YACHAY TECH UNIVERSITY

SYLLABUS

1. General Information					
A.	SCHOOL	Physical Sciences and Nanotechnology	B.	MAJOR	Physics Nanotechnology
C.	COURSE	Quantum Mechanics I	D.	CODE	ECFN1009
E.	LEVEL	6th	F.	ACADEMIC TERM	Second Semester 2024
G.	CURRICULAR UNIT	Professional	H.	STUDY MODE	In person
I.	TOTAL HOURS	160	J.	PROFESSORS	Wladimir Eduardo Banda Barragán
K.	WEEKLY CLASS SCHEDULE	13:00 - 15:00 Wednesday 09:00 - 11:00 Thursday 09:00 - 11:00 Friday	L.	WEEKLY TUTORING SCHEDULE	14:00 - 15:00 Monday 12:00 - 13:00 Tuesday

2. Prerequisites and Corequisites			
PREREQUISITES		COREQUISITES	
COURSE	Code	COURSE	Code
Mathematical Physics I	ECFN1004		
Classical Mechanics	ECFN1006		
Modern Physics	ECFN1007		

3. Course Description

This course provides an introduction to the formal mathematical treatment of Quantum Mechanics. The course introduces the Schrödinger Equation and its solutions for different potentials, emphasising on the statistical interpretation of the wave function and its importance for the description of experiments at quantum scales. Topics range from quantum experiments, wave functions, the time-independent Schrödinger's equation, through Hilbert spaces and the mathematical formalism of quantum mechanics, to the description of the hydrogen atom and two-particle systems. The course includes examples of different applications of quantum mechanics, and guides students into writing Hamiltonians for different physical systems and extracting information about them.

4. Course Contribution to professional training

The course helps students to develop the mathematical skills needed to create realistic models of quantum systems.

5. Course objectives

- Understand the fundamental ideas and experiments that led to the formulation of quantum mechanics.
- Learn the mathematical skills and formalism needed to solve Schrödinger's equation and interpret its solutions.
- Study the Hamiltonians of quantum systems in 1D, 2D, and 3D for different potentials and coordinates, and provide a detailed quantum description of the hydrogen atom and two-particle systems.
- Use quantum mechanics to analyse real microscopic phenomena and interpret experimental data.

6. Units / Contents / Hours / Evaluation Instruments

CURRICULAR UNITS	CONTENTS	TEACHING HOURS	HOURS OF INTERNSHIP AND EXPERIMENTAL LEARNING	HOURS OF INDEPENDENT LEARNING	EVALUATION INSTRUMENTS
Unit 1. The Schrödinger equation	Review of quantum experiments and mathematical tools.	3	2	2	Classwork (quizzes), homework (assignments), and exams.
	The wave function and the Schrödinger equation.	3	2	2	Classwork (quizzes), homework (assignments), and exams.
	Statistical interpretation of the wave function and probability.	3	2	2	Classwork (quizzes), homework (assignments), and exams.
	Normalisation, momentum, and the uncertainty principle.	3	2	2	Classwork (quizzes), homework (assignments), and exams.
Unit 2. Quantum Mechanics in 1D	Stationary states and the time-independent Schrödinger equation.	3	3	3	Classwork (quizzes), homework (assignments), and exams.
	Free particles and wave packets.	3	3	3	Classwork (quizzes), homework (assignments), and exams.
	Finite, Infinite potential wells, and the harmonic oscillator.	3	3	3	Classwork (quizzes), homework (assignments), and exams.

	Delta-function potentials, tunnelling and scattering states.	3	3	3	Classwork (quizzes), homework (assignments), and exams.
Unit 3. Mathematical formalism of Quantum Mechanics	Linear algebra, Hermitian operators, and Hilbert space	3	2	2	Classwork (quizzes), homework (assignments), and exams.
	Eigenfunctions, eigenvectors, and eigenvalues for discrete and continuous spectra.	3	2	2	Classwork (quizzes), homework (assignments), and exams.
	Dirac notation and the Generalised statistical interpretation	3	2	2	Classwork (quizzes), homework (assignments), and exams.
	Operators of position and momentum and the uncertainty principle	3	2	2	Classwork (quizzes), homework (assignments), and exams.
Unit 4. Quantum Mechanics in 3D	Schrodinger Equations in Spherical Coordinates	4	3	3	Classwork (quizzes), homework (assignments), and exams.
	Coulomb potential and quantum description of the Hydrogen atom	4	3	3	Classwork (quizzes), homework (assignments), and exams.
	Angular momentum and spin	4	3	3	Classwork (quizzes), homework (assignments), and exams.
	Larmor precession and the Stern- Gerlach experiment	4	3	3	Classwork (quizzes), homework (assignments), and exams.
Unit 5. Two-Particle Systems and quantum applications	Identical particles and introduction to two-particle systems.	3	2	2	Classwork (quizzes), homework (assignments), and exams.
	Exchange interactions, spin, and the generalised symmetrisation principle	3	2	2	Classwork (quizzes), homework (assignments), and exams.

