

<b>Faculty: Faculty of Science</b>	
<b>Department: Physics</b>	<b>Program: M. Sc. of Physics</b>
<b>Semester: Second</b>	<b>Academic year:2023/2024</b>



## Course Plan

### First: Course Information

<b>Course Name:</b>	Advanced Quantum Mechanics			<b>Course No. 0302751</b>	
<b>Credit Hours:</b>	3 hrs	<b><i>Theoretical</i></b>	3	<b><i>Practical</i></b>	0
<b>Prerequisite:</b>		<b>Class Number: 1</b>		<b>Lecture Time: 4:30-7:30 (Monday)</b>	
<b>Level in JNQF</b>	<b>7</b>				
<b>Course Nature:</b>	<div><div><input type="checkbox"/> <i>Mandatory Faculty Requirement</i> <input type="checkbox"/> <i>Mandatory University Requirement</i> <input type="checkbox"/> <i>Optional Specialty Requirement</i></div><div><input type="checkbox"/> <i>Optional University Requirement</i> <input type="checkbox"/> <i>Ancillary Course</i> <input checked="" type="checkbox"/> <i>Mandatory Specialization requirement</i></div></div>				
<b>Type Of Educatin:</b>	<div><div><input checked="" type="checkbox"/> <i>Face-to-Face Learning</i> <input type="checkbox"/> <i>Blended Learning(2 Face-to-Face + 1Asynchronous)</i> <input type="checkbox"/> <i>Online Learning (2 Synchronous+1Asynchronous)</i></div></div>				

### Second: Instructor's Information

<b>Name: Dr. Saleem Qashou</b>		<b>Academic Rank: Assistant Professor</b>	
<b>Office Number:384 D</b>		<b>Phone Number:</b>	<b>Email: sqashou@zu.edu.jo</b>
<b>Office Hours:</b>		<b>Monday 3:00:4:30. Wednesday 3:00:4:30</b>	

### Third: Short Description of the Course

*In this course students are expected to learn about Matrix representation of operators, Schrodinger's equation for central field, Angular momentum, Time- independent perturbation theory, Time-dependent perturbation theory.*

#### Fourth: Objectives:

1. To apply matrix representation (Matrix Representation of Kets, Bras, and Operators, Change of Bases and Unitary Transformations, Matrix Representation of the Eigenvalue Problem)
2. To Solve Schrodinger's equation for central field (The Free Particle in Spherical Coordinates, The Hydrogen Atom)
3. To use Time-independent perturbation as an approximation technique to simplify many of problems which couldn't be solved exactly.
4. we are going to consider approximation methods treating Hamiltonians that depend explicitly on time.

#### Fifth: Learning Source

<b>Designated Book:</b>	1. Modern Quantum Mechanics 2. Quantum Mechanics	
<b>1. Author: J. J. Sakurai</b> <b>2. Nouredine Zettili</b>	<b>Print: 3<sup>rd</sup> edition</b> <b>: 3<sup>rd</sup> edition</b>	<b>1. Year: 2020</b> <b>2. Year : 2022</b>
<b>Additional Sources:</b> <b>Website:</b>	• <b>Advanced topics in Quantum mechanics, Macros Marino, Cambridge University Press</b>	
<b>Teaching Type:</b>	<input checked="" type="checkbox"/> Classroom <input type="checkbox"/> Laboratory <input type="checkbox"/> Workshop <input type="checkbox"/> MS Teams <input type="checkbox"/> Moodle	

#### Sixth: Learning Outcomes

<b>Number</b>	<b>Course learning output</b>	<b>Associated PILOs Code</b> <i>Choose one PILO for each CILO*</i>	<b>Assessment method**</b> <i>Choose at least two methods</i>	<b>Scores out of 100</b> State the total score identified for each CILO	<b>Minimum acceptable Score/percentage (%)</b> <i>The percentage should not be less than 50% ***</i>
<b>pKnowledge</b>					
K1	To understand the main concepts of Bra-ket: Dirac notation for the scalar product, Matrix Representation of the Eigenvalue, Uncertainty Relation between Two Operators	PK1	Mid-Exam Quiz Final exam	12	6(50%)
K2	Recognize the methodology of solving problems by using time-independent perturbation theory and time dependent-perturbation theory	PK2	Mid-Exam Quiz Final exam	12	6(50%)
K3	Convert the physical description of many phenomenon's related to the quantum mechanical problems into the mathematical necessary to solve it.	PK3	Mid-Exam Quiz Final exam	10	5(50%)
K4	Apply the knowledge of central field in the spherical coordinates in order to explain the model of the Hydrogen atom	PK4	Mid-Exam Quiz Final exam	8	4(50%)
<b>Skills</b>					
S1	Solving many of quantum problems by using the appropriate method.	PS1	Mid-Exam Quiz Final exam	18	9(50%)
S2	When dealing with the Hydrogen atom, the solution by applying the spherical coordinates is the best one	PS2	Mid-Exam Quiz Final exam	12	6(50%)
S3	When approximations are necessary, then it is important to use them effectively (e.g. time-dependent and time-dependent perturbation techniques)	PS3	Mid-Exam Quiz Final exam	18	9(50%)

