Course Specification

(Bachelor)

Course Title: :	**Quantum Mechanics (1)**
Course Code:	**PHY 1312**
Program:	**Bachelor of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	4
Last Revision Date:	***26/09/2024***

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A. General information about the course:

1. Course Identification

1. Credit hours: (3)

2. Course type

A.	☐University	☐ College	☒ Department	☐Track	☐Others
B.	☒ Required			☐Elective	

3. Level/year at which this course is offered: (Level 5/ Year 3)

4. Course General Description:

This course provides an introduction to the concepts and formalism of quantum mechanics. Primary emphasis is on the time-independent Schrödinger equation and its applications to simple systems such as the harmonic oscillator, the square-well potential, Delta-function potential, and the hydrogen atom without spin. The postulates of quantum mechanics will be developed in the formalism of operator observables acting on a linear state space of wave functions, in analogy with finite dimensional matrix operations on vectors..

5. Pre-requirements for this course (if any)**:**

Modern Physics, PHY 1250

6. Co-requisites for this course (if any)**:**

7. Course Main Objective(s):

- **Know the main features of the historical development of quantum mechanics.**
- **Acquire knowledge of the core aspects of quantum mechanics.**
- **Learn how to use the tools of quantum mechanics.**
- **Apply foundational mathematics to quantum mechanics.**
- **Learn the techniques to solve, through discussion and reading, a wide range of specific theoretical problems including their backgrounds and implications.**

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid • Traditional classroom		

No	Mode of Instruction	Contact Hours	Percentage
	• E-learning		
4	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	**30**
2.	**Laboratory/Studio**	**0**
3.	**Field**	**0**
4.	**Tutorial**	**30**
5.	**Others (specify)**	**0**
Total		60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Outline the background and main features of the historical development of quantum mechanics.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**State the historical importance of De Broglie's hypothesis, Schrödinger's wave function, and Born's probabilistic interpretation of the wave function.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Describe and solve the Schrödinger equation in the standard one-dimensional examples- infinite and finite square wells, infinite well potentials, free particle, harmonic oscillator, and hydrogen atom.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.4	**Define and describe the Hilbert space, Dirac notation, and Basic postulates of Quantum Mechanics.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			
2.1	**Explain and summarize the basic knowledge gained from studying electromagnetic fields course**.	**S1, S2**	▪ Lectures. ▪ Class discussions. ▪ Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	**Develop the students ability to solve and analyze problems in physics related the topics covered by the course.**	**S2, S3**	▪ Problem classes and group tutorial. Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. Homework.
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S4, S5**	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
1.	**Introduction (Historical Background)**: Development of the quantum theory, Experiments that led to the formulation of quantum mechanics, Wave-particle duality.	**4**
2.	**Wave Function:** Schrödinger equation, Statistical interpretation, Probability, Normalization, Fourier transform, Momentum, Position and momentum operators, Expectation value, Eherenfest's theorem, Uncertainty principle.	**16**

3.	**Time-Independent Schrödinger Equation:** Introduction, Method of separation of variables, Stationary states, Hamiltonian, Linear combination, Infinite square well, Harmonic oscillator, Free particle, Delta-function potential, Finite square well, Hydrogen atom.	20
4.	**Formalism& Mathematical background:** Hilbert space; vectors; Inner product; Linear transformation, Observables; Hermitian operators; Determinate states, Eigenfunctions of a Hermitian operator; Discrete spectra; Continuous spectra, Generalized statistical interpretation, The Uncertainty principle; Proof the generalized uncertainty principle; The Minimal-uncertainty wave packet; The Energy-time uncertainty principle, Dirac notation; Matrix elements; Ket; Bra; Dual space; Projection operator.	20
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc......)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**6th week**	**25 %**
4.	**Midterm Exam 2**	**12th week**	**25 %**
5.	**Final Exam**	**16th week**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	- Sadiku M., ***Elements of Electromagnetic***, 2nd Edition, Saunders College (1995).
Supportive References	- Nayfeh M.H. and Brussel M.K, ***Electricity and Magnetism,*** John-Wiley & Sons, New York (1985). - Griffiths D. J., ***Introduction to Electrodynamics,*** 3rd Edition, Prentice Hall, N. J, USA (1999).
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities	**- Classrooms.** **- Labs.**

Items	Resources
(Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	
Technology equipment (projector, smart board, software)	- **Classroom equipped with a whiteboard and a projector.**
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	- **Students** - **Second examiner**	- **Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)**
Effectiveness of Students assessment	- **Instructors**	- **Direct (exams, HW, project, ...)**
Quality of learning resources	- **Faculty** - **Students**	- **Indirect (surveys)**
The extent to which CLOs have been achieved	- **Instructors** - **Program Leaders**	- **Direct (excel sheet)**
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**Quality Unit-Physics Department**
REFERENCE NO.	**Department council No. 06**
DATE	**26/09/2022**