PHYS 494
UG Intro to Quantum Computing
Spring 2024
University of Tennessee, Knoxville

Meeting Time and Place: Nielsen 608 Monday/Wednesday/Friday 8:00 – 8:50 AM
Office Hours: Monday/Wednesday/Friday 9:00 – 10:00 AM, by appointment or whenever you find me at my office.
Course Credit Hours: 3

Faculty Contact Information
Dr. Elias Kokkas: Nielsen 616
Email: ikokkas@vols.utk.edu

Course Description: In this course, we will introduce quantum information and quantum computation at a level suitable for students with knowledge of high school physics and algebra. The aim of this course is to present a few important applications of quantum computation and how we can achieve quantum supremacy. During this course students will have the opportunity to run "quantum problems" on IBM's software Qiskit (no python knowledge is required). Topics covered include: Linear algebra; Probability Theory; Qubits; Entanglement; Quantum Gates and Circuits; Quantum Algorithms; Quantum Hardware.

Learning Environment: The course will be taught in a traditional in-person lecture method. During the lecture presentation small problems (quizzes) will be given and students are expected to work on them in small groups. Working on these quizzes will count for the participation component of the grade.

Course Communications: Communication outside of class times will be through UTK email and Canvas. Please monitor your UTK email and Canvas regularly. For technical issues, contact the OIT HelpDesk via phone (865) 974-9900 or online at http://help.utk.edu/.

How to Be Successful in This Course: Being organized and keeping up with reading assignments is essential to success in this course. Come to class prepared to discuss the material and to work with other students. If you're willing to work and learn this should be a really fun course.

Texts/Resources/Materials:
In this course, we won't follow a specific book, rather I am going to compile material from different sources. I am going to post my lecture notes on Canvas. Some of the sources that I will follow are:
1. Quantum Computing for Everyone by Chris Bernhardt
2. Introduction to Quantum Information Science Lecture Notes by Scott Aaronson

Homework problem sets will be posted on canvas. There will be five sets of homework problems throughout the course.

Course Requirements, Assessments, and Evaluations:
The final grade will be assigned from the weighted average based on the following *provisional* grading scale.

A	90 and above
A-	87 and above
B+	83 and above
B	80 and above
B-	77 and above
C+	73 and above
C	70 and above
C-	67 and above
D+	63 and above
D	60 and above
D-	57 and above
F	below 57

Grade Breakdown

Participation	10%
Homework	50%
Exams (Midterm and Final)	40% (20% each for exams)

Late Policy
Worked handed in late will incur a 10% penalty with an additional 5% penalty after the first day, up to a maximum of 50%

Modules:

Module 1	Basics of Quantum Physics	Double-slit experiment, superposition of states, collapse of the wavefunction, spin, polarization
	Basics of Quantum Physics	Quantum vector states, Dirac notation, measurement, probability amplitudes
	Linear Algebra	Review basics properties of 2x2 matrices, find eigenvalues and eigenvectors
Module 2	Single Qubit	Spin based qubit, Pauli matrices, Different qubit bases, Bloch sphere
	Many Qubits	Focus on 2 qubits, Tensor product, Entanglement
Module 3	Basics of Quantum Computation	Classical logic gates, Quantum gates, Quantum circuits
	Quantum Protocols	Quantum parallelism, Superdense coding, Quantum teleportation
	Quantum Algorithms	Deutsch algorithm, Deutsch-Jozsa algorithm, quantum advantage
Module 4	Quantum Error Correction (QEC)	Bit flip errors and QEC, Phase flip error and QEC
	Quantum Networks	Quantum games, Quantum cryptography
	Quantum Hardware	Current hardware technologies
Extra	Qiskit	Run simple examples of python scripts (the basis of the code will be given), Run quantum simulations

Tentative Schedule of Lectures:

Day	Date	Topic	Homework
Monday	1/22/24	Introduction / Overview	
Wednesday	1/24/24	Introduction / Overview	
Friday	1/26/24	Module 1	
Monday	1/29/24	Module 1	
Wednesday	1/31/24	Module 1	
Friday	2/2/24	Module 1	
Monday	2/5/24	Module 1	
Wednesday	2/7/24	Module 1	
Friday	2/9/24	Module 1	HW 1 DUE
Monday	2/12/24	Module 1	
Wednesday	2/14/24	Module 1	

Friday	2/16/24	Module 2	
Monday	2/19/24	Module 2	
Wednesday	2/21/24	Module 2	
Friday	2/23/24	Module 2	HW 2 DUE
Monday	2/26/24	Module 2	
Wednesday	2/28/24	Module 2	
Friday	3/1/24	Module 3	
Monday	3/4/24	Module 3	
Wednesday	3/6/24	Module 3	
Friday	3/8/24	Buffer class	HW 3 DUE
Monday	3/11/24	Review	
Wednesday	3/13/24	SPRING BREAK	
Friday	3/15/24	SPRING BREAK	
Monday	3/18/24	MIDTERM EXAM	
Wednesday	3/20/24	Qiskit	
Friday	3/22/24	Module 3	
Monday	3/25/24	Module 3	
Wednesday	3/27/24	Module 3	
Friday	3/29/24	SPRING RECESS	
Monday	4/1/24	Module 3	
Wednesday	4/3/24	Module 3	HW 4 DUE
Friday	4/5/24	Module 3	
Monday	4/8/24	Module 3	
Wednesday	4/10/24	Qiskit	
Friday	4/12/24	Qiskit	
Monday	4/15/24	Buffer class	
Wednesday	4/17/24	Module 4	
Friday	4/19/24	Module 4	
Monday	4/22/24	Module 4	
Wednesday	4/24/24	Module 4	HW 5 DUE
Friday	4/26/24	Module 4	
Monday	4/29/24	Module 4	
Wednesday	5/1/24	Module 4	
Friday	5/3/24	Buffer class	
Monday	5/5/24	Review	
Wednesday	5/8/24	STUDY DAY	
Wednesday	5/15/24	FINAL EXAM	

Your Role in Improving Teaching and Learning Through Course Assessment:
At UT, it is our collective responsibility to improve the state of teaching and learning. During the semester, you may be requested to assess aspects of this course either during class or at the

completion of the class. You are encouraged to respond to these various forms of assessment as a means of continuing to improve the quality of the UT learning experience.

Key Campus Resources for Students:
- [Center for Career Development](#) (Career counseling and resources; HIRE-A-VOL job search system)
- [Course Catalogs](#) (Listing of academic programs, courses, and policies)
- [Hilltopics](#) (Campus and academic policies, procedures and standards of conduct)
- [OIT HelpDesk](#) (865) 974-9900
- [Schedule of Classes/Timetable](#)
- [Student Health Center](#) (visit the site for a list of services)
- [Student Success Center](#) (Academic support resources)
- [Undergraduate Academic Advising](#) (Advising resources, course requirements, and major guides)
- [University Libraries](#) (Access to library resources, databases, course reserves, and services)

If you need to miss class for illness, please email: ikokkas@vols.utk.edu as soon as possible.
You can find COVID 19 information and updates at *[utk.edu/coronavirus](#)*.

The instructor reserves the right to revise, alter or amend this syllabus as necessary. Students will be notified in writing / email of any such changes.
Updated January 15, 2024