هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T4
2020

Course Specifications

Course Title:	**Quantum Mechanics (1)**
Course Code:	**PHY3506**
Program:	**Physics**
Department:	**Physics**
College:	**Applied Sciences**
Institution:	**Umm Al-Qura University**

Table of Contents

A. Course Identification

1. Credit hours: 4 hrs	
2. Course type a. University ☐ College ☐ Department ☑ Others ☐ b. Required ☑ Elective ☐	
3. Level/year at which this course is offered: 7/3rd year	
4. Pre-requisites for this course (if any): Classical Mechanics (3)	
5. Co-requisites for this course (if any):	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	40	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	40
2	Laboratory/Studio	-
3	Tutorial	-
4	Others (specify) Exams/ Quizzes	-
	Total	40

B. Course Objectives and Learning Outcomes

1. Course Description

This course is intended to introduce concepts in quantum mechanics such that the behavior of the physical universe can be understood from a fundamental point of view. It provides a foundation for further study of quantum mechanics.
Content will include: The wavefunction and Schrodinger equation, operators, eigenfunctions, compatible observables, infinite well in one and three dimensions, degeneracy; Fourier methods and momentum space; Hermiticity; scalar products of wave functions, completeness relations, matrix mechanics; harmonic oscillator in one and three dimensions.

2. Course Main Objective

The main objective of this course is to provide the students with basic theoretical concepts and formalism of quantum mechanics for solving relevant physical problems. This includes the wave mechanics developed by Schrödinger and others and some aspects of the matrix formalism first developed by Heisenberg.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	Describe quantum mechanical systems by wave functions.	K1(I), K2(I)
1.2		
1.3	Recall the time-dependent and time-independent Schrödinger equation for simple potentials like for instance the Infinite Square Well and harmonic oscillator.	K1(I), K2(I)
1.4	Explain the concept of uncertainty in quantum physics.	K2(I)
1.5	Recognize the concept of eigenvalues, eigenfunctions, energy levels, bound and scattering states.	K1(I), K2(I)
1.6	Recognize the spin and angular momentum states as well as the angular momentum addition rules.	K1(I)
2	**Skills :**	
2.1	Solve the Schrödinger equation for potential in one dimension,	S1(I), S2(I)
2.2	Apply operators to it to obtain information about a particle's physical properties such as position, momentum, and energy.	S1(I)
2.3		S1(I)
2.4	describe the role of degeneracy in the occurrence of electron shell structure in atoms.	S1(I), S2(I)
2.5	Combine spin and angular momenta.	S1(I)
2.6		S2(I)
3	**Values:**	
3.1	Participate effectively in multidisciplinary and/or interdisciplinary teams.	V2(I)
3.2		
3.3		
3.4		

C. Course Content

No	List of Topics	Contact Hours
1	**Wave Functions in Quantum Mechanics:** Schrödinger equation, Statistical interpretation of the wavefunction, Normalization, Square-integrable wavefunction, expectation value, Momentum vs. Position space, Heisenberg uncertainty principle, the postulates of quantum mechanics	8
2	**One-Dimensional Problems:** Stationary States, Bound States & Scattering States, The Infinite Square Well, The Harmonic Oscillator, The Free Particle, The Delta Function Potential, The Finite Square Well.	12
3	**Formalism of Quantum Mechanics:** The Hilbert Space, Dimension and Basis of Vector Space, Square-Integrable Functions, Dirac notation, Operators, Observables, Eigenvalues and Eigenvectors, Discrete & Continuous Spectra, Matrix Representation of Kets, Bras, and Operators, momentum space wave function, Generalized Uncertainty Principle.	10
4	**Three-Dimensional Problems:** 3D Problems in Cartesian Coordinates, 3D Problems in Spherical Coordinates,	10
Total		40

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Describe quantum mechanical system by a wave function.	1. Lectures. 2. Discussions 3. Slides and computer simulation software may be used to clarify concepts. 4. Problems solving 5. Students may be asked to solve some problems using the MATLAB language.	1- Homework assignments. 2- Group Project assignment. 3- Question – answer session in class. 4- Exams: quizzes, Mid-term, and final exam
1.2	Recognize the meaning of the expectation value of any physical quantity.		
1.3	Be familiar with the time-dependent and time-independent Schrödinger equation for simple potentials like the Infinite Square Well and harmonic oscillator.		
1.4	Know the concept of uncertainty in quantum physics.		
1.5	Recognize the concept of eigenvalues, eigenfunctions, energy levels, bound and unbounded states.		
1.6	Recognize the spin and angular momentum states.		
2.0	**Skills**		
2.1	Solve the Schrodinger equation for some basic, physically important types of potential in one dimension, and estimate the shape of the wave function based on the shape of the potential.	1. Lectures. 2. Discussions. 3. Problem solving. 4. Encourage the student to look for the information in different references. 5. 6. Define duties for each chapter	**1**- Homework assignments. **2**- Group Project assignment. **3**- Question – answer session in class. **4**- Exams: quizzes, Midterm and final exams.
2.2	Apply operators to it to obtain information about a particle's physical properties such as position, momentum and energy.		
2.3	Use the commutation relations of operators to determine whether two physical properties can be simultaneously measured.		
2.4	Apply the separation of variables technique to solve problems in more than one dimension and to describe the role of degeneracy in the occurrence of electron shell structure in atoms.		
2.6	knowledge about fundamental quantum mechanical processes in nature.		
3.0	**Values**		
3.1	Participate effectively in multidisciplinary and/or interdisciplinary teams	**1.** Group assignments **2.** Clarify deadlines of assignments, reports, and exams.	**1.** Evaluate the efforts of each student in preparing the report.
3.2	Accepting different ideas and respecting other opinions.		

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
3.3	Manage a project (modelling or simulation) with due attention to time and resource management		**2.** Evaluate the work in teams. Evaluation of student's presentations.
3.4	Take responsibility and take the course instructions seriously.		

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Exercises and Homwork	All weeks	10%
2	Participation in activities and quizzes.	All weeks	10%
3	Midterm exam	6^{th} week	30%
4	Final exam	End of the term	50%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice:

Students are supervised by academic advisers in the physics Department and the timetables for academic advice were given to the student each semester. (8hrs per week).

F. Learning Resources and Facilities

1.Learning Resources

Required Textbooks	Introduction to Quantum Mechanics 2nd Edition, by David J. Griffiths, Pearson Education Limited (2014).
Essential References Materials	**1.** Quantum Mechanics: Concepts and Applications 2nd Edition, by Noureddine Zettili, John Wiley & Sons, Ltd, (2009). **2.** Quantum Physics, 3rd Edition, by Stephen Gasiorowicz, John Wiley & Sons, Inc, (2003).
Electronic Materials	https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2013/lecture-videos/
Other Learning Materials	

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	Classroom
Technology Resources	data show, software

Item	Resources
(AV, data show, Smart Board, software, etc.)	
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Student Feedback on Effectiveness of Teaching	Students	Direct
Evaluation of Teaching	Department	Indirect
Improvement of Teaching	Program leaders	Direct
Quality of learning resources	Faculty	Direct
Extent of achievement of course learning outcomes	Program leaders	Direct

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)
Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)
Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	Dr Atif Ismail, Dr. Walid Belhadj and Prof. Khaled Abdel-Waged
Reference No.	
Date	