Syllabus for ECE 382V- Introduction to Quantum Computing Systems:
From A Software and Architecture Perspective

Course: ECE 382V- QUANTUM COMP SYS SW/ARCH PERSP
Term: Fall 2023
Unique #s: 18116
Lecture: T TH 5:00 pm -6:30 pm ECJ 1.308
Instructor:

Poulami Das
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Office Hours: In-person Tuesday 3-4 pm or by appointment

Teaching Assistant:
To Be Decided

Course Description: Quantum computers promise to speedup many important applications, some of which are almost impossible to solve even on the world's most powerful supercomputers in a reasonable amount of time. Today, quantum computers with a few hundred qubits are already available, and qubit counts are expected to cross a few thousands in the coming years. Quantum computing is an interdisciplinary field with topics ranging from applications and algorithms to programming, compilers, systems, architecture, and physical devices. This course will focus on the architecture and software stack that translates the mathematical properties of quantum states that algorithms rely on into state changes on the physical qubits, much like how general-purpose computers require compilers, micro-architecture, and system-level solutions for functionality and high performance.

Course Objectives: Equip students with a basic understanding of quantum computing from a software and systems perspective so that they can potentially pursue advanced research in related areas.

Course Topics (tentative):
- Basics of quantum computing (superposition, entanglement) and fundamental quantum algorithms (Bernstein Vazirani, Grover etc.)
- Quantum hardware limitations (noisy qubit devices and imperfect quantum operations)
- Noisy Intermediate Scale Quantum (NISQ) computing
- Error mitigation for NISQ applications
- Fault Tolerant Quantum Computing
- Quantum Error correction for FTQCs
- Quantum cloud services

Prerequisites: Basic programming skills and background of digital logic design.

Textbook: None [Mostly recent papers from ISCA, MICRO, HPCA, and ASPLOS will be covered]

Optional: (1) Quantum Computation and Quantum Information by Nielsen and Chuang
(2) Quantum Computer Systems Research for Noisy Intermediate-Scale Quantum Computers by Yongshan Ding and Frederic T. Chong
(3) Quantum Computing Progress and Prospect, NAE Report

Lecture Contents: Will be available on Canvas

Grading:
- 2 Homework Assignments: 5x2 = 10%
- 2 Lab Assignments: [15+15] = 30%
- 2 Midterms = 2x20 = 40%
- 1 Final Exam/ Project = 20%

Homework Policy: Homework assignments must be submitted on Canvas by 11:59pm on the due date shown in schedule. Late submissions are not allowed.

Lab Policy: Labs are due at 11:59pm on the due date and must be submitted on Canvas.

Course Email List: Email announcements will be sent out through Canvas and go to the email address on the registrar's records. It is your responsibility to read your email on a regular basis. Email has been approved as official communication at the University of Texas. There will also be an Ed Discussion site.

Academic Integrity: Each student in the course is expected to abide by the University of Texas Honor Code: "As a student at The University of Texas at Austin, I shall abide by the core values of the University and uphold academic integrity." **Plagiarism is taken very seriously at UT.** Therefore, if you use words or ideas that are not your own (or that you have used in a previous class), you must cite your sources. Otherwise, you will be guilty of plagiarism and subject to academic disciplinary action, including failure of the course. You are responsible for understanding UT's Academic Honesty and the University Honor Code which can be found at the following web address: https://deanofstudents.utexas.edu/conduct/standardsofconduct.php

Note that all students in this course are expected to submit their own work for all homework and lab assignments, quizzes, and exams. Submitting work found on the internet, generated by generative AI tools such as ChatGPT, or work done (or partially done) by peers, former students, or any family members, friends etc. will be considered violations of the university honor code and will be subject to academic disciplinary action.

Q Drop Policy: If you want to drop a class after the 12th class day, you'll need to execute a Q drop before the Q-drop deadline, which typically occurs near the middle of the semester. Under Texas law, you are only allowed six Q drops while you are in college at any public Texas institution. For more information, see: http://www.utexas.edu/ugs/csacc/academic/adddrop/qdrop

Sharing of Course Materials is Prohibited: No materials used in this class, including, but not limited to, lecture hand-outs, videos, assessments (quizzes, exams, papers, projects, homework assignments), in-class materials, review sheets, and additional problem sets, may be shared online or with anyone outside of the class unless you have my explicit, written permission. Unauthorized sharing of materials promotes cheating. It is a violation of the University's Student Honor Code and an act of academic dishonesty. I am aware of the sites used for sharing materials, and any materials found online that are associated with you, or any suspected unauthorized sharing of materials, will be reported to Student Conduct and Academic Integrity in the Office of the Dean of Students. These reports can result in sanctions, including failure in the course.

Class Recordings: Class recordings are reserved only for students in this class for educational purposes and are protected under FERPA. The recordings should not be shared outside the class in any form. Violation of this restriction by a student could lead to Student Misconduct proceedings.

