Kingdom of Saudi Arabia
National Commission for
Academic Accreditation & Assessment

المملكة العربية السعودية
الهيئة الوطنية للتقويم
والاعتماد الأكاديمي

كلية العلوم التطبيقية
Faculty of Applied Sciences

Kingdom of Saudi Arabia
The National Commission for Academic Accreditation & Assessment

T6. Course Specifications (CS)

Course title: Quantum Mechanics (1)

Course code: 23063323-4

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Course Specifications

Institution: **Umm AL – Qura University**	Date : **18/1/1439**
College/Department : **College of Applied Science – Department of Physics**	

A. Course Identification and General Information

1. Course title and code: **Quantum Mechanics (1) (code: 23063323-4)**
2. Credit hours: **4 Hrs**
3. Program(s) in which the course is offered. **BSc Physics**
(If general elective available in many programs indicate this rather than list programs)
4. Name of faculty member responsible for the course
One of the academic staff member
5. Level/year at which this course is offered : **3rd Year / 5th Level**
6. Pre-requisites for this course (if any) : **Theoretical Methods in Physics (1) (4032141-4)**
7. Co-requisites for this course (if any) : ---
8. Location if not on main campus: **Main campus and Alzaher**
9. Mode of Instruction (mark all that apply)

a. traditional classroom	✓	What percentage?	100%
b. blended (traditional and online)		What percentage?	
c. e-learning		What percentage?	
d. correspondence		What percentage?	
f. other		What percentage?	

Comments:

B Objectives

1. What is the main purpose for this course? Explain that, the quantum mechanics is a more general theory which contains classical mechanics as a limiting case and in fact historically quantum mechanics was developed by analogy with classical theory. Demonstrate theoretical knowledge and have practical skills and personal attributes that will be required for quantum mechanics. Demonstrate an ability to initiate and sustain in-depth research relevant to quantum mechanics.
2. Briefly describe any plans for developing and improving the course that are being implemented. (e.g. increased use of IT or web based reference material, changes in content as a result of new research in the field) 1- Outlines of the physical laws, principles and the associated proofs. 2. Highlighting the day life applications whenever exist. 3. Encourage the students to see more details in the international web sites and reference books in the library. 4- Encourage the student to build an example of different experiments related to course 5- Frequently check for the latest discovery in science

C. Course Description (Note: General description in the form used in Bulletin or handbook)

Course Description: Course description: 1- **Wave-Particle Duality and Uncertainty**: Probability interpretation for wave-functions; wave packets, momentum representation; group velocity and phase velocity for a free particle, dispersion and time evolution; uncertainty principle for position and momentum. 2- The Schrödinger Equation: Introduction to operators and conjugate variables; eigenfunctions and eigenvalues, time-dependent and -independent wave equations; probability density and current; stationary states. 3- **Unbound Particles:** solutions for a free particle, beams, one-dimensional potentials; boundary conditions; reflection and transmission for a square potential step and barrier; tunnelling. 4- **Bound Particles**: Particle in an infinite potential well; zero-point energy; orthogonality and parity of eigenfunctions, normalization; eigenfunction expansions. Finite potential well. Harmonic oscillator. 3D box; separation of variables; degeneracy. 5- **Operator Methods:** Observables and operators; Hermitian operators. Dirac notation, eigenstates and eigenvalues. Correspondence of observables with operators; orthogonality and completeness of eigenstates. Postulates of quantum mechanics. Probability of outcomes of measurements; expectation values. Compatible and incompatible observables; commuting operators and simultaneous eigenstates; non-commuting operators; generalised uncertainty relations; minimum uncertainty states. The harmonic oscillator; ladder operators, eigenstates,

equipartition. Time dependence; evolution of expectation values. Ehrenfest's theorem. Time-energy uncertainty relation. Symmetry operators and conserved quantities.
6- **Quantum Mechanics in Three Dimensions:** General formulation. Spherically symmetric systems; orbital angular momentum; angular momentum operators; eigenvalues and eigenstates; orbital magnetic moment. Eigenfunctions; spherical harmonics; parity. Rotational invariance and angular momentum conservation. The three-dimensional harmonic oscillator; quantum numbers and degeneracies. Central potentials and conservation of angular momentum. Separation of variables; the radial equation. The hydrogen atom; quantum numbers; overall wavefunctions. Non-central potentials.
7- **Spin:** Stern-Gerlach experiment and spin; spin eigenstates. Matrix methods applied to angular momentum; Pauli matrices; spinors. Combining spin and orbital angular momentum; combining spins; singlet and triplet states.

