University of Halabja

College of Science

Physics department

Quantum Mechanics

Academic Year: 2023-2024

1. Information on the Programme	
Higher education institution	**University of Halabja**
College	**College of Science**
Department	**Physics**
Field of study	**Quantum Mechanics**
Cycle of study[1]	**First Cycle**
Specialization/ Study program	**N/A**
Form of education	**Full time**

2. Information on the Discipline			
Discipline Name	**Quantum Mechanics**	**Discipline Code**	UOH102502
ECTS	**5**	**Language**	English
Lecturer (Theory)	**Ala Hamd Hssain**	**Home page**	https://sites.google.com/uoh.edu.iq/ala-hamid
E-mail	**Ala.hssain@uoh.edu.iq**	**Tel**	+964 7701599351
Practical/Seminar/ laboratory/ project Lecturer		**Home page**	……..
E-mail		**Tel**	
Study Year	**1**	**Semester**	1th
Assessment type[2]	**Continuous Evaluation**	**Discipline status**	
Content[3]	**CD**	**Mandatory**[4]	MD

3. Prerequisites (if applicable)	
Curriculum-related	Math up to and including differential equations and linear algebra (matrices), A course in modern physics including a qualitative understanding of wave/particle duality and basics about an atomic theory like electron energy levels and how light and matter (electrons) interact.
Skills-related	Scientific Imagination

	No. of Weeks	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week	8th Week	9th Week	10th Week	11th Week	12th Week	13th Week	14th and 15th Week (Final	Total
Contact Hours	Theoritical	3	3	3	3	3	3	3		3	3	3	3	3		36
	Practice															0
	Lab./Tutorial															0
	Fieldtrips/Visits							1			1					2
	Project															0
Self Study	Curriculum (articles+media+net)						1			1			1			3
	Curriculum (Books)	1	1													2
	Homework	1	1			1		1			1		1			6
	Quizzes				1		1			1		1		1		5
	Assignments					1							1			2
	Reports															0
	Presentation								1							1
	Midterm Exam (Thr. + Pr.)	1	3													4
	Final Exam (Thr. + Pr.)	1													6	6

4. Total Estimated Time (teaching hours per semester[5])

Contact Hours	59	Self study		66
Total Workload	125	ECTS		5
Items	**NO.**	**TF.**	**WL.**	**ECTS**
Lecture (Thr.)	13	3	39	1.44
Lecture (Pr.)	0	0	0	0.00
Lecture (Tut.)	0	0	0	0.00
Fieldtrips/Visits	2	10	20	0.74
Project	0	0	0	0.00
Curriculum(articles+media+net)	10	0.2	2	0.07
Curriculum (Books)	40	0.5	20	0.74
Homework	6	2	12	0.44
Quizzes	5	0.2	1	0.04
Assignments	2	3	6	0.22
Reports	0	0	0	0.00
Presentation	1	3	3	0.11
Midterm Exam (Thr. + Pr.)	1	8	8	0.30
Final Exam (Thr. + Pr.)	1	14	14	0.52

5. Conditions (if applicable)	
For the Theoretical	The student must respect his classmates and teachers. Students must present 90% of lectures.
For the Practical/Lab.	

6. Cumulated specific competences	
Professional competencies	Problem-solving, Thinking like a physicist.
Transversal competences	Data analyzing, Problem-solving, teamwork, and critical thinking.

7. Discipline objectives (based on the cumulated specific competencies)	
General objective	Quantum mechanics is the fundamental theory to describe the infinitesimally small objects, elucidating the physical properties of nature at the scale of atoms and subatomic particles.

Specific objectives (Learning Outcomes)	On successful completion of the Course, you should be able to: 1. Have a historical background of some theories that led to the foundation of Quantum Mechanics. Topics include: Black body radiations, photoelectric effect, de Broglie waves, and the wave-particle duality of matter and light. 2. Introduction to wave mechanics: Schrödinger's equation, wave functions, wave packets, probability amplitudes, the Heisenberg uncertainty principle. Solutions to Schrödinger's equation in one dimension: transmission and reflection at a barrier, barrier penetration, potential wells, the simple harmonic oscillator. 3. Schrödinger's equation in three dimensions: central potentials and introduction to hydrogenic systems.

8. Content

Theoretical- Number of hours	**Teaching**	**Observation**
First week	Introduction: Particle Aspect of Radiation**,** Wave Aspect of Particles**,** Heisenberg's Uncertainty Principle, Probabilistic Interpretation**,** Atomic Transitions and Spectroscopy**,** Bohr Model of the Hydrogen Atom, Wave Packets	3 hours
Second week	Mathematical Tools of Quantum Mechanics, The Hilbert Space and Wave Functions, Dimension and Basis of a Vector Space, Dirac Notation, Operators, Hermitian Adjoint, Functions of Operators, Eigenvalues and Eigenvectors of an Operator	3 hours
Third week	Representation in Discrete Bases, Representation in Continuous Bases, Parity Operator, Matrix and Wave Mechanics	3 hours

Fourth week	Postulates of Quantum Mechanics, The State of a System, Observables and Operators	3 hours
Fifth week	Time Evolution of the System's State Schrödinger Equation and Wave Packet, Symmetries and Conservation Laws	3 hours
Sixth week	One-Dimensional Problems, Discrete Spectrum (Bound States), Continuous Spectrum (Unbound States), Mixed Spectrum,	3 hours
Seventh week	The Free Particle: Continuous States, The Potential Step, The Potential Barrier and Well, The Tunneling Effect, The Infinite Square Well Potential,	3 hours
Eighth week		3 hours
Ninth week		3 hours
Eleventh week		3 hours
Twelfth week		3 hours
Thirteenth week		3 hours

9. Compulsory bibliography

1- Zettili, Nouredine (2009). Quantum Mechanics: Concepts and Applications. Chichester, UK: Wiley.

Optional bibliography

1- David McMahon (2005). Quantum Mechanics Demystified-McGraw-Hill Professional

10. Corroborating the discipline content with the expectations of the epistemic community representatives, of the professional associations, and of the relevant employers in the corresponding field

1. **Fundamental of physics**
2. **Technical Knowledge**
3. **Problem-solving**
4. **Use mathematics to solve problems.**
5. **How to address problems**

11. Assessment			
Type of Activity	**Assessment criteria**[2]	**Assessment type**	**Final grade Percentage**
Theoretical	**…..**	**writing examination**	**…**
Practical/Laboratory			
Activity during semester	**Oral Exam**	**Assignment, Seminars Quiz &Class Activity**	**%40**
Performance standards:			

Theoretical Lecturer	**Ala Hamd Hssain**
Practice Lecturer	

Approved by the Curriculum Development committee	
1	م.ی سامان سەرکەوت جعفر
2	د.ئالا حامد حسين
3	م.ی بهاالدين محمد حسين
Head of the Department/ Dean	م.ی هيوا عبدالله

Notes:

1 Cycle of studies - choose one of the three options: Bachelor «1», Master «2», Ph.D. «3»

2 (Exam: oral examination, written exam), and (Continous Evaluation(CE), portfolio).

3 Discipline status (content) - for the Bachelor level, choose one of the options: FD (fundamental (General) discipline), PF (Preparatory Disciplines in the Field), SD (Specialty Disciplines), CD (Complementary Disciplines), DU (disciplines based on the university's options).

4 Discipline status (compulsoriness) - choose one of the options

– MD (Mandatory discipline),

- OD (optional discipline),

- ED (Elective (Facultative) discipline).

5 Note: 1 ECTS = 27 hours workload; ECTS=WL/27, The first week is registration and introduction to the course.