S4	The ability of using many of mathematical tools and the convenient mathematical functions such as Bessel's function, Hermit's function, Legendre's function in solving many of quantum mechanics problems.	PS4	Mid-Exam Quiz Final exam	10	5(50%)
Competences <sup>1</sup>					
C1	Students should accept full responsibility for their own learning.	PC1			
C2	Working a knew problems and identify the suitable way to solve the problem..	PC2			

## Seventh: Course Structure

Lecturer Date	Teaching Outcome	Topics	Teaching Procedures	Teaching Methods	References
4/3	PK1, PK3, PS1, PC1,	Bra-ket: Dirac notation for the scalar product, Operators, Hermitian and skew-Hermitian operators, Projection Operators, Commutator Algebra, Uncertainty Relation between Two Operators,	Direct	Lecturing, Whiteboard, DataShow	Text Book
11/3	PK1, PK3, PS1, PC1,				
18/3	PK1, PK3, PS1, PC1,	Eigenvalues and Eigenvectors of an Operator, Unitary Transformations, Matrix Representation of Kets, Bras, and Operators, Matrix Representation of the Eigenvalue Problem. Solving Problems	Direct	Lecturing, Whiteboard, DataShow	Text Book
25/3	PK1, PK3, PS1, PC1,		Direct	Lecturing, Whiteboard, DataShow	Text Book
1/4	PK3, PK4, PS1, PS4, PC2	Central Potential: General Treatment , The Free Particle in Spherical Coordinates, The Spherical Square Well Potential .	Direct	Lecturing, Whiteboard, DataShow	Text Book
8/4	PK3, PK4, PS1, PS4, PC2		Direct	Lecturing, Whiteboard, DataShow	Text Book
15/4	PK3, PK4, PS1, PS4, PC2	The Hydrogen Atom, Effect of Magnetic Fields on Central Potentials	Direct	Lecturing, Whiteboard, DataShow	Text Book
22/4	PK3, PK4, PS1, PS4, PC2		Direct	Lecturing, Whiteboard, DataShow	Text Book
29/4	PK2, PK3, PS1, PS3, PC1, PC2	Time-Independent Perturbation Theory, Nondegenerate Perturbation Theory, Degenerate Perturbation Theory, Fine Structure and the Anomalous Zeeman Effect	Direct	Lecturing, Whiteboard, DataShow	Text Book
6/5	PK2, PK3, PS1, PS3, PC1, PC2		Direct	Lecturing, Whiteboard, DataShow	Text Book

13/5	PK2, PK3, PS1, PS3, PC1, PC2	Time-dependent perturbation theory, The Pictures of Quantum Mechanics, The Schrödinger Picture, The Heisenberg Picture , The Interaction Picture	Direct	Lecturing, Whiteboard, DataShow	Text Book
20/5	PK2, PK3, PS1, PS3, PC1, PC2		Direct	Lecturing, Whiteboard, DataShow	Text Book
27/5	PK2, PK3, PS1, PS3, PC1, PC2	Transition probability, Adiabatic Approximation, Solved Problems	Direct	Lecturing, Whiteboard, DataShow	Text Book
3/6	PK2, PK3, PS1, PS3, PC1, PC2		Direct	Lecturing, Whiteboard, DataShow	Text Book
9- 27/6	Final exam				

Education procedures: (Direct, synchronous, asynchronous). \* \* Teaching methods: Lecture, video..... \* \* Reference: Pages of the book, recorded lecture, video

## Eighth: Assessment methods

Methods	Fully Electronic Education	Integrated Teaching	Direct Teaching								
				K1	K2	K3	K4	S1	S2	S3	S4
Mid-Exam			30	6		4	2	4	6		8
Quiz			20	2	4	4	2	2	2	4	
Final			50	4	8	2	4	12	4	14	2
Total out of 100			100	12	12	10	8	18	12	18	10

## Ninth: Course Policies

- Meeting the deadline for the lecture.
- Commitment to interaction and participation.
- Interactive lectures will be given through a platform (MS Teams).
- Duties and tests will be given through a platform (Moodle).
- Commitment to the right appearance in front of the camera with the proper background.
- University regulations for attendance and absence from lectures and examinations are in force.
- Academic Integrity: Fraud or moral impersonation are unacceptable and are punishable according to university regulations and instructions.

Approval	Name	Date	Signature
Head of Department			
Faculty Dean			