ECE 595: An Introduction to Quantum Computing

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Office: ECE 229-B

Office hours: Tuesdays @ 3:30-5:00pm or by appointment.

Course Description:

The field of quantum computing has experienced tremendous growth in the last few years thanks to the progress made in developing experimental quantum computing platforms. With claims of computing exponentially faster than possible classically, quantum computing promises to be a fruitful realization of a new 'unconventional computing' paradigm. To what extent is this true? What is responsible for this power and what are its limitations? These are the questions we hope to address in this course.

The course will describe what makes quantum computing different from classical computing. The intent of this course is to make the exciting topic of quantum computing accessible to a broad scientific audience. The objective is to arm you with enough knowledge in the subject matter to be able to understand, judge, and contribute to the development of this growing field. The course is designed to be self-contained, so no knowledge in quantum mechanics will be assumed. An advanced engineering mathematics background (at least on the level of ECE 300), which should include basic concepts from linear algebra such as vector spaces, linear transformations, eigenvalues, and eigenvectors, should be sufficient.

Course Outline:

(1) From bits to qubits (a linear algebra review)
(2) Illuminating few qubit protocols
(3) Computing with superpositions: the power and drawback of quantum parallelism
(4) 'Simple' quantum algorithms (Deutsch, Bernstein-Vazirani, Simon's, quantum Fourier transform)
(5) Factoring on a quantum computer and breaking RSA encryption (Shor's algorithm)
(6) Unstructured search on a quantum computer (Grover's algorithm)
(7) A first introduction to quantum error correction (the Steane Code)

Whenever possible, we will use available quantum information processing devices such as the IBM Q Experience to illustrate the state of experimental quantum computing today.

Grading: Homework 70%, Final project 30%

The recommended but not required textbooks will be "Quantum Computer Science: An Introduction" by David Mermin, "Quantum Computing: A Gentle Introduction" by Eleanor Rieffel & Wolfgang Polak, and "Quantum Computation and Quantum Information" by Michael Neilson & Isaac Chuang.

Accommodation Statement:
In accordance with University Policy 2310 and the Americans with Disabilities Act (ADA), academic accommodations may be made for any student who notifies the instructor of the need for an accommodation. It is imperative that you take the initiative to bring such needs to the instructor's attention, as I am not legally permitted to inquire. Students who may require assistance in emergency

evacuations should contact the instructor as to the most appropriate procedures to follow. Contact Accessibility Resource Center at 277-3506 or arc.unm.edu for additional information.

Credit hour statement
Federal Credit Hour Definition: A credit hour is an amount of work represented in intended learning outcomes and verified by evidence of student achievement that is an institutionally- established equivalency that reasonably approximates not less than:
(1) one hour of classroom or direct faculty instruction and a minimum of two hours of out-of-class student work each week for approximately fifteen weeks for one semester or trimester hour of credit, or ten to twelve weeks for one quarter hour of credit, or the equivalent amount of work over a different amount of time; or (2) at least an equivalent amount of work as required in paragraph (1) of this definition for other activities as established by an institution, including laboratory work, internships, practica, studio work, and other academic work leading toward to the award of credit hours. 34CFR 600.2 (11/1/2010)

Title IX Statement:
Title IX prohibitions on sex discrimination include various forms of sexual misconduct, such as sexual assault, rape, sexual harassment, domestic and dating violence, and stalking. Current UNM policy designates instructors as required reporters, which means that if I am notified (outside of classroom activities) about any Title IX violations, I must report this information to the Title IX coordinator. If you or someone you know has been harassed or assaulted and would like to receive support and academic advocacy, there are numerous confidential routes available to you. For example, you can contact the Women's Resource Center, the LGBTQ Resource Center, Student Health and Counseling (SHAC), or LoboRESPECT. LoboRESPECT can be contacted on their 24-hour crisis line, (505) 277-2911 and online at loborespect@unm.edu. You can receive non-confidential support and learn more about Title IX through the Title IX Coordinator at (505) 277-5251 and http://oeo.unm.edu/title-ix/. Reports to law enforcement can be made to UNM Police Department at (505) 277-2241.

Citizenship and/or Immigration Status:
All students are welcome in this class regardless of citizenship, residency, or immigration status. Your professor will respect your privacy if you choose to disclose your status. As for all students in the class, family emergency-related absences are normally excused with reasonable notice to the professor, as noted in the attendance guidelines above. UNM as an institution has made a core commitment to the success of all our students, including members of our undocumented community. The Administration's welcome is found on our website: http://undocumented.unm.edu/.

Academic Integrity Statement:
Each student is expected to maintain the highest standards of honesty and integrity in academic and professional matters. The University reserves the right to take disciplinary action, up to and including dismissal, against any student who is found guilty of academic dishonesty or otherwise fails to meet the standards. Any student judged to have engaged in academic dishonesty in course work may receive a reduced or failing grade for the work in question and/or for the course.
Academic dishonesty includes, but is not limited to, dishonesty in quizzes, tests, or assignments; claiming credit for work not done or done by others; hindering the academic work of other students; misrepresenting academic or professional qualifications within or without the University; and nondisclosure or misrepresentation in filling out applications or other University records.

Safety:
UNM offers several resources to help keep Lobos safe.

LoboGuardian, https://loboguardian.unm.edu is a mobile app that increases user safety by creating a virtual safety network of friends and family. The entire UNM campus has blue light emergency phones. UNM Police Department, tel.: (505) 277-2241, offers a free escort service for safety.

Lobo Alerts https://loboalerts.unm.edu is UNM's emergency text messaging system that can inform you of any occurrences that impact safety.

Get Help Now at https://loborespect.unm.edu/Get%20Help%20now/ index.html LoboRespect Advocacy Center, for concerns such as sexual misconduct, hate/bias, bullying, hazing.

Student Health Services https://shac.unm.edu provides counseling and health services to all students.