1 Topics to be Covered

Topics	No of Weeks	Contact hours
❖ **Wave Particle Duality, Probability, and the Schrodinger Equation** • Radiation as Particles, Electrons as Waves. • Plane Waves and Wavepackets. • The Probability Interpretation of the Wavefunction. • The Schrodinger Equation. • The Heisenberg Uncertainty Relations. • The Probability Current. • Expectation Values and the Momentum in Wave Mechanics; The Momentum in Wave Mechanics, Wavefunction in Momentum Space.	2	8
❖ **Eigenvalues, Eigenfunctions, and the Expansion Postulate** • The Time-Independent Schrodinger Equation. • Eigenvalue Equations. • The Eigenvalue Problem for a Particle in a Box. • The Expansion Postulate and Its Physical Interpretation. • Momentum Eigenfunctions and the Free Particle; Normalization of the Free Particle Wave Function, Degeneracy. • Parity.	2	8
❖ **One-Dimensional Potentials** • The Potential Step. • The Potential Well. • The Potential Barrier. • An Example of Tunneling. • Bound States in a Potential Well. • The Harmonic Oscillator.	2	8

❖ **The General Structure of Wave Mechanics** • Eigenfunctions and Eigenvalues; The Hamiltonian Operator. • Other Observables. • Vector Spaces and Operators. • Degeneracy and Simultaneous Observables. • Time Dependence and the Classical Limit.	**2**	**8**
❖ **Angular Momentum** • The Angular Momentum Commutation Relations. • Raising and Lowering Operators for Angular Momentum. • Representation of $\|\lambda, \mathbf{m}\rangle$ States in Spherical Coordinates.	**1**	**4**
❖ **The Schrodinger Equation in Three Dimensions and the Hydrogen Atom** • The Central Potential. • The Hydrogen Atom. • The Energy Spectrum. • The Free Particle.	**2**	**8**
❖ **Spin** • Eigenstates of Spin 1/2. • The Intrinstic Magnetic Moment of Spin 1/2 Particles. • Addition of Two Spins. • The Addition of Spin 1/2 and Orbital Angular Momentum. • General Rules for Addition of Angular Momenta.	**1.5**	**6**
❖ **Matrix Representation of Operators** • Matrices in Quantum Mechanics. • Matrix Representation of Angular Momentum Operators. • General Relations in Marix Mechanics. • Matrix Representation of Spin 1/2.	**1.5**	**6**
	14 weeks	**56 hrs**

2. Course components (total contact hours and credits per semester):						
	Lecture	Tutorial	Laboratory or Studio	Practical	Other:	Total
Contact Hours	**56**				**14**	**70**
Credit	**4**					

3. Additional private study/learning hours expected for students per week.	14

4. Course Learning Outcomes in NQF Domains of Learning and Alignment with Assessment Methods and Teaching Strategy

On the table below are the five NQF Learning Domains, numbered in the left column.
First, insert the suitable and measurable course learning outcomes required in the appropriate learning domains (see suggestions below the table).
Second, insert supporting teaching strategies that fit and align with the assessment methods and intended learning outcomes.
Third, insert appropriate assessment methods that accurately measure and evaluate the learning outcome. Each course learning outcomes, assessment method, and teaching strategy ought to reasonably fit and flow together as an integrated learning and teaching process. (Courses are not required to include learning outcomes from each domain.)

Code #	NQF Learning Domains And Course Learning Outcomes	Course Teaching Strategies	Course Assessment Methods
1.0	**Knowledge**		
1.1	Define the physical quantities, physical phenomena, and basic principles.	1- Demonstrating the basic principles through lectures. 2. Discussing phenomena with illustrating pictures and diagrams. 3. Lecturing method: Board, Power point. 4. Discussions 5. Brain storming 6. Start each chapter by general idea and the benefit of it.	Solve some example during the lecture. Discussions during the lectures Exams: a) Quizzes (E-learning) b) Short exams (mid- term exams) c) Long exams (final) d) Oral exams .
1.2	Describe the physical laws and quantities using mathematics		
2.0	**Cognitive Skills**		
2.1	Apply the laws of physics to calculate some quantities.	1. Preparing main outlines for teaching. 2. Following some proofs. 3. Define duties for each chapter	1. Exams (Midterm, final, quizzes) 2. Asking about physical laws previously taught
2.2	Solve problems in physics by using suitable mathematics.		
2.3	Analyse and interpret quantitative results.		