	Atoms, the periodic table, and introduction to solids	3	2	2	Classwork (quizzes), homework (assignments), and exams.
	Applications of quantum mechanics	3	2	2	Classwork (quizzes), homework (assignments), and exams.
TOTAL		64	48	48	160

7. Learning outcomes of the course

LEARNING OUTCOMES		STUDENT IS REQUIRED TO: (EVIDENCE OF LEARNING)
A.	Understand the fundamental ideas and experiments that led to the formulation of quantum mechanics.	Submit quizzes based on reading material and laboratory applets (classwork). Hand in the solutions to problem sets and submit group projects (homework). Solve problems in exams (mid-term and final exams).
B.	Learn the mathematical skills and formalism needed to solve Schrödinger's equation and interpret its solutions.	Submit quizzes based on reading material and laboratory applets (classwork). Hand in the solutions to problem sets and submit group projects (homework). Solve problems in exams (mid-term and final exams).
C.	Study the Hamiltonians of quantum systems in 1D and 3D for different potentials and coordinates, and provide a detailed quantum description of the hydrogen atom and two-particle systems.	Submit quizzes based on reading material and laboratory applets (classwork). Hand in the solutions to problem sets and submit group projects (homework). Solve problems in exams (mid-term and final exams).
D.	Use quantum mechanics to analyse real microscopic phenomena and interpret experimental data.	Submit quizzes based on reading material and laboratory applets (classwork). Hand in the solutions to problem sets and submit group projects (homework). Solve problems in exams (mid-term and final exams).

8. Methodology

1. Interactive lectures including theory and exercises.
2. Classwork including exercises and quizzes based on reading material and online laboratory applets.
3. Individual and group projects including problem sets and bibliographic research.

9. Information Sources (Bibliography)

9.1 Main

Author/s	Title of Work	Edition	Year of Publication	Publishing house - Country	Availability at Yachay Tech Library
Griffiths, David	Introduction to Quantum Mechanics	2nd	2017	Cambridge University Press – United States	530.12 G8553i 2017

9.2 Complementary

Author/s	Title of Work	Edition	Year of Publication	Publishing house - Country	Availability at Yachay Tech Library
Townsend, John	A Modern Approach to Quantum Mechanics	2nd	2012	University Science Books – United States	530.12 T748m 2012
Tong, David	Lectures on Quantum Mechanics	--	2021	http://www.damtp.cam.ac.uk/user/tong/quantum.html	Online

10. Student's Evaluation

10.1. Evaluation during the course*

Midterm Exam (EME)		Formative Evaluation (EFO)		Laboratory (LAB) **		Final Exam (EFI)		Total
1 Midterm Exam	30 %	Homework average (problem sets, project reports, and online laboratory)	20 %	Classwork average (reading tasks, concept quizzes, and online laboratory)	20 %	1 Final Exam	30 %	100 %
Subtotal	30 %	Subtotal	20 %	Subtotal	20 %	Subtotal	30 %	

10.2. Makeup Exam

N/A

11. General considerations
● Students are responsible for ensuring the academic integrity of their submitted assignments and exams. ● Cheating in exams, plagiarising, and copying solutions from other students, from solution manuals, or from previous years' solutions are all breaches of academic integrity. ● Academic misconduct will be penalised according to the University’s regulations. ● Assignment deadlines and exam dates will be discussed and agreed upon in class. Once fixed, they are hard deadlines.

(*) The teaching staff will register the scores generated up to mid-semester in Moodle, by the deadline set in the academic calendar for this term. When defining the weights of each item, it is necessary to observe what is established in Article 35 of the Internal Rules of the Academic Regime of UITEY.

(**) For courses without a laboratory component, indicate: N/A.

Prepared by:	Reviewed by:	Approved by:
PROFESSOR - PROFESSORS	**DESIGNATED PERSONNEL**	**DEAN – LANGUAGE DIRECTOR**
SIGNATURE AND DATE:	**SIGNATURE AND DATE:**	**SIGNATURE AND DATE:**