Course Title	Course Code	Number of Study Hours				Year	Level	Prerequisites
		Theo.	Lab.	Credit	ECTS			
Quantum Mechanics	PHYS603	3	-	3	11	1st	2nd	-

Student's workload			
In-class activities	Contact Hours	Self-learning/study	Hours
Lectures	45	Preparation for classes	148
Laboratory	-	Case studies	-
Exams and quizzes	5	Working on lab experiment	-
Lab demo	-	HW/Assignments	61
		Study for exam	50
Total	50	Total	259
Total Learning Hours = 309		Equivalent ECTS points= Total LH/28 = 11	

BRIEF COURSE DESCRIPTION

- This course is designed to establish the foundation of quantum mechanics starting with the axioms of quantum mechanics in finite and infinite dimensional vector spaces and their applicability to physics examples such as spin, position and momentum. The course then develops the use of unitary transformation and its essential role in deriving the commutation relations of various physical quantities. The course also addresses the quantum dynamics and provides the essential techniques to solve various physical systems. The theory of angular momentum is extensively studied in view of rotational symmetry, orbital angular momentum, Schrodinger's equation for central potentials, addition of angular momenta and tensor operators.

COURSE OBJECTIVES

The main objectives of this course are focused on the following:

1. Design vector spaces related to the physical quantities of interest in both Dirac representation and matrix representation.
2. Perform essential calculations such as expectation values, commutation relations and uncertainty relations.
3. Discuss the role of symmetry and unitary transformation in physics in general and in quantum mechanics in particular such as in deriving the commutation relation and comparing them to their classical analogues when existed, the time evolution of a quantum system.
4. Solve the eigenvalue problems for various quantum mechanical systems such as a particle in a box, the harmonic oscillator and the hydrogen atom, addition of angular momenta problems.
5. Distinguish between Schrödinger and Heisenberg pictures while studying the dynamics of quantum systems.
6. Perform commutation relations for angular momenta operators including spin.

COURSE CONTENTS

- The Stern-Gerlach Experiment, Kets, Bras, and Operators, Base Kets and Matrix Representations
- Measurements, Observables, Uncertainty Relations. Change of Basis.
- Position, Momentum, and Translation, Wave Functions in Position and Momentum Space.
- Time Evolution and the Schrodinger Equation.
- The Schrodinger Versus the Heisenberg Picture.
- Simple Harmonic Oscillator, Schrödinger Wave Equation.
- Elementary Solution to the Schrodinger equation: Various Examples.
- Rotations and Angular Momentum Commutation Relations, Spin 1/2 Systems in Finite Rotation.
- SO(3), SU(2) and Euler Rotations, Density Operators and Pure Versus Mixed Ensembles SO(3), SU(2) and Euler Rotations, Density Operators and Pure Versus Mixed Ensembles.
- Eigenvalues and Eigenstates of Angular Momentum. Orbital Angular Momentum.
- Schrodinger's Equation for Central Potentials, Addition of Angular Momenta, Tensor Operators.

ASSESSMENT CRITERIA	COURSE TEACHING STRATEGIES
• Mid-Term exams: 20 % • Assignments, classroom activities and Quizzes: 30 % • Final Exam: 50%	• Lectures, Discussion, Hands-on Tutorials, Active Learning.

TEXT BOOK	REFERENCE BOOKS
• J. J. Sakurai and Jim J. Napolitano, Modern Quantum Mechanics, (3rd edition, Cambridge University Press, 2021).	• L. E Ballentine, Quantum Mechanics: a Modern Development, (2nd edition, World Scientific, 2014). • R. Shankar, Principles of Quantum Mechanics, (2nd edition, Kluwer Academic, 1994).