2.4	Apply physical principle on day life phenomena.	4. Encourage the student to look for the information in different references. 5. Ask the student to attend lectures for practice solving problem.	3. Writing reports on selected parts of the course. 4. Discussions of how to simplify or analyze some phenomena.
2.5	Derive the physical laws and formulas.		
3.0	**Interpersonal Skills & Responsibility**		
3.1	Show responsibility for self-learning to be aware with recent developments in physics	• Search through the internet and the library. • Small group discussion. • Enhance self-learning skills. • Develop their interest in Science through : (lab work, visits to scientific and research institutes).	• Evaluate the efforts of each student in preparing the report. • Evaluate the scientific reports. • Evaluate the team work in lab and small groups. • Evaluation of students presentations.
3.2	Work effectively in groups and exercise leadership when appropriate.		
4.0	**Communication, Information Technology, Numerical**		
4.1	Communicate effectively in oral and written form.	• Incorporating the use and utilization of computer, software, network and multimedia through courses • preparing a report on some topics related to the course depending on web sites	• Evaluating the scientific reports. • Evaluating activities and homework
4.2	Collect and classify the material for the course.		
4.3	Use basic physics terminology in English.		
4.4	Acquire the skills to use the internet communicates tools.		
5.0	**Psychomotor (NA)**		

5. Map course LOs with the program LOs. (Place course LO #s in the left column and program LO #s across the top.)																
Course LOs #	**Program Learning Outcomes (Use Program LO Code #s provided in the Program Specifications)**															
	1.1	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**3.1**	**3.2**	**4.1**	**4.2**	**4.3**	**4.4**	**5.1**	**5.2**
1.1	✓															
1.2		✓														
1.3																
2.1				✓												
2.2					✓											
2.3						✓										
2.4							✓									
2.5								✓								
3.1									✓							
3.2										✓						
4.1											✓					
4.2												✓				
4.3													✓			
4.4														✓		
5.1																
5.2																

6. Schedule of Assessment Tasks for Students During the Semester			
	Assessment task (e.g. essay, test, group project, examination, speech, oral presentation, etc.)	Week Due	Proportion of Total Assessment
1	Exercises & Home works	All weeks	5 %
2	Participation	All weeks	5 %
3	In-Class Problem Solving	13th,7th week	10%
4	Midterm 1	6th week	15%
5	Midterm 2	10th week	15%
6	Final Exam	16th week	50%

D. Student Academic Counseling and Support

1. Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice. (include amount of time teaching staff are expected to be available each week)

Each student will supervise by academic adviser in physics Department and the time table for academic advice were given to the student each semester. (4hrs per week)

E Learning Resources

1. List Required Textbooks

1. S. Gasiorowicz, "Quantum Mechanics", John Wiley & Sons, Inc., 3rd Ed. (2003).

2. List Essential References Materials (Journals, Reports, etc.)

3. List Recommended Textbooks and Reference Material (Journals, Reports, etc)

1- David J. Griffiths "Introduction to Quantum Mechanics", Pearson Prentice Hall, New York, USA, (2005).
2- Nouredine Zettili, "Quantum Mechanics: Concepts and Applications", John Wiley & Sons, Inc. (2001).

4. List Electronic Materials, Web Sites, Facebook, Twitter, etc.

- http://en.wikipedia.org/wiki/Quantum Mechanics/
- http://www.dmoz.org/Science/Physics/Quantum Mechanics/

5. Other learning material such as computer-based programs/CD, professional standards or regulations and software. N/A

F. Facilities Required

Indicate requirements for the course including size of classrooms and laboratories (i.e. number of seats in classrooms and laboratories, extent of computer access etc.)
1. Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.) There are enough classrooms provided with a good accommodation, including good air condition, good Data show, suitable white board.
2. Computing resources (AV, data show, Smart Board, software, etc.) In each class room and laboratories, there is a data show, and board.
3. Other resources (specify, e.g. if specific laboratory equipment is required, list requirements or attach list) Each Class room and laboratories require a TV screen at least 65 inch-and smart, and double layer white board.

G Course Evaluation and Improvement Processes

1 Strategies for Obtaining Student Feedback on Effectiveness of Teaching • Course reports • Course evaluation.
2 Other Strategies for Evaluation of Teaching by the Instructor or by the Department • Revision of student answer paper by another staff member. • Analysis the grades of students.
3 Processes for Improvement of Teaching • Preparing the course as PPT. • Using scientific flash and movies.

- Periodical revision of course content.

4. Processes for Verifying Standards of Student Achievement (e.g. check marking by an independent member teaching staff of a sample of student work, periodic exchange and remarking of tests or a sample of assignments with staff at another institution)

- The instructors of the course are checking together and put a unique process of evaluation.
- Check marking of a sample of papers by others in the department.
- Feedback evaluation of teaching from independent organization.
- Independent evaluation by another instructor that give the same course in another faculty.
- Evaluation by the accreditation committee in the university.

5 Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement.

1- The following points may help to get the course effectiveness
   - Student evaluation
   - Course report
   - Program report
   - Program Self study
2- According to point 1 the plan of improvement should be given.

Name of Instructor: _____Abdelrahman Lashin_____

Signature: _____ Date Report Completed: _____

Name of Field Experience Teaching Staff _____

Program Coordinator:_____

Signature: _____ Date Received: _____