage breakdown is as follow:

Grading Information

Assignment	30%
Midterm Exam	20%
Final Exam	20%
Project	20%
Seminar Reports	10%

Determination of Grades

- Every assignment has equal weight (totally 30% of the final score)
- Assignment and Project reports must be submitted on time to receive full credit. Late submission: Half of the credit will be given if submitted within 3 days after the due date. No credit will be given if submitted after late submission due date.

Grading Breakdown:

A = 100 to 93 points

A minus = 92 to 88 points

B plus = 87 to 84 points

B = 83 to 79 points

B minus = 78 to 75 points

C plus = 74 to 72 points

C = 71 to 69 points

C minus = 68 to 65 points

D plus = 64 to 62 points

D = 61 to 59 points

D minus = 58 to 55 points

F = 55 points or lower

EE Department Honor Code

The Electrical Engineering Department will enforce the following Honor Code that must be read and accepted by all students.

"I have read the Honor Code and agree with its provisions. My continued enrollment in this course constitutes full acceptance of this code. I will NOT:

- Take an exam in place of someone else, or have someone take an exam in my place
- Give information or receive information from another person during an exam
- Use more reference material during an exam than is allowed by the instructor
- Obtain a copy of an exam prior to the time it is given
- Alter an exam after it has been graded and then return it to the instructor for re-grading
- Leave the exam room without returning the exam to the instructor."

Measures Dealing with Occurrences of Cheating

- Department policy mandates that the student or students involved in cheating will receive an "F" on that evaluation instrument (paper, exam, project, homework, etc.) and will be reported to the Department and the University.

• A student's second offense in any course will result in a Department recommendation of suspension from the University.

University Policies

Per University Policy S16-9 (PDF) (http://www.sjsu.edu/senate/docs/S16-9.pdf), relevant university policy concerning all courses, such as student responsibilities, academic integrity, accommodations, dropping and adding, consent for recording of class, etc. and available student services (e.g. learning assistance, counseling, and other resources) are listed on the Syllabus Information (https://www.sjsu.edu/curriculum/courses/syllabus-info.php) web page. Make sure to visit this page to review and be aware of these university policies and resources.

Course Schedule

Class Days/Time:	Monday and Wednesday 4:30PM-05:45PM
Classroom:	Clark Building 238

Week		Seminar	Assignment	Project
1	21-Aug	Introduction		
	23-Aug	Basic Mathematics and Quantum Mechanics		
2	28-Aug	Basic Mathematics and Quantum Mechanics		
	30-Aug	Basic Mathematics and Quantum Mechanics		
3	4-Sep	Labor Day – No Class		
	6-Sep	Basic Mathematics and Quantum Mechanics	Assignment 1 due on 9/10	
4	11-Sep	Basic Mathematics and Quantum Mechanics		
	13-Sep	Qubit and Entanglement		
5	18-Sep	Qubit and Entanglement		
	20-Sep	Quantum Gate		
6	25-Sep	Quantum Gate		

	27-Sep	Quantum Gate	Assignment 2 due on 10/1	
7	2-Oct	Quantum Gate		
	4-Oct	Quantum Circuit and Teleportation		
8	9-Oct	Quantum Circuit and Teleportation		
	11-Oct	Review	Assignment 3 due on 10/15	
9	16-Oct	Midterm		
	18-Oct	Deutsch's Algorithm		
10	23-Oct	Grover's Algorithm		
	25-Oct	Grover's Algorithm		
11	30-Oct	Quantum Fourier Transformation		
	1-Nov	Encryption and Shor's Algorithm		
12	6-Nov	Encryption and Shor's Algorithm		
	8-Nov	Physical Qubits	Assignment 4 due on 11/12	
13	13-Nov	Physical Qubits		
	15-Nov	Physical Qubits		
14	20-Nov	Physical Qubits		Phase 1 Project Due 11/19
	22-Nov	Non-Instructional Day		
15	27-Nov	Physical Qubits		
	29-Nov	Physical Qubits		Phase 2 Project Due 12/3
16	4-Dec	Physical Qubits		
	6-Dec	Review		
Final Exam		Thursday, December 14 2:45-5:00 PM		