

SYLLABUS
Fall 2021
Quantum Computing
For graduate students

Course Information:

Class time: Mon & Wed: 10:00am-11:15am

Course number: Physics 5V48, PHYS 4V11

Classroom: SCI 3.240

Instructor: Professor Chuanwei Zhang

Office:

Email: chuanwei.zhang@utdallas.edu

Phone: 972-883-4520

Office hours: to be determined

Course Pre-requisites, Co-requisites, and/or Other Restrictions

(including required prior knowledge or skills)

Math 2418 Linear algebra or equivalent. Undergraduate quantum mechanics is recommended, but not required

Course Description:

Provides an introduction to the theory and practice of quantum computation.

Topics covered:

Physics of information processing; quantum logic; quantum algorithms including Shor's factoring algorithm; quantum communications; quantum error corrections; quantum hardware.

Additional requirement for graduate students: An independent research project under the instructor's supervision.

Learning Outcomes:

The undergraduate student in the class will learn the foundation of quantum computation and quantum communications as well as certain practical applications. They will develop basic problem solving ability for fundamental issues as well concrete examples. The study will help them in the future work and research, either in industry or academy.

Difference Outcomes for graduate students: In addition to the above learning outcomes at undergraduate level, the graduate student will learn how to perform scientific research in the field of quantum information science, which involves literature reading, topic selection, concrete calculation, oral presentation and scientific writing.

Textbooks and Materials

- Quantum Computation & Quantum Information, (10th Ann Ed), by Nielsen and Chuang ISBN: 9781107002173 (RECOMMENDED)
- Quantum Computer Science: An Introduction, by N. D. Mermin, ISBN: 9780521876582, CAMBRIDGE UNIV PRESS (RECOMMENDED)

Calendar of events and assignments:

Middle term exam: to be determined

Final exam week: to be determined

Final Project Due: to be determined

Homework: Due time is specified for each assignment.

Description of the final project for graduate students: A few possible research topics and related references will be provided to students. Students will need to discuss with the instructor to select one topic. The students need to read the literatures and discuss with the instructor for a potential problem. The students will solve the problem with the assistant of the instructor. The students need to summarize the results in a final research essay.

Some interesting links regarding quantum computer

<https://quantumai.google/>

<https://www.nature.com/articles/d41586-019-03213-z>

<https://www.ibm.com/quantum-computing/>

<https://www.ibm.com/quantum-computing/what-is-quantum-computing/>

<https://www.sciencemag.org/news/2020/09/ibm-promises-1000-qubit-quantum-computer-milestone-2023>

<https://ionq.com/>

<https://techcrunch.com/2020/12/09/ionq-plans-to-launch-a-rack-mounted-quantum-computer-for-data-centers-in-2023/>

Assignments & Academic Calendar

(Topics, Reading Assignments, Due Dates, Exam Dates)

Homework problems will be assigned from textbooks and additional sources. Homework normally is to be turned in at the start of class on Monday. Exceptions will be clearly posted with the assignment. Your work should be neat, problems should be ordered, and pages should be stapled.

Students may work on homework with classmates, but each student is required to write up his/her answers independently. Outright copying is not permitted. You are required to write all collaborating group members' names at the start of the problem. Failure to disclose all members of a collaborating homework group will be treated as plagiarism. I recognize that some students will master this material better by working in peer groups, however I reserve the right to restrict homework collaboration at my discretion. If you need additional help, you should be discussing the problem with the course TA or the instructor, and not consulting a solution key from the publisher or any other source.

Grading Policy

(including percentages for assignments, grade scale, etc.)

Individual Homework problems are usually given equal weight and are graded on a 10 point scale. Homework will count towards 30% of the course grade. Exams will count for 50% of the course grade. There will be a midterm exam and a final exam, each carrying equal weight. The research project will count 20% toward the final grade.

Course & Instructor Policies

(make-up exams, extra credit, late work, special assignments, class attendance, classroom citizenship, etc.)

