Course and Contact Information

Instructor: Dr. Hiu Yung Wong
Office Location: ENG 363
Telephone: 408-924-3910
Email: hiuyung.wong@sjsu.edu
Office Hours: Mon: 9:00am-10:30am, Wed: 4:15pm-5:45pm, or by appointment
Class Days/Time: Monday and Wednesday 3:00pm-4:15pm
Classroom: ENG 401
Prerequisites: EE221

Course Format

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 your official email (the email address stored on your MySJSU account) and the messaging system through MySJSU at http://my.sjsu.edu (or other communication system as indicated by the instructor) to learn of any updates.

Course Description

This course is self-contained. This course introduces the basics of the hardware implementations and algorithms for quantum computing. Essential quantum mechanics will be reviewed (including Bra-Ket notation, spins, Hilbert Space, Simple Harmonic Oscillator, Block Sphere, Tensor Product, Density Operator). Then various implementations of Qubits are discussed with emphasis on electron spins in quantum dots and Josephson junction. Other qubits such as topological insulator, trapped ion and defect centers will also be discussed. Finally, quantum gates, logics and circuits will be discussed, followed by three representative quantum computing algorithms (Deutsch’s, Grover’s and Shor’s). Error correction will also be covered. Student will perform quantum computing simulation and experiment through “IBM Q Experience”.

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**


**Other Readings**

**Quantum Mechanics:**

**Physics of Qbit Elements:**
- Introduction to Superconducting Circuits, A. M. Kadin, John Wiley & Sons, 1998

**Quantum Computing Theory and Algorithms:**

**Library Liaison:** Rachel Silverstein, rachel.silverstein@sjsu.edu

**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.”

**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**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Assignment</td>
<td>30%</td>
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<tr>
<td>Midterm Exam</td>
<td>20%</td>
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<tr>
<td>Final Exam</td>
<td>25%</td>
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<tr>
<td>Project</td>
<td>25%</td>
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**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:**

- 90% and above         A
- 89% to 85%            A minus
- 84% to 82%            B plus
- 81% to 79%            B
- 78% to 75%            B minus
- 74% to 72%            C plus
- 71% to 69%            C
- 68% to 65%            C minus
- 64% to 62%            D plus
- 61% to 59%            D
- 58% to 55%            D minus
- below 55%             F

**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 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.
EE 225, Introduction to Quantum Computing, Spring 2020

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

<table>
<thead>
<tr>
<th>Week</th>
<th>Seminar</th>
<th>Assignment/Mid-term</th>
<th>Project</th>
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<tr>
<td>1</td>
<td>QM Review: Kets, Bras, and Operators, Superposition, Entanglement, Tensor Product</td>
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<td>2</td>
<td>QM Review: Identical particles, Block Sphere and Hilbert Space</td>
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<tr>
<td>3</td>
<td>QM Review: Harmonic Oscillator, Spins and Qubits</td>
<td>Assignment 1</td>
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<td>Cbit and Qbit</td>
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<td>Josephson Junction</td>
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<td>Quantum Dots</td>
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<td>7</td>
<td>Phase Qubits, Charge Qubits, Flux Qubits, Spin Qubits</td>
<td>Assignment 3</td>
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<td>8</td>
<td>Other Physical Qubits: Topological Insulator, Ion Traps, Diamond Defect center</td>
<td>Midterm</td>
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<td>Interaction, Relaxation and Decoherence</td>
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<td>10</td>
<td>Quantum Gate and Quantum Circuit</td>
<td>Assignment 4</td>
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<td>11</td>
<td>Quantum Gate and Quantum Circuit</td>
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<td>12</td>
<td>Deutsch’s Algorithm</td>
<td>Assignment 5</td>
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<td>Grover’s Algorithm</td>
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<td>Shor’s Algorithm</td>
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<td>15</td>
<td>Error Correction</td>
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<td>Project Due</td>
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<td>Wednesday, May 13</td>
<td>Final Exam 1215-1430</td>
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