

Quantum Mechanics-1

MONSOON SEMESTER, 2022

Shiv Nadar University

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CONTENTS

1. Some Mathematical Preliminaries

- a) Rotations in 3D Space : Classifications of 3-Scalars, 3-Vectors and 3-Tensors (Cartesian)
- b) The Lorentz Transformation, Classification of 4-Scalars, 4-Vectors, and 4-Tensors
- c) Inner and Outer Products of Tensors : Contraction, Invariants etc.

2. Quantum Dynamics

- a) The Schrödinger Equation : A Discretized Approach
- b) State Vectors, Operators for Physical Quantities, Properties of Hermitian Operators
- c) Free Particles, The Harmonic Oscillator

3. Equations of Motion for Operators

- a) Functions of Operators
- b) Schrödinger vs. Heisenberg Representations
- c) The Time Development Operator in various Situations
- d) Formal Iterative Solution of the General Time Development Operator

CONTENTS

5. Orbital Angular Momentum and Central Potentials

- a) Definition and Commutation Relations
- b) Rotations and their Group Properties
- c) Differential Operator Representations
- d) Eigenfunctions and Eigenvalues of Angular Momentum
- e) Spherical Harmonics*

6. Spin- ($1/2$ & 1)

- a) Introducing spin (1 and $1/2$ particles)
- b) Stern-Gerlach experiment
- c) Matrix Representations
- d) Rotations in Spin Space and Rotation Matrices for Spin- $1/2$
- e) Spin Magnetic Moment, the Zeeman Effect and Spin-orbit Coupling
- f) Electromagnetic Waves and Polarization of Light
- g) Polarization as a Quantum Degree of Freedom

CONTENTS

7. Transformation and Symmetries

- a) Analogy to Classical Mechanics, Noether's theorem
- b) Conservation in Quantum Mechanics

8. Approximation Methods

A. Time-independent Perturbation Theory

- a) Development of the Perturbation Series
- b) Degenerate state Perturbation Theory

B The Variational Principle, WKB (if time permits)

REFERENCES

There are several good references on QM.

I will follow my notes. However, the following references may be useful.

1. Modern Quantum Mechanics, J. Sakurai
2. MIT Opencourseware (by Prof. Barton Zwiebach)

2. See also :

Principles of Quantum Mechanics, R. Shankar

Lectures on Quantum Mechanics, S. Weinberg

Quantum Mechanics, B.H. Bransden and C.J. Joachain

Introductory Quantum Mechanics, R. Liboff

Quantum Mechanics, L. Schiff

Introduction to Quantum Mechanics, D. Griffiths

- Organization :
 - Last teaching day : 2nd December
 - Total lecture weeks : 14 (approx.)
 - Tutorials : as per schedule
- Examination date : as per SNU schedule
- Attendance : as per SNU policy

- Evaluation :
 - Homeworks : 30%
 - Mid-Semester examination: 35%
 - End-Semester examination: 35%

Your feedback is very important for the improvement of this course. Please feel free to contact me with your comments/ suggestions.

**Thank you for your interest in this topic
of discussion!**