Notes, homework solutions, exams, and exam solutions that are provided to the class are strictly for personal use. They do not become the property of the student, and they may not be distributed or shared with anyone outside this class without the written permission of the instructor. Seeking help from an instructor solution manual, a solution posted on the Internet, a homework solution from a student who has previously studied the course (except for the Teaching Assistant), or previous exams of this instructor is expressly forbidden. Violations will be prosecuted per the UTD Academic Dishonesty policy. My recommended penalty to the UTD Judicial Officer for any violation is likely to be a course grade of F.

Field Trip Policies

Off-campus Instruction and Course Activities

Off-campus, out-of-state, and foreign instruction and activities are subject to state law and University policies and procedures regarding travel and risk-related activities. Information regarding these rules and regulations may be found at the website address http://www.utdallas.edu/BusinessAffairs/Travel_Risk_Activities.htm. Additional information is available from the office of the school dean. Below is a description of any travel and/or risk related activity associated with this course.

No field trips are anticipated.

Student Conduct & Discipline

The University of Texas System and The University of Texas at Dallas have rules and regulations for the orderly and efficient conduct of their business. It is the responsibility of each

student and each student organization to be knowledgeable about the rules and regulations which govern student conduct and activities. General information on student conduct and discipline is contained in the UTD publication, A to Z Guide, which is provided to all registered students each academic year.

The University of Texas at Dallas administers student discipline within the procedures of recognized and established due process. Procedures are defined and described in the Rules and Regulations, Board of Regents, The University of Texas System, Part 1, Chapter VI, Section 3, and in Title V, Rules on Student Services and Activities of the university's Handbook of Operating Procedures. Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations (SU 1.602, 972/883-6391).

A student at the university neither loses the rights nor escapes the responsibilities of citizenship. He or she is expected to obey federal, state, and local laws as well as the Regents' Rules, university regulations, and administrative rules. Students are subject to discipline for violating the standards of conduct whether such conduct takes place on or off campus, or whether civil or criminal penalties are also imposed for such conduct.

Academic Integrity

The faculty expects from its students a high level of responsibility and academic honesty. Because the value of an academic degree depends upon the absolute integrity of the work done by the student for that degree, it is imperative that a student demonstrate a high standard of individual honor in his or her scholastic work.

Scholastic dishonesty includes, but is not limited to, statements, acts or omissions related to applications for enrollment or the award of a degree, and/or the submission as one's own work or material that is not one's own. As a general rule, scholastic dishonesty involves one of the following acts: cheating, plagiarism, collusion and/or falsifying academic records. Students suspected of academic dishonesty are subject to disciplinary proceedings.

Plagiarism, especially from the web, from portions of papers for other classes, and from any other source is unacceptable and will be dealt with under the university's policy on plagiarism (see general catalog for details).

Please consult Course and Instructor Policies for more specific information pertaining to this course. It is a student's responsibility to seek guidance if a policy or its application to a specific situation is not clear.

Email Use

The University of Texas at Dallas recognizes the value and efficiency of communication between faculty/staff and students through electronic mail. At the same time, email raises some issues concerning security and the identity of each individual in an email exchange. The university encourages all official student email correspondence be sent only to a student's U.T. Dallas email address and that faculty and staff consider email from students official only if it originates from a UTD student account. This allows the university to maintain a high degree of

confidence in the identity of all individual corresponding and the security of the transmitted information. UTD furnishes each student with a free email account that is to be used in all communication with university personnel. The Department of Information Resources at U.T. Dallas provides a method for students to have their U.T. Dallas mail forwarded to other accounts.

Withdrawal from Class

The administration of this institution has set deadlines for withdrawal of any college-level courses. These dates and times are published in that semester's course catalog. Administration procedures must be followed. It is the student's responsibility to handle withdrawal requirements from any class. In other words, I cannot drop or withdraw any student. You must do the proper paperwork to ensure that you will not receive a final grade of "F" in a course if you choose not to attend the class once you are enrolled.

Student Grievance Procedures

Procedures for student grievances are found in Title V, Rules on Student Services and Activities, of the university's *Handbook of Operating Procedures*.