Services for Students with Disabilities: The university is committed to creating an accessible and inclusive learning environment consistent with university policy and federal and state law. Please let me know if you experience any barriers to learning so I can work with you to ensure you have equal opportunity to participate fully in this course. If you are a student with a disability, or think you may have a disability, and need accommodations please contact Disability and Access (D & A). Here are some examples of the types of diagnoses and conditions that can be considered disabilities: Attention-Deficity/Hyperactivity Disorders (ADHD), Autism, Blind & Visually Impaired, Brain Injuries, Deaf & Hard of Hearing, Learning Disabilities, Medical Disabilities, Physical Disabilities, Psychological Disabilities and Temporary Disabilities. Please refer to D&A's website for contact and more information: https://diversity.utexas.edu/disability/. If you are already registered with D&A, please deliver your Accommodation Letter to me as early as possible in the semester so we can discuss your approved accommodation and needs in this course.

Counseling and Mental Health Center: Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep, and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. http://www.cmhc.utexas.edu/individualcounseling.html

Religious Holy Days: A student who misses classes or other required activities, including examinations, for the observance of a religious holy day should inform the instructor as far in advance of the absence as possible so that arrangements can be made to complete an assignment within a reasonable period after the absence. A reasonable accommodation does not include substantial modification to academic standards, or adjustments of requirements essential to any program of instruction. Students and instructors who have questions or concerns about academic accommodations for religious observance or religious beliefs may contact the Office for Inclusion and Equity. The University does not maintain a list of religious holy days.

BeVocal: BeVocal is a university-wide initiative to promote the idea that individual Longhorns have the power to prevent high-risk behavior and harm. At UT Austin all Longhorns have the power to intervene and reduce harm. To learn more about BeVocal and how you can help to build a culture of care on campus, go to: https://wellnessnetwork.utexas.edu/BeVocal.

COVID-19 Update: While we will post information related to the contemporary situation on campus, you are encouraged to stay up-to-date on the latest news as related to the student experience. https://coronavirus.utexas.edu/students

Concerns about the safety or behavior of fellow students: If you have concerns about the safety or behavior of fellow students, TAs or Professors, call BCAL (the Behavior Concerns Advice Line): 512-232-5050. Your call can be anonymous. If something doesn't feel right – it probably isn't. Trust your instincts and share your concerns.

Title IX Reporting: Title IX is a federal law that protects against sex and gender-based discrimination, sexual harassment, sexual assault, sexual misconduct, dating/domestic violence and stalking at federally funded educational institutions. UT Austin is committed to fostering a learning and working environment free from discrimination in all its forms. When sexual misconduct occurs in our community, the university can:

1. Intervene to prevent harmful behavior from continuing or escalating.
2. Provide support and remedies to students and employees who have experienced harm or have become involved in a Title IX investigation.
3. Investigate and discipline violations of the university's [relevant policies](https://titleix.utexas.edu/relevant-polices/) (https://titleix.utexas.edu/relevant-polices/).

Beginning January 1, 2020, Texas Senate Bill 212 requires all employees of Texas universities, including faculty, report any information to the Title IX Office regarding sexual harassment, sexual assault, dating violence and stalking that is disclosed to them. Texas law requires that all employees who witness or receive any information of this type (including, but not limited to, writing assignments, class discussions, or one-on-one conversations) must be reported. **I am a Responsible Employee and must report any Title IX related incidents** that are disclosed in writing, discussion, or one-on-one. Before talking with me, or with any faculty or staff member about a Title IX related incident, be sure to ask whether they are a responsible employee. If you would like to speak with someone who can provide support or remedies without making an official report to the university, please email advocate@austin.utexas.edu. For more information about reporting options and resources, visit http://www.titleix.utexas.edu/, contact the Title IX Office via email at titleix@austin.utexas.edu, or call 512-471-0419.

Although graduate teaching and research assistants are not subject to Texas Senate Bill 212, they are still mandatory reporters under Federal Title IX laws and are required to report a wide range of behaviors we refer to as sexual misconduct, including the types of sexual misconduct covered under Texas Senate Bill 212. The Title IX office has developed supportive ways to respond to a survivor and compiled campus resources to support survivors.

Emergency Evacuation Procedures: The following recommendations regarding emergency evacuation from the Office of Campus Safety and Security, 512-471-5767, http://www.utexas.edu/safety/
Occupants of buildings on The University of Texas at Austin campus are required to evacuate buildings when a fire alarm is activated. Alarm activation or announcement requires exiting and assembling outside.

- Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building.
- Students requiring assistance in evacuation shall inform their instructor in writing during the first week of class.
- In the event of an evacuation, follow the instruction of faculty or class instructors. Do not re-enter a building unless given instructions by the following: Austin Fire Department, The University of Texas at Austin Police Department, or Fire Prevention Services office.
- Link to information regarding emergency evacuation routes and emergency procedures can be found at: www.utexas.edu/emergency