هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

2023
TP-153

Course Specification
(Bachelor)

Course Title:	Quantum Physics 2
Course Code:	2034204-2
Program:	Bachelor in Physics
Department:	Physics Department
College:	College of Science
Institution:	Taif University
Version:	3
Last Revision Date:	24/05/2022

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 8/ year 4)					
4. Course general Description:					
Operators (Review). Matrix formulation of Quantum Physics. The simple harmonic oscillator problem. Time development of a system in terms of operators. Interaction of electrons with electromagnetic field; Zeeman effect. Approximation Methods					
5. Pre-requirements for this course (if any):					
Quantum Physics 1 (2033202-3)					
6. Co-requisites for this course (if any):					
None					
7. Course Main Objective(s):					

- **To introduce students to operators and their role in Quantum Physics.**
- **To solve the simple harmonic oscillator problem using operators.**
- **To point out the importance of Quantum Physics in other disciplines, and in research.**
- **To draw the attention of students to the special functions that appear in Quantum Physics, and previously in Mathematical Physics 1.**
- **To study the time evolution of a system.**
- **To teach the students the interaction of electrons with electromagnetic field, and to relate that to experiments where available, as Zeeman Effect.**
- **To represent matrix formulation in Quantum Physics.**
- **To point out the importance of approximation methods in Quantum Physics.**

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	2	100 %
2	E-learning	0	0 %
3	Hybrid • Traditional classroom • E-learning	0	0 %
4	Distance learning	0	0 %

3. Contact Hours (based on the academic semester)

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

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

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	Define the fundamental concepts of quantum physics theory	K2	Lecture	Written exam and homework reports
1.2	Understanding the quantum physics precisely the approach methods to solve Schrodinger equation	K3	Lecture and group discussion	Written exam
2.0	**Skills**			
2.1	To use mathematical formulation to describe the physical principle or phenomena.	S1	Lecture	Written exam and homework reports

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
2.2	How to use physical laws and principles to understand the subject	S3	Lecture and group discussion	Written exam; and summarizing research papers
3.0	**Values, autonomy, and responsibility**			
3.1	Show responsibility for working independently and for continuous improvement of personal capabilities	V1	Group discussion	Project and Class performance
3.2	Enrich his/here physics understanding of Quantum Physics-2 rather than using it as pure mathematics. Communicate and explain the physics wealth in Quantum Physics-2 with others by speaking and writing	V2	Group discussion	Homework reports and projects

C. Course Content

No	List of Topics	Contact Hours
1.	Operators-Review: ▪ Definition of an operator ▪ Schrödinger equation ▪ Solutions of the eigenvalue equation ▪ Superposition principle ▪ Commutation relations ▪ Coordinate operators ▪ Linear momentum and angular momentum operators	4
2.	Matrix formulation of Quantum Physics: ▪ Basis and Representations ▪ Elementary matrix properties ▪ Matrix representation of harmonic oscillator operators ▪ The energy representation ▪ Matrix representation of angular momentum operators	6

	▪ The Pauli spin matrices	
3.	The simple harmonic oscillator problem: ▪ Definition of the simple harmonic oscillator problem ▪ Ladder operators ▪ Eigenstates and eigenvalues ▪ The interpretation of the wave function as probability amplitude	4
4.	Time development of a system in terms of operators: ▪ Time-dependent Schrödinger equation; separation of variables ▪ Time development of a harmonic oscillator ▪ Ehrenfest's principle ▪ Description of a systems by three pictures: Schrödinger, Heisenberg, and Dirac	4
5.	Interaction of electrons with electromagnetic field: ▪ Maxwell's equations ▪ Coupling of electrons to vector potential ▪ Schrödinger equation for an electron in a uniform magnetic field ▪ The normal Zeeman effect ▪ The anomalous Zeeman effect	4
6.	Approximation Methods: ▪ Time-independent, non-degenerate and degenerate perturbation theory ▪ The Stark effect ▪ Time-dependent perturbation theory ▪ Variational method	6
7.	General Review	2
	Total	**30**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Activities	Periodically	20%
2.	Periodic exam 1	8^{th} -9^{th}	15%
3.	Periodic exam 2	13^{th} -14^{th}	15%
4.	Final exam	16^{th} -17^{th}	50%

*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	R. L. Liboff; Introductory Quantum Mechanics; Addison-WesleyPublishingCompany, Massachusetts, (1980).
Supportive References	S. Gasiorowicz, Quantum Physics, John Wiley and Sons, New York (1974).

Electronic Materials	http://hyperphysics.phy-astr.gsu.edu/
Other Learning Materials	MATHEMATICA, MATHLAB

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Lecture room with max 60 seats
Technology equipment (projector, smart board, software)	data show, Smart Board, software
Other equipment (depending on the nature of the specialty)	None

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Student Feedback on Effectiveness of Teaching	Students	Indirect
Evaluation of Teaching	Peer reviewer Program coordinator Departmental council Faculty council	Indirect
Improvement of Teaching	Program coordinator Relevant committee	Direct
Quality of learning resources	Students Instructor Department Faculty	Indirect
Extent of achievement of course learning outcomes,	Program coordinator Instructor Departmental council	Direct

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

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**PHYSICS DEPARTMENT COUNCIL**
REFERENCE NO.	**NO. 4-45**
DATE	**27/09/2023 (12/03/1445)**

قسم الفيزياء
Physics Department
TU
جامعة الطائف
TAIF UNIVERSITY