Course Specification
(Postgraduate)

Course Title:	**Topics in Quantum Mechanics**
Course Code:	**202612-3**
Program:	**Master of applied mathematics**
Department:	**Mathematics and Statistics**
College:	**Science**
Institution:	**Taif university**
Version:	1
Last Revision Date:	**20/10/2023**

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A. General information about the course:

1. Course Identification:

1. Credit hours: (3)				
2. Course type				
A.	☐University	☐College	☐Department	☐Track
B.	☐ Required		☒ Elective	
3. Level/year at which this course is offered: Level 2/First Year				
4. Course general Description:				

The student chooses any of the following topics that serve the direction of his research: Vectors space- Linear Operators-Hermitian Operators- The Eigenvalue Problem- Observables- Completeness- Expansion in Eigen-kets; Dirac delta Function- Transformation Functions; Change of Representation-

The Schrodinger Picture of Quantum Mechanics- The Heisenberg Picture- and The Interaction Picture. The Oscillator in the Heisenberg Picture- The Energy-Eigenvalue Problem for the Oscillator-

Physical Interpretation of N- a- and a+; Bosons and Fermions- Transformation Function from N to q Representation for Oscillator-

- Eigenvalues and Eigenvectors of Angular Momentum- Pauli Spin Operators- Spin Operators in the Heisenberg Picture- Some General Operator Theorems- Ordered Boson Operators-Algebraic Properties of Boson Operators- Characteristic Functions

Some quantum states such as Coherent States and squeezed states-
Phase space functions (P,Q,W)
Dynamical Behavior of a Quantum System
The wave function of a two-level atom-Quantum information processing.

5. Pre-requirements for this course (if any)**:**
None
6. Pre-requirements for this course (if any)**:**
None
7. Course Main Objective(s):

The student will be taught as follows:

1. **Introduce quantum mechanics in framework of operators and matrix representation.**
2. **Explain the different pictures of quantum mechanics such as Schrödinger picture, Heisenberg picture and interaction picture**
3. **Study the physical interpretation of N- a- and a+; Bosons and Fermions**
4. **Study the eigenvalues and Eigenvectors of Angular Momentum**

5. **Study the transformation Function from N to q representation for Oscillator**
6. **Study the algebraic properties of Boson operators and characteristic functions**
7. **Study the coherent state in quantum mechanics**
8. **Study the squeezed state in quantum mechanics**
9. **Study the dynamical behavior of the quantum system**
10. **Study the phase space functions (P,Q,W)**
11. **Find the wave function for a two-level atom**
12. **Give a simple idea about the quantum computer as a new technology for quantum Mechanics and optics.**

2. Teaching Mode: (mark all that apply)

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

3. Contact Hours: (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	**45**
2.	**Laboratory/Studio**	NA
3.	**Field**	NA
4.	**Tutorial**	NA
5.	**Others (specify)……**	NA
	Total	**45**

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	Recognize quantum mechanics in framework of operators and matrix representation.	K1	Lectures, group discussion `	Exams, Quizzes, Assignments

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.2	Describe the different pictures of quantum mechanics	K2	Lectures, group discussion	Exams, Quizzes, Assignments
2.0	**Skills**			
2.1	Explain the mathematical properties of the squeezed and coherent states	S3	Lectures, group discussion	Exams, Quizzes, Assignments, report
2.2	Apply the annihilation and creation operators to find the energy eigenstates of the Harmonic oscillator	S1	Lectures, group discussion	Exams, Quizzes, Assignments, report
3.0	**Values, autonomy, and responsibility**			
3.1	Participate effectively within groups and independently.	V1	Lectures, group discussion	Exams, Quizzes, Assignments, report
3.2	Accept critical thinking, communication skills and mathematical techniques in solving many problems in other disciplines	V3	Lectures, group discussion	Exams, Quizzes, Assignments, report

C. Course Content:

No	List of Topics	Contact Hours
1.	Linear Operators-Hermitian Operators- The Eigenvalue Problem- Observables-Completeness	6
2.	Expansion in Eigen-kets; Dirac delta Function- Transformation Functions; Change of Representation	3
3.	The Schrodinger Picture of Quantum Mechanics- The Heisenberg Picture- and The Interaction Picture.	6
4.	The Oscillator in the Heisenberg Picture- The Energy-Eigenvalue Problem for the Oscillator-	6
5.	Physical Interpretation of N- a- and a+; Bosons and Fermions-Transformation Function from N to q Representation for Oscillator-	3
6.	- Eigenvalues and Eigenvectors of Angular Momentum- Pauli Spin Operators-Spin Operators in the Heisenberg Picture- Some General Operator Theorems-Ordered Boson Operators-Algebraic Properties of Boson Operators-Characteristic Functions	3

7.	Mathematical properties of coherent band squeezed states	3
8.	Phase space functions (P,Q,W)	6
9.	Dynamical Behavior of a Quantum System	3
10.	The wave function of a two-level atom	6
Total		**45**

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Quizzes and HomeWorks**	**Continues**	**10 %**
2.	**Midterm exam**	**8^{th} -9^{th}**	**20 %**
3.	**Final exam**	**16^{th}**	**70%**

*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	D. J. Griffiths, Introduction to Quantum Mechanics, 2nd edition, Pearson Prentice Hall, NJ, USA, 2004. http://www.fisica.net/mecanica-quantica/Griffiths%20-%20Introduction%20to%20quantum%20mechanics.pdf
Supportive References	R. L. Liboff, Introductory Quantum Mechanics, Addison Wesley, 2002.
Electronic Materials	Journal of modern optics, Optics communication.
Other Learning Materials	Publisher's website at https://en.wikipedia.org/wiki/Quantum_mechanics

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Classrooms
Technology equipment (Projector, smart board, software)	Data show, Blackboard, Maple and MATLAB software
Other equipment (Depending on the nature of the specialty)	Wi-Fi internet connections

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students	Indirect
Effectiveness of students assessment	Students	Indirect
Quality of learning resources	Students	Indirect
The extent to which CLOs have been achieved	Peer reviewer	Direct
Other		

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

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	Department of Mathematics and Statistics
REFERENCE NO.	
DATE	20/10/2023

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