In attempting to resolve any student grievance regarding grades, evaluations, or other fulfillments of academic responsibility, it is the obligation of the student first to make a serious effort to resolve the matter with the instructor, supervisor, administrator, or committee with whom the grievance originates (hereafter called "the respondent"). Individual faculty members retain primary responsibility for assigning grades and evaluations. If the matter cannot be resolved at that level, the grievance must be submitted in writing to the respondent with a copy of the respondent's School Dean. If the matter is not resolved by the written response provided by the respondent, the student may submit a written appeal to the School Dean. If the grievance is not resolved by the School Dean's decision, the student may make a written appeal to the Dean of Graduate or Undergraduate Education, and the dean will appoint and convene an Academic Appeals Panel. The decision of the Academic Appeals Panel is final. The results of the academic appeals process will be distributed to all involved parties.

Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations.

Incomplete Grade Policy

As per university policy, incomplete grades will be granted only for work unavoidably missed at the semester's end and only if 70% of the course work has been completed. An incomplete grade must be resolved within eight (8) weeks from the first day of the subsequent long semester. If the required work to complete the course and to remove the incomplete grade is not submitted by the specified deadline, the incomplete grade is changed automatically to a grade of **F**.

Disability Services

The goal of Disability Services is to provide students with disabilities educational opportunities equal to those of their non-disabled peers. Disability Services is located in room 1.610 in the Student Union. Office hours are Monday and Thursday, 8:30 a.m. to 6:30 p.m.; Tuesday and Wednesday, 8:30 a.m. to 7:30 p.m.; and Friday, 8:30 a.m. to 5:30 p.m.

The contact information for the Office of Disability Services is:
The University of Texas at Dallas, SU 22
PO Box 830688
Richardson, Texas 75083-0688
(972) 883-2098 (voice or TTY)

Essentially, the law requires that colleges and universities make those reasonable adjustments necessary to eliminate discrimination on the basis of disability. For example, it may be necessary to remove classroom prohibitions against tape recorders or animals (in the case of dog guides) for students who are blind. Occasionally an assignment requirement may be substituted (for example, a research paper versus an oral presentation for a student who is hearing impaired). Classes enrolled students with mobility impairments may have to be rescheduled in accessible facilities.

The college or university may need to provide special services such as registration, note-taking, or mobility assistance. It is the student's responsibility to notify his or her professors of the need for such an accommodation. Disability Services provides students with letters to present to faculty members to verify that the student has a disability and needs accommodations. Individuals requiring special accommodation should contact the professor after class or during office hours.

Religious Holy Days

The University of Texas at Dallas will excuse a student from class or other required activities for the travel to and observance of a religious holy day for a religion whose places of worship are exempt from property tax under Section 11.20, Tax Code, Texas Code Annotated.

The student is encouraged to notify the instructor or activity sponsor as soon as possible regarding the absence, preferably in advance of the assignment. The student, so excused, will be allowed to take the exam or complete the assignment within a reasonable time after the absence: a period equal to the length of the absence, up to a maximum of one week. A student who notifies the instructor and completes any missed exam or assignment may not be penalized for the absence. A student who fails to complete the exam or assignment within the prescribed period may receive a failing grade for that exam or assignment.

If a student or an instructor disagrees about the nature of the absence [i.e., for the purpose of observing a religious holy day] or if there is similar disagreement about whether the student has been given a reasonable time to complete any missed assignments or examinations, either the student or the instructor may request a ruling from the chief executive officer of the institution, or his or her designee. The chief executive officer or designee must take into account the legislative intent of TEC 51.911(b), and the student and instructor will abide by the decision of the chief executive officer or designee.

Comet Creed

This creed was voted on by the UT Dallas student body in 2014. It is a standard that Comets choose to live by and encourage others to do the same:

“As a Comet, I pledge honesty, integrity, and service in all that I do.”

UT Dallas Syllabus Policies and Procedures

The information contained in the following link constitutes the University’s policies and procedures segment of the course syllabus.

Please go to <http://go.utdallas.edu/syllabus-policies> for these policies.

These descriptions and timelines are subject to change at the discretion of the Professor.