Al al-Bayt University
Qality and Assurance Department

Faculty of Science
Physics Department

Course Outline of Quantum Mechanics I

1. Instructor's Information

Instructor's / Coordinator's Name:	Dr. Ahmed Fawaz Al-Jamel
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Research and Teaching Assistant / Supervisor / Technical (if any):	NA

2. Course Description

This is an Introductory course in quantum mechanics (or wave mechanics) for students who already took successfully Modern Physics and Mathematical Physics I. We begin by introducing the idea of the state of a particle by introducing the key function, viz., wave function, and discuss its meaning and properties, and the equation that it obeys, Schrödinger equation. After a thorough treatment of bound and unbound states in one-dimension, simple three-dimensional systems are discussed. Time independent and dependent Schrödinger wave equation, Solution of Schrödinger wave equation, Dirac Bra-Ket formalism, Operators, Eigenvalues, Eigenfunctions, applications of Schrödinger wave equation, Angular momentum.

3. Course Information

Course No.: 402461	Course Title: Quantum Mechanics 1	Level: 3rd or 4th yr
Course Type: Theoretical	Prerequisite: Modern Physics	Class Time: 10:00-11:00
Academic Year:2019-2020	Semester: Fall	Study hours:

4. Course Objectives:

a-	Review the historical origins of quantum mechanics (QM).
b-	Introduce the basic postulates of quantum mechanics and its various tools and concepts (wavefunction, Schrödinger equation, Hermitian operators, eigenvalues etc.)

c-	Explore the analytical solutions to the Schrodinger equation for various potentials such as particle in a box, potential steps, potential well, harmonic oscillator and H-atom.
d-	Introduce the creation and annihilation operators to solve the SHO.
e-	Use the Dirac Bra-Ket notations in various formalisms of QM.

5. Learning Outcomes (LO)
(Knowledge, Skills, and Competencies)(K,S,C)

Upon successful completion of the course, the students will be able to:

LO 1. Recognize the basic characteristics and statistical nature of quantum systems. (K)
LO 2. State the basic postulates of quantum mechanics. (K)
LO 3. Use the wavefunction to calculate expectation values of physical quantities like position and momentum using operators. (S)
LO 4. Apply Schrödinger equation as an energy eigenvalue problem to solve ideal simple systems with simple potentials such as particle in a box, potential barriers, and potential steps. (S)
LO 5. Solve the Schrödinger equation for more realistic problems such as tunnelling and harmonic oscillator and hydrogen atom. (S,C)
LO 6. Interpret the various results obtained from the applications on different quantum. (S,C)

6. Course Content

Week	Topic	Comments	Course Outcome
1	**CHAPTER 0: OVERTURE**	We review basic ideas covered in modern physics, and emergence of quantum mechanics.	LO1
2-4	**Chapter 1: THE WAVE FUNCTION** ➢ The Schrodinger equation ➢ The statistical interpretation ➢ Probability ➢ Normalization ➢ Momentum ➢ The uncertainty principle	To describe the state of a particle in QM language, we need to use the Schrodinger equation. The solution of this equation is called the wavefunction. It has a statistical interpretation. We can use it to find the expectation value of various physical quantities such as position, momentum, energy, etc.	LO1+ LO2+LO3

5-8	**Chapter 2: TIME-INDEPENDENT SCHRODINGER EQUATION** ➢ Stationary states ➢ The infinite-square well ➢ The harmonic oscillator ➢ The Free particle ➢ The delta-function potential ➢ The Finite square well	As prototype and exactly solvable potential problems in QM, we discuss and solve the situations to the left. These problems will be of great importance for students toward mastering the basic tools of QM.	LO2+LO3+ LO5+LO6
~FIRST EXAM ON OCTOBER 21 2019 (SUNDAY) 25%			
9-11	**Chapter 3: FORMALISM** ➢ Hilbert space ➢ Observables ➢ Eigenfunctions of a Hermitian operator ➢ Generalized statistical interpretation ➢ The uncertainty principle ➢ Dirac notation	In this chapter, we formulate the language of QM and most of what we did previously at a more advanced and appropriate level suing the concepts of Hilbert space and Dirac notations.	LO3+LO4
SECOND EXAM ON DECEMBER 01 2019 (SUNDAY) 25%			
12-15	**Chapter 4: Quantum mechanics in three dimensions** ➢ Schrodinger equation in spherical coordinates ➢ The Hydrogen atom ➢ Angular momentum ➢ Spin	Applications in three-dimensional space will be discussed as more realistic. The concept of angular momentum and spin in QM will be introduced. The concept of degeneracy will be introduced and explained and link it to symmetry.	LO5+LO6
16	Review	Review	**Final Exam**

7. Teaching and Learning Strategies and Evaluation Methods

No.	**Learning Outcomes**	**Teaching Strategies**	**Learning Activities**	**Evaluation /Measurement Method (Exam/ presentations/ discussion/ assignments)**
1	(LO1)	trad. lect.	Discussion & Problem Solving	HW & Mid-exam & Final Exam
2	(LO2)	trad. lect.	Discussion & Problem Solving	HW & Mid-exam & Final Exam
3	(LO3)	trad. lect.	Discussion & Problem Solving	HW & Mid-exam & Final Exam
4	(LO4)	trad. lect.	Discussion & Problem Solving	HW & Mid-exam & Final Exam
5	(LO5)	trad. lect.	Discussion & Problem Solving	HW & Mid-exam & Final Exam

8. Assessment

Methods Used	Assessment Time	Distribution of grades
1- semester work (report, assignments, attendance)	During semester	00%
3- First Exam	Tenth week	25%
3- Second Exam		25%
4- Final Exam	Week of the final exams	50%

9. Textbook

Main Reference	**Introduction to Quantum Mechanics, 2nd Edition,** □ **ISBN-10:** 0131118927 □ **ISBN-13:** 978-0131118928
Author	**David J. Griffiths**
Publisher	Pearson Prentice Hall
Year	2004
Edition	2nd (or any Edition)
Textbook Website	https://www.amazon.com/Introduction-Quantum-Mechanics-David-Griffiths/dp/0131118927

10. Extra References (books and research published in periodicals or websites)

1-	Stephen Gasiorowicz, Quantum Physics, John Wiley & Sons, Inc. 3rd Ed., (2003).
2-	J. L. Powell and B. Crasemann, Quantum Mechanics, Addison-Wesley Publishing Company.
3-	R. Shankar, Principles of Quantum Mechanics, 2nd Ed., Plenum Press.
4-	David Mcmahon, Quantum Mechanics Demystified, ISBN-13: 978-0071765633.