

## YACHAY TECH UNIVERSITY

### COURSE PROGRAM

1. General Information							
A.	SCHOOL	Physical Sciences and Nanotechnology			B.	MAJOR	Physics Nanotechnology
C.	COURSE	Quantum Mechanics I			D.	CODE	ECFN1009
E.	CURRICULAR UNIT	Professional			F.	STUDY MODE	In person
G.	TOTAL HOURS	64 <sup>1</sup>	48 <sup>2</sup>	48 <sup>3</sup>			

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

3. Course Description
<p>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.</p>

<sup>1</sup> Teaching Hours

<sup>2</sup> Hours of Internship and Experimental Learning

<sup>3</sup> Hours of Independent Learning

#### 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

CURRICULAR UNITS	CONTENTS
Unit 1. The Schrödinger equation	Review of quantum experiments and mathematical tools.
	The wave function and the Schrödinger equation.
	Statistical interpretation of the wave function and probability.
	Normalisation, momentum, and the uncertainty principle.
Unit 2. Quantum Mechanics in 1D	Stationary states and the time-independent Schrödinger equation.
	Free particles and wave packets.
	Finite, Infinite potential wells, and the harmonic oscillator.
	Delta-function potentials, tunnelling and scattering states.
Unit 3. Mathematical formalism of Quantum Mechanics	Linear algebra, Hermitian operators, and Hilbert space
	Eigenfunctions, eigenvectors, and eigenvalues for discrete and continuous spectra.
	Dirac notation and the Generalised statistical interpretation
	Operators of position and momentum and the uncertainty principle
Unit 4. Quantum Mechanics in 3D	Schrodinger Equations in Spherical Coordinates
	Coulomb potential and quantum description of the Hydrogen atom
	Angular momentum and spin
	Larmor precession and the Stern- Gerlach experiment

Unit 5. Two-Particle Systems and quantum applications	Identical particles and introduction to two-particle systems.
	Exchange interactions, spin, and the generalised symmetrisation principle
	Atoms, the periodic table, and introduction to solids
	Applications of quantum mechanics

## 7. Learning outcomes of the course

### CAREER LEARNING OUTCOMES (ONLY THOSE THAT SPECIFICALLY APPLY TO THE SUBJECT)

A.	Understand the fundamental ideas and experiments that led to the formulation of quantum mechanics.
B.	Learn the mathematical skills and formalism needed to solve Schrödinger's equation and interpret its solutions.
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.
D.	Use quantum mechanics to analyse real microscopic phenomena and interpret experimental data.

## 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	<a href="http://www.damtp.cam.ac.uk/user/tong/quantum.html">http://www.damtp.cam.ac.uk/user/tong/quantum.html</a>	Online

## 10. Student's Evaluation

### 10.1. Evaluation during the course

Midterm Exam (EME) <input checked="" type="checkbox"/>	Formative Evaluation (EFO) <input checked="" type="checkbox"/>	Laboratory (LAB) <input checked="" type="checkbox"/>	Final Exam (EFI) <input checked="" type="checkbox"/>
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The inputs that contribute to the completion of this format must be taken from the major project or major redesign approved by CES.

Prepared by:	Reviewed by:	Approved by:
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