PHY5503: INTRODUCTION TO QUANTUM TECHNOLOGY

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Introduction to Quantum Technology

Subject Code
PHY - Physics
Course Number
5503

Academic Unit
Physics (PHY)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
PHY8513 Introduction to Quantum Technology

Part II Course Details

Abstract

The Introduction to Quantum Technology course offers a captivating journey into the fascinating world of quantum mechanics and its ground-breaking applications. This course provides a comprehensive overview of quantum technology's fundamental principles and potential impact. Students will study quantum information science, exploring concepts such as qubits, quantum gates, and entanglement. They will uncover the mysteries of quantum computing, discovering powerful algorithms and the intricacies of quantum error correction. The course also covers quantum communication, cryptography, and secure communication protocols. Moreover, students will explore quantum sensing and metrology, unlocking the potential for precise measurements and imaging. Upon completion, students will possess a solid foundation in quantum technology, empowering them to pursue further studies or careers in this rapidly advancing field that promises to revolutionize industries worldwide.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Understand various quantum enabled technologies		x	x	
2	Understand Quantum superposition, entanglement measurement		x	x	
3	Understand Qubits and quantum states		x	x	
4	Understand Quantum gates and circuits		x	x	
5	Understand different physical platforms		x	x	
6	Understand Quantum algorithms (e.g., Shor's algorithm, Grover's algorithm)		x	x	
7	Understand Quantum cryptography and secure communication		x	x	
8	Understand Quantum key distribution protocols		x	x	
9	Understand Quantum teleportation and quantum networks		x	x	
10	Understand Quantum-enhanced measurements		x	x	
11	Understand Applications in precision measurement and imaging		x	x	
12	Understand Quantum simulators and their applications		x	x	

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Presentation of course material	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	3

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Assignments	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	40	-	Yes
2	Test	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	30	-	Yes

Continuous Assessment (%)

70

Examination (%)

30

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

30

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for the examination and continuous assessment must be obtained.

Assessment Rubrics (AR)

Assessment Task

Tests (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

The student demonstrates an understanding of the principles of quantum physics for solving common quantum technology problems.

Excellent

(A+, A, A-) High (Outstanding achievement and accurate understanding)

Good

(B+, B, B-) Significant (Good achievement with largely accurate understanding)

Fair

(C+, C, C-) Satisfied (Moderate achievement with some accurate understanding)

Marginal

(D) Basic (Essential achievement with a basic understanding)

Failure
(F) Not reaching marginal level

Assessment Task
Assignments (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
The student completes all the assignments and demonstrates a good understanding of the taught material by solving the given problems.

Excellent
(A+, A, A-) High (Outstanding achievement and accurate understanding)

Good
(B+, B, B-) Significant (Good achievement with largely accurate understanding)

Fair
(C+, C, C-) Satisfied (Moderate achievement with some accurate understanding)

Marginal
(D) Basic (Essential achievement with a basic understanding)

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Assessment Task
Tests (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Capacity for using physics knowledge and theory to solve problems

Excellent

(A+, A, A-) Will exhibit a high level of competence in understanding, explaining, and integrating the knowledge in written format

Good

(B+, B) Will exhibit a good level of competence in understanding, explaining, and integrating the knowledge in written format

Marginal

(B-, C+, C) Will exhibit some deficiencies in understanding, explaining, and integrating the knowledge in written format

Failure

(F) Will exhibit lack of competence in understanding, explaining, and integrating the knowledge in written format

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Part III Other Information

Keyword Syllabus

- Introduction to Quantum Mechanics
  Wave-particle duality, uncertainty principle, quantum states, operators, measurement, observables
- Quantum Computing
  Qubits, quantum gates, quantum algorithms, Grover's algorithm, Shor's algorithm, quantum simulation, optimization, error correction, fault tolerance
- Quantum Communication
  Quantum key distribution, QKD, quantum teleportation, quantum networks, secure communication, quantum internet
- Quantum Sensing
  Quantum sensing, quantum metrology, precision measurements
- Technologies
  Sensing, measuring, imaging, communication, simulation and computing
- Platforms
  Superconducting qubits, Trapped ions, photonics, Nuclear magnetic resonance, Quantum dots, Diamond vacancies.

Reading List

Compulsory Readings

	Title
1	Michael A. Nielsen, Isaac L. Chuang Quantum Computation and Quantum Information CUP 2010. https://doi.org/10.1017/CBO9780511976667

Additional Readings

	Title
1	R. Loudon, Quantum Theory of Light, 3rd Edition (Oxford University Press, 2000)