

San José State University
Department of Electrical Engineering
EE 225, Introduction to Quantum Computing, Section 1, Fall 2021

Course and Contact Information

Instructor:	Dr. Hiu Yung Wong
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Office Hours:	Mon: 9:00am-10:30am, Wed: 12:00pm-1:30pm, or by appointment Zoom (in-person visit by appointment)
Class Days/Time:	Monday and Wednesday 05:45PM-07:00PM
Classroom:	ENG 345
Prerequisites:	Graduate standing or instructor approval

Course Format

Course Description

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, Grover's and Shor's). Error correction. Quantum computing simulation and experiment through IBM Q Experience.

Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on Canvas Learning Management System course login website at <http://sjsu.instructure.com>. You are responsible for regularly checking with the messaging system through [MySJSU](http://one.sjsu.edu) on [Spartan App Portal](http://one.sjsu.edu) <http://one.sjsu.edu> to learn of any updates. For help with using Canvas see [Canvas Student Resources page](#).

Course Learning Outcomes (CLO)

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

CLO2: Able to enumerate the pros and cons of various physical implementations of quantum bits

CLO3: Able to describe the current landscape of quantum computing development in the industry and academia

CLO4: Able to construct Quantum circuit and perform simulations

Upon successful completion of this course, students will be able to:

1. Demonstrate an understanding of the fundamentals of Electrical Engineering, including its mathematical and scientific principles, analysis and design.
2. Demonstrate the ability to apply the practice of Engineering in real-world problems.

Required Texts/Readings

Textbook

Lecture notes

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).

Physics of Qbit Elements:

- Semiconductor Nanostructures: Quantum states and electronic transport, Thomas Ihn, Oxford University Press, 2010. (available as a multi-user e-book in SJSU Library.)
- Quantum Transport: Introduction to Nanoscience, Y. V. Nazarov and Y. M. Blanter, Cambridge University Press, 2009. (available in both a print and multi-user e-book version through the SJSU library collection)
- Introduction to Superconducting Circuits, A. M. Kadin, John Wiley & Sons, 1998

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).

Library Liaison: Traci Engel (traci.engel@sjsu.edu, 408-808-2106)

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](http://www.sjsu.edu/gup/syllabusinfo/) 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.”

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%
Attendance*	10%

*Attendance becomes online if the school is shut down due to any reasons.

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

Classroom Protocol

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

University Policies

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' [Syllabus Information web page](http://www.sjsu.edu/gup/syllabusinfo/) at <http://www.sjsu.edu/gup/syllabusinfo/>"

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.

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***The schedule is subject to change with advance notice on Canvas.

Week		Seminar	Assignment	Project
1	23-Aug	Basic Mathematics and Quantum Mechanics		
	25-Aug	Basic Mathematics and Quantum Mechanics		
2	30-Aug	Basic Mathematics and Quantum Mechanics		
	1-Sep	Basic Mathematics and Quantum Mechanics		
3	6-Sep	Labor Day – No Class		
	8-Sep	Basic Mathematics and Quantum Mechanics	Assignment 1 due on 9/12	
4	13-Sep	Quantum Bits, Gates and Circuits		
	15-Sep	Quantum Bits, Gates and Circuits		
5	20-Sep	Quantum Bits, Gates and Circuits		
	22-Sep	Quantum Bits, Gates and Circuits		
6	27-Sep	Quantum Bits, Gates and Circuits		
	29-Sep	Measurement	Assignment 2 due on 10/3	
7	4-Oct	Measurement		
	6-Oct	Teleportation		
8	11-Oct	Teleportation		
	13-Oct	Review	Assignment 3 due on 10/17	
9	18-Oct	Midterm		
	20-Oct	Deutsch's Algorithm		
10	25-Oct	Deutsch's Algorithm		
	27-Oct	Grover's Algorithm		
11	1-Nov	Grover's Algorithm		
	3-Nov	Encryption and Shor's Algorithm		
12	8-Nov	Encryption and Shor's Algorithm		
	10-Nov	Encryption and Shor's Algorithm	Assignment 4 due on 11/14	
13	15-Nov	Encryption and Shor's Algorithm		
	17-Nov	Physical Qubits		
14	22-Nov	Physical Qubits		

	24-Nov	Non-Instructional Day		
15	29-Nov	Physical Qubits		
	1-Dec	Physical Qubits		Project Due 12/5
16	6-Dec	Review		
Final Exam		Wednesday, December 8 5:15-7:30 PM		