Fall 2022 CIS492 / CIS 593 Syllabus
Special Topic in Quantum Computing

Course Description:

Quantum qubits and states, entanglement, quantum gates, quantum algorithms such as Deutsch-Jozsa algorithm, Simon's algorithm, Shor's algorithm, Grover's Search, etc. and hands-on programming with IBM Qiskit.

Prerequisites: MTH 288, ESC 310 and CIS 265

Textbooks: *Quantum Computing for Everyone*, by *C Bernhardt,* MIT Press, 2019

Qiskit textbook (https://qiskit.org/textbook/)

References: *Quantum Computing for Computer Scientists*,
by *Noson S. Yanofsky and Mirco A. Mannucci*, Cambridge University Press, 2008

Lectures: Friday 2:35 - 5:25 PM, FH 314 & FH 306

Instructors: Janche Sang (CS), Mehdi Rahmati (EE) & Hiram H. López Valdez (MATH)
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Office Hours: (to be determined)
(others by appointment, emails preferred)
Withdrawal: Friday, Sep. 9 (without W grade)
Friday, Nov. 4 (with W grade)

Expected Outcomes:

- Be familiar with quantum gate operations and the mathematics behind them
- Understand the concepts of superposition and entanglement and be able to build simple quantum circuits
- Have the knowledge of quantum algorithms (Deutsch-Jozsa, Simon, Grover, and Shor) and their complexity classes
- Be able to implement and execute quantum programs on simulators and real quantum computers

Grading Policy:

Assignments (3)	15%
Class Attendance and Participation	5%
Lab Reports (7)	35%
Test (3)	45%

- Homework assignments (3) are designed for you to prpare the tests. They will be given on Sep 23, Oct 21 and Dec 2. Due dates are the following Tuesday, Sep 27, Oct 25 and Dec 6, respectively. The answer kit will be available the following day on Wednesday; so, no late assignement is accepted.
- All lab reports (7) are due by the end of the day of the lab.

- Tests (3) are closed-book tests. No cheat sheet is allowed.
- The course grade is based on a student's overall performance through the entire semester. The total points will be curved.

Other Information:

- Students will use quantum computing simulator, available through the Qiskit open-source, software development kit, but also use a real IBM QC for one or more labs.
- Students are encouraged to discuss homework assignments with classmates. However, each student must do his/her own work. Evidence of copying will result in a zero grade for all students involved. Also, students are responsible for protecting their own programs. Academic misconduct and cheating will not be tolerated. Violations will be subject to disciplinary action as specified in the CSU Student Conduct Code.

Class schedule:

Date	Topic1	Topic2	Instructor
Week 1 (9/2)	Introduction (chap 1)	Overview of main concepts - qubit, superposition, interference & entanglement	Chansu
Week 2 (9/9)	Linear algebra (chap 2)	Linear algebra (chap 2)	Hiram
Week 3 (9/16)	Spin & Qubits (chap 3)	Hands-on Lab #1 (Python & Jupyter)	Hiram/Janche
Week 4 (9/23)	Spin & Qubits (chap 3)	Quantum gates (chap 7a)	Hiram/Mehdi
Week 5 (9/30)	Test #1	Entanglement (chap 4)	Hiram/Mehdi
Week 6 (10/7)	Entanglement (chap 4)	Hands-on Lab #2 (Qiskit programming)	Mehdi/Janche
Week 7 (10/14)	Bell's inequality (chap 5a)	Hands-on Lab #3 (Entanglement)	Mehdi/Janche
Week 8 (10/21)	Ekert, QKD (chap 5b) & Hands-on Lab #4 (QKD)	Guest speaker (Cleveland Clinic/IBM)	Janche/(Hiram)
Week 9 (10/28)	Test #2	Quantum gates (chap 7b: Superdense code, Teleportation & Error correction)	Mehdi
Week 10 (11/4)	Complexity, Deutsch & Deutsch-Jozsa algorithms (chap 8a)	Hands-on Lab #5 (Deutsch)	Janche
Week 12 (11/18)	Simon's algorithm (chap 8b)	Hands-on Lab #6 (Simon)	Janche
Week 14 (12/2)	Shor's algorithm & Grover's algorithm (chap 9b)	Hands-on Lab #7 (Grover)	Janche
Week 15 (12/9)	Test #3	* Backup	Janche