هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA T4 2020

Course Specifications

Course Title:	**Quantum Mechanics (2)**
Course Code:	**PHY3507**
Program:	**Physics**
Department:	**Physics**
College:	**Applied Sciences**
Institution:	**Umm Al-Qura University**

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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: 8/3rd Year
4. Pre-requisites for this course (if any): **Quantum Mechanics (1)**
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 builds upon quantum mechanics (1) in the previous level, and specifically introduces a variety of theoretical developments, including the theory of angular momentum, spin, Time –Independent perturbation theory, variational principle, and identical particles.

2. Course Main Objective

This course together with quantum mechanics (1) and quantum mechanics (3) offer a systematic introduction and fundamental background to non-relativistic quantum mechanics.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge and understanding**	
1.1	Describe spin and orbital angular momentum operators, angular momentum states, as well as the angular momentum addition rules.	K1(I)
1.2	Identify symmetric or asymmetric wave functions.	K2(I)
1.3	Differentiate between Fermions and Bosons.	K1(I)
1.4	Describe approximate methods for solving the Schrödinger equation (the variational method, Stationary perturbation theory).	K1(I), K2(I)
2	**Skills:**	
2.1	Combine spin and orbital angular momenta.	S1(I)
2.2	Solve the Schrödinger equation for interacting many particles systems.	S1(I), S2(I)
2.3	Apply the variational method and time-independent perturbation theory to solve simple problems.	S1(I), S2(I)
3	**Values:**	
3.1	Participate effectively in multidisciplinary and/or interdisciplinary teams.	V2(I)
3.2		V1(I), V2(I)
3.3		V1(I)
3.4		V1(I)

C. Course Content

No	List of Topics	Contact Hours
1	Central Potential, Hydrogen Atom, Orbital Angular Momentum, Spin Angular Momentum, Eigenfunctions of Orbital Angular Momentum.	8
2	**Addition of Angular Momenta:** Rotations in Classical Physics, Rotations in Quantum Mechanics, Infinitesimal Rotations, Finite Rotations properties of the Rotation Operator, Euler Rotations, Representation of the Rotation Operator, Rotation Matrices and the Spherical Harmonics, General Formalism of Angular Momentum (Total Angular Momentum), Addition of Angular Momenta, Calculation of the Clebsch–Gordan Coefficients, Coupling of Orbital and Spin Angular Momenta.	10
3	**Time evolution of a quantum system:** Time dependent Schrödinger equation, The Schrödinger and Heisenberg pictures, Interaction Picture,	12
4	**Interaction of electron with electromagnetic field:** coupling of electron to vector potential, the normal Zeeman effect, electron motion in a uniform magnetic field,	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	Be familiar with spin and orbital angular momentum operators, angular momentum states, as well as the angular momentum addition rules.	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 MATLAB language	1- Homework assignments. 2- Group Project assignment. 3- Question – answer session in class. 4- Exams: quizzes, Mid-term, and final exams
1.2	Description of a system of identical particles by appropriate symmetric or asymmetric wave functions.		
1.3	Differentiate between Fermions and Bosons.		
1.4	Describe approximate methods for solving the Schrödinger equation (the variational method, Stationary perturbation theory).		
2.0	**Skills**		
2.1	Combine spin and orbital angular momenta.	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	knowing how to deal with the Schrödinger equation for interacting many particles systems.		
2.3	Apply the variational method and time-independent perturbation theory to solve simple problems.		
3.0	**Values**		
3.1	Participate effectively in multidisciplinary and/or interdisciplinary teams	**1.** Groupe assignments **2.** Clarify deadlines for delivery of assignments, reports, and exams.	**1.** Evaluate the efforts of each student in preparing the report. **2.** Evaluate the work in teams. Evaluation of student's presentations.
3.2	Accepting different ideas and respecting other opinions.		
3.3	Manage a project (modelling or simulation) with due attention to time and resource management		
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 HomeWorks	All weeks	10%
2	Participation in activities	All weeks	10%
3	Mid-term exam	5th 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.)	Lecture room Labs
Technology Resources (AV, data show, Smart Board, software, etc.)	data show
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/Issues	Evaluators	Evaluation Methods

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	