Course Specification
(Bachelor)

Course Title: :	**Quantum Mechanics (2)**
Course Code:	**PHY 1313**
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***

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (2)					
2. Course type					
A.	☐University	☐ College	☒ Department	☐Track	☐Others
B.	☒ Required		☐Elective		
3. Level/year at which this course is offered: (Level 6/ Year 3)					
4. Course General Description:					
A continuation of PHY 1312, this course introduces quantum mechanics in three-dimensional systems, perturbation and approximation methods, and scattering theory.					
5. Pre-requirements for this course (if any)**:**					
Quantum Mechanics (1), PHY 1312					
6. Co-requisites for this course (if any)**:**					
7. Course Main Objective(s):					
At the end of this course, students will be able to: • **Apply the concept of quantum Mechanics to quantitatively predict behavior of the quantum physical systems.** • **Choose the appropriate mathematical techniques.** • **Deal with conceptually rich and technically difficult theoretical problems.** • **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	45	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	**15**
2.	**Laboratory/Studio**	**0**
3.	**Field**	**0**
4.	**Tutorial**	**30**
5.	**Others (specify)**	**0**
Total		45

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	**Describe the Schrödinger equation in three dimensions and quantization of angular momentum.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**Outline the background and main features of perturbation method.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Define and write the WKB Approximation for solving the Eigenvector equation.**	**K1, K2**	• Lectures. • Class discussions. Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. Homework.
1.4	**Describe the scattering theory.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			
2.1	**Explain and summarize the basic knowledge gained from studying the 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**	**S4, S5**	• Lectures. • Class discussions.	▪ Exams.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	orally, and using IT for acquiring and analyzing information.		• Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ 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.	**Quantum Mechanics in Three Dimensions:** Introduction, Schrödinger equation in spherical coordinates, Method of separation of variables, Angular equation, Azimuthal quantum number, magnetic quantum number, radial equation, Effective potential, Infinite spherical well, Hydrogen atom, Angular momentum, Eigenvalues, Eigen functions, Spin. Pauli spin matrices, Stern-Gerlach experiment, Addition of angular momenta.	**10**
2.	**Time-Independent Perturbation Theory:** Nondegenerate perturbation theory, First-order corrections, Second-order corrections, Degenerate perturbation theory, Fine structure of Hydrogen, Stark effect, Zeeman effect, Hyperfine splitting.	**10**
3.	**WKB Approximation:** Classical region, Tunneling, Connection Formulas.	**10**
4.	**Time-Dependent Perturbation Theory:** Quantum dynamics, perturbed system, Time-Dependent Perturbation Theory, Two-Level systems, Emission and absorption of radiation, incoherent perturbation, spontaneous emission.	**10**
5.	**Scattering:** Introduction, Classical scattering theory, Quantum scattering theory, Partial wave analysis, Phase shifts, Born approximation.	**5**
Total		**45**

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	6thweek	25 %
3.	Midterm Exam 2	12thweek	25 %
4.	Final Exam	16thweek	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	- Griffiths D.J., ***Introduction to Quantum Mechanics***, 2nd Edition, Pearson Prentice Hall, NJ, USA (2004).
Supportive References	- Gasiorowicz S., ***Quantum Physics,*** 3rd Edition, Wiley, NJ, USA (2003). - Liboff R.L., ***Introductory Quantum Mechanics,*** Addison Wesley(2002).
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, laboratories, exhibition rooms, simulation rooms, etc.)	- Classrooms. - Labs.
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.

Assessment Areas/Issues	Assessor	Assessment Methods
		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	26/09/2024