Syllabus of MSc Qualification Exam
Physics Department - 2023

Quantum Mechanics

1. Origins of Quantum Mechanics

1.1 Particle Aspect of Radiation
- 1.1.1 Blackbody Radiation
- 1.1.2 Photoelectric Effect
- 1.1.3 Compton Effect
- 1.1.4 Pair Production

1.2 Wave Aspect of Particles

1.3 Classical and Quantum view of Particles and Waves

1.4 Wave Packets
- 1.4.1 Localized Wave Packets
- 1.4.2 Wave Packets and the Uncertainty Relations
- 1.4.3 Motion of Wave Packets

2. Mathematical Tools of Quantum Mechanics

2.1 The Hilbert Space and Wave Functions

2.2 Dirac Notations

2.3 Operators

2.4 Representation in Discrete Bases
- 2.4.1 Matrix Representation of Kets, Bras and Operators
- 2.4.2 Matrix Representation of the Eigenvalue Problem

2.5 Parity Operator

3. Postulates of Quantum Mechanics

3.1 Introduction

3.2 The Basic Postulates of Quantum Mechanics

3.3 The State of a System
- 3.3.1 Probability Density
- 3.3.2 The Superposition Principle

3.4 Observables and Operators

3.5 Measurement in Quantum Mechanics
- 3.5.1 How Measurements Disturb Systems
- 3.5.2 Expectation Values
- 3.5.3 Measurement and the Uncertainty Relations

Reference:

Nouredine Zettili, Quantum Mechanics Concepts and Applications, Wiley, Second edition, 2009.

Classical Mechanics

1- Units and Dimensions.
2- Linear and Projectile Motions.
3- Particle dynamics.
4- Works and Energy.
5- Momentum and Collisions.

References: Physics Part I, Robert Resnick and David Halliday.

Atomic Physics

Chapter 1; Special Relativity

Chapter 2; Particle Properties of waves

Chapter 3; Wave Properties of Particles

Chapter 4; Atomic Structure

Reference: Concepts of Modern Physics - Author: Arthur Beiser.

Elements of Electromagnetics

Chapter 4 Electrostatic Fields

4.1. Introduction
4.2. Gauss's Law--Maxwell's Equation
4.3. Applications of Gauss's Law
4.4. Electric Potential
4.5. Relationship between E and V--Maxwell's Equation
4.6. An Electric Dipole and Flux Lines
4.7. Energy Density in Electrostatic Fields

Chapter 5 Electric Fields in Material Space

5.1. Introduction
5.2. Convection and Conduction Currents
5.3. Conductors
5.4. Polarization in Dielectrics
5.5. Dielectric Constant and Strength
5.6. Linear, Isotropic, and Homogeneous Dielectrics
5.7. Continuity Equation and Relaxation Time
5.8. Boundary Conditions

Chapter 7 Magnetostatic Fields

7.1. Introduction
7.2. Biot-Savart's Law
7.3. Ampere's Circuit Law--Maxwell's Equation
7.4. Applications of Ampere's Law
7.5. Magnetic Flux Density--Maxwell's Equation
7.6. Maxwell's Equations for Static EM Fields

Chapter 9 Maxwell's Equations

9.1. Introduction
9.2. Faraday's Law
9.3. Transformer and Motional EMFs
9.4. Displacement Current
9.5. Maxwell's Equations in Final Forms

Chapter 10 Electromagnetic Wave Propagation

10.1. Introduction
10.2. Waves in General
10.3. Wave Propagation in Lossy Dielectrics
10.4. Plane Waves in Lossless Dielectrics
10.5. Plane Waves in Free Space
10.6. Plane Waves in Good Conductors
10.7. Power and Poynting Vector

Reference: Elements of Electromagnetics 3rd Edition - by Matthew N Sadiku