



THE UNIVERSITY OF  
**TENNESSEE**  
KNOXVILLE  
**BIG ORANGE. BIG IDEAS.**

**PHYS 642**  
**Advanced Topics: Quantum Information,**  
**Fall 2023**

University of Tennessee, Knoxville

**Meeting Time and Place:** Nielsen 306 Tuesday and Thursday 4:05 – 5:20 PM

**Office Hours:** Tuesday/Thursday 5:30 – 6:30 PM, 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](mailto:ikokkas@vols.utk.edu)

Webpage: TBD

**Course Description:** The aim of this course is to introduce the concepts of quantum information and quantum computation. Topics covered include: review fundamentals of quantum mechanics; density operator; no-cloning theorem; quantum teleportation; qubits and quantum gates; quantum circuits; quantum algorithms; quantum parallelism; quantum Fourier transform; quantum searching; quantum noise; quantum error correction. During the course the student will be introduced to quantum software (e.g., qiskit) and run quantum algorithms on simulators.

**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/>.



**Modules:**

<b>Module 1</b>	Dirac notation, Axioms of quantum mechanics
	Density operator, Schmidt decomposition, entanglement
	No-cloning theorem, quantum teleportation, dense coding
<b>Module 2</b>	Basics of quantum computation, single qubit gates
	Multi-qubits, controlled gates, universal set of gates
	Quantum circuits
<b>Module 3</b>	Basics of quantum algorithms
	Quantum parallelism, Deutsch-Josza algorithm
	Quantum Fourier transform
	Quantum searching, phase estimation*, factorizing*
<b>Module 4</b>	Quantum noise
	Quantum error correction

\*Will be covered if time allows, otherwise it will be discussed in the next semester.

**University Policies:**

**Academic Integrity:** “An essential feature of the University of Tennessee, Knoxville is a commitment to maintaining an atmosphere of intellectual integrity and academic honesty. As a student of the university, I pledge that I will neither knowingly give nor receive any inappropriate assistance in academic work, thus affirming my own personal commitment to honor and integrity.”

**University Civility Statement:** Civility is genuine respect and regard for others: politeness, consideration, tact, good manners, graciousness, cordiality, affability, amiability and courteousness. Civility enhances academic freedom and integrity, and is a prerequisite to the free exchange of ideas and knowledge in the learning community. Our community consists of students, faculty, staff, alumni, and campus visitors. Community members affect each other’s well-being and have a shared interest in creating and sustaining an environment where all community members and their points of view are valued and respected. Affirming the value of each member of the university community, the campus asks that all its members adhere to the principles of civility and community adopted by the campus: <http://civility.utk.edu/>

**Physics and Astronomy Civility Statement:** As a department, we are committed to creating an environment that welcomes all people, regardless of their identities. We value the diversity that enriches our department. We understand the importance of free and open dialogue that includes the free exchange of ideas. We do not tolerate uncivil speech or any form of discourse that infringes on others’ rights to express themselves, or has a negative impact on their education, or work environment. We actively promote an environment of collegiality and an atmosphere of mutual respect and civility. We understand that respect includes being considerate of others’ feelings, circumstances, and their individuality. We recognize the necessity of a civil community

in realizing the potential of individuals in teaching, learning, research, and service. We believe these values extend beyond the department into our work within physics regionally, nationally, and internationally, as well as work and studies in the university, and the broader community. We encourage all members of the department to intervene and report any incidents involving bigotry, or that violate the university code of conduct.

**Reporting:** Anyone who experiences or observes any such incident is encouraged to report it to the Department Head or one of the Associate Heads. Students can also speak to any faculty or staff member with whom they feel comfortable. Incidents that involve sexual harassment or stalking will be reported to the office of Title IX under mandatory reporting requirements.

Additional resources and reporting available at: <http://www.phys.utk.edu/about/civility-community.html>

**Disability Services:** “The University of Tennessee, Knoxville, is committed to providing an inclusive learning environment for all students. If you anticipate or experience a barrier in this course due to a chronic health condition, a learning, hearing, neurological, mental health, vision, physical, or other kind of disability, or a temporary injury, you are encouraged to contact Student Disability Services (SDS) at 865-974-6087 or [sds@utk.edu](mailto:sds@utk.edu). An SDS Coordinator will meet with you to develop a plan to ensure you have equitable access to this course. If you are already registered with SDS, please contact your instructor to discuss implementing accommodations included in your course access letter.”

**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](mailto:ikokkas@vols.utk.edu) as soon as possible.

You can find COVID 19 information and updates at [utk.edu/coronavirus](https://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 August 20, 2023*