PHY3251: QUANTUM MECHANICS

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Quantum Mechanics

Subject Code
PHY - Physics
Course Number
3251

Academic Unit
Physics (PHY)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
(1) AP3202/PHY3202 Modern Physics
(2) MA2158 Linear Algebra and Calculus (or equivalent)*

Precursors
Nil

Equivalent Courses
AP3251 Quantum Physics

Exclusive Courses
Nil

Additional Information
* This pre-requisite requirement (MA2158) is waived for Advanced Standing I students and Advanced Standing II students.

Part II Course Details

Abstract

To provide a fundamental understanding to the principles of modern physics. To lay the foundation for advanced courses such as solid-state physics. To introduce applications in semiconductor physics and electronic devices.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Establish the concept of the wave-particle duality of matter.	10	x		
2	Understand quantum state, wavefunction and its probability interpretation.	15	x		
3	Apply the Schrödinger equation to solve various problems: 1D quantum well, 1D potential barrier tunneling, 1D harmonic oscillator.	15		x	
4	Apply the Schrödinger equation to solve 3D physical system: the hydrogen atom.	10		x	
5	Understand quantized orbital angular momentum and spin angular momentum of electrons.	15		x	
6	Understand the fine structure of the hydrogen atom.	10		x	
7	Obtaining brief knowledge of identical particles.	10		x	
8	Understand time-independent perturbation theory	15		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.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Present basic theories, concepts and examples	1, 2, 3, 4, 5, 6, 7	2 hours/week
2	Tutorials	Provide additional explanations and help the students to practice what they learn in the lectures	1, 2, 3, 4, 5, 6, 7	1 hour/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Assignments	1, 2, 3, 4, 5, 6, 7	20	
2	Quizzes	1, 2, 3, 4, 5, 6, 7	20	

Continuous Assessment (%)

40

Examination (%)

60

Examination Duration (Hours)

2

Additional Information for ATs

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

Assessment Rubrics (AR)

Assessment Task

1. Assignments

Criterion

The student completes all assessment tasks/activities and the work demonstrates excellent understanding of the scientific principles and the working mechanisms.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not reaching marginal level

Assessment Task

2. Quizzes

Criterion

The student can thoroughly identify and explain how the principles are applied to science and technology for solving physics and engineering problems.

Excellent (A+, A, A-)

High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal level

Assessment Task
3. Examination

Criterion
The student can thoroughly identify and explain how the principles are applied to science and technology for solving physics and engineering problems.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal level

Part III Other Information

Keyword Syllabus

- The Stern-Gerlach Experiment.
- The Schrödinger Equation.
- The Infinite Square Well.
- The Harmonic Oscillator
- The Delta-Function Potential and Finite Square Well.
- Mathematical Foundations of Quantum Mechanics.
- Matrix Mechanics and Dirac Notation.
- Schrödinger Equation in 3D Systems.
- The Hydrogen Atom.
- Angular Momentum (orbital and spin); Angular Momentum Additions.
- Time-independent Perturbation Theory (non-degenerate and degenerate).
- Identical Particles.

Reading List

Compulsory Readings

	Title
1	David J. Griffiths, Introduction to Quantum Mechanics, Cambridge University Press; 3rd edition (August 16, 2018).

Additional Readings

	Title
1	J. J. Sakurai, Modern Quantum Mechanics, Cambridge University Press; 2nd edition (September 22, 2017).
2	R. Shankar, Principles of Quantum Mechanics, Plenum Press; 2nd edition (March 16, 2011).
3	Richard L. Liboff, Introductory Quantum Mechanics, Addison-Wesley; 4th edition (August 18, 2002).
4	The Feynman Lectures on Physics, Vol. III.