The Hong Kong University of Science and Technology

PHYS4812: Contemporary Applications of Physics: Quantum Information Technology
1 credit

Instructor:
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Office Hours: Wednesday 2-3pm
Office: Room 4484

Meeting Time and Venue:
Lectures:
Time: WeFr 4:30pm - 05:50pm
Venue: Rm 1409, Lift 25-26

Course Description:
The course explores the fundamental principles and emerging trends in quantum computation, communication, and information. Designed for upper-level undergraduate students, it covers essential topics such as the quantum circuit model, quantum algorithms, entanglement, quantum information, and the physical realization of various quantum technologies (e.g., photonic and superconducting qubits, ultracold atoms). Through a literature review culminating in a term paper, students will deepen their understanding of current advancements in quantum technologies and their implications across various fields.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. **Understanding Quantum Concepts:** Students will demonstrate a clear understanding of fundamental principles of quantum computation, information, and communication, including the quantum circuit model and key algorithms.
2. **Understanding Current Trends in Quantum Technologies:** Students will understand the latest trends and developments in quantum technologies, including advancements in quantum computing, communication, sensing, and simulation. They will evaluate the impact of these technologies on fields like cryptography and materials science, identifying key challenges and opportunities in the quantum landscape.
3. **Literature Review Skills:** Students will effectively review and summarize existing literature on contemporary quantum technologies, including quantum sensing and simulation.
4. **Communication Skills:** Students will communicate complex quantum concepts clearly and concisely in their term papers, demonstrating effective organization and articulation of ideas.

Tentative plan

Lecture	Date	Content
1	October 2	Introduction to Qubit
2	October 4	Quantum algorithms
3	October 9	Physical realization of qubit and quantum gates
4	October 16	Quantum Entanglement
5	October 18	Quantum communication
6	October 23	Quantum teleportation
7	October 25	Quantum Error Correction
8	October 30	Quantum technology

Assessment and Grading

Term paper (100 %)

- **2nd December 2024 (Monday), 11:59pm**
- You can select any topic mention in this course.
- About 800 words except the reference.
- Readers of your term paper would be **general scientists**.
- A term paper will be evaluated based on

Academic correctness	Up to +30 pts.
Complete literature review	Up to +30 pts.
Proper citations	Up to + 10 pts.
Creative Writing skill	Up to + 10 pts.
Scientific Writing skill	Up to + 20 pts.
Plagiarism	Unconditionally – 30 pt.

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates comprehensive understanding and innovative application of quantum concepts. Term paper is clear, well-structured, and reflects critical thinking.
B	Good Performance	Shows solid grasp of key concepts with competent application in term paper. Writing is mostly clear with minor errors.
C	Satisfactory Performance	Adequate understanding of materials; term paper covers basics but lacks depth. Writing is generally clear but contains several errors.
D	Marginal Pass	Limited understanding; term paper is poorly organized and lacks critical analysis. Writing is unclear with multiple errors.
F	Fail	Lacks understanding of fundamental concepts; term paper is incomplete or irrelevant. Writing is unclear and fails to meet requirements.

Communication and Feedback

Assessment marks for individual the term paper will be communicated via Canvas within two weeks of submission. Feedback on team paper will include comments on strengths and areas for improvement. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Course AI Policy

The use of Generative AI is permitted with proper acknowledgement to assist students with drafting and writing their papers.

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST - Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.

Student Rubrics

Use the following rubrics to guide you for the term paper that you submit in this course.

Criteria	Excellent	Good	Satisfactory	Marginal	Fail
Academic Correctness	Demonstrates exceptional accuracy in the application of quantum concepts and theories, with no errors.	Shows strong accuracy in applying quantum concepts, with minor errors.	Displays satisfactory accuracy, with some errors that do not significantly detract from the overall understanding.	Contains several inaccuracies that impact the understanding of quantum concepts.	Lacks accuracy, demonstrating a fundamental misunderstanding of key concepts.
Complete Literature Review	Provides a comprehensive review of relevant literature, integrating a wide range of sources.	Offers a solid review of literature, covering most key sources effectively.	Presents a satisfactory review, but may miss some important sources or perspectives.	Provides a limited review, lacking depth and breadth in coverage of literature.	Fails to provide a coherent literature review, missing key sources entirely.
Proper Citations	Consistently uses proper citation style with no errors in formatting.	Mostly uses proper citation style with minor formatting errors.	Uses citation style correctly but contains multiple formatting errors.	Inconsistently applies citation style, with numerous errors in formatting.	Fails to use proper citations, with little to no adherence to citation style.
Creative Writing Skill	Exhibits exceptional creativity and originality in presenting ideas and arguments.	Demonstrates good creativity, with original insights and engaging presentation.	Shows some creativity, but ideas may be somewhat conventional or predictable.	Lacks creativity, with few original insights and a formulaic presentation.	Fails to engage the reader, with no creative elements in the writing.
Scientific Writing Skill	Writing is clear, concise, and well-organized, effectively communicating complex ideas.	Writing is mostly clear and organized, with minor issues in clarity or flow.	Writing is generally understandable but may lack clarity or organization in places.	Writing is unclear and poorly organized, making it difficult to follow.	Writing is incoherent, with significant issues in clarity and organization.