16/07/2019

QUANTUM MECHANICS II

86-312-09

Lecturer: Prof. Eugene Kogan

Course type: Lecture + Practice

Date: 2019-2020 **semester:** B **weekly hours:** 3L + 2P

Aim of the course:

The purpose of the course is to teach advanced Quantum Mechanics.

Details of subjects to be covered:

Detailed teaching program for all classes:

I.BASICS OF QUANTUM MECHANICS

A. Schrodinger Equation
B. Rectangular Potential Well
C. Harmonic Oscillator
D. The Transmission Coefficient
E. Plane Rotator
F. Central potential
G. Relative and Center-of-Mass Coordinates
H. The Hydrogen Atom

II. SPIN-1/2

A. Two-Level Systems
B. Pauli Matrices
C. Precession in a Magnetic Field
D. Magnetic Resonance
E. Nuclear Magnetic Resonance

III. Ammonia Molecule

A. The Molecule in a Static Electric Field
B. The Molecule in a Time-Dependent Electric Field
C. The Ammonia Maser

D. The Absorption (Emission) of Light

IV. PERTURBATION THEORY

A. Perturbations Independent of Time
B. The Secular Equation
C. Perturbations Depending on Time
D. Perturbation Acting for a Finite Time
E. Periodic Perturbation
F. Potential Energy as a Perturbation

V. THE QUASI-CLASSICAL CASE

A. The wave function
B. Boundary conditions
C. Bohr and Sommerfeld's Quantization Rule
D. Quasi-Classical Motion in a Centrally Symmetric Field
E. Penetration Through a Potential Barrier

VI. ADDITION OF ANGULAR MOMENTA 30

A. Angular-Momentum Operators
B. Two Spin- 1/2 Particles
C. The Hyperfine Splitting in Hydrogen Atom
D. Addition of Angular Momenta

VII. SCATTERING

A. Scattering in Classical Mechanics
B. Scattering in Quantum Mechanics
C. The Born Approximation
D. The Partial Waves

E. Analytic Properties of the Scattering Amplitude

F. The Scattering of Slow Particles
G. Resonance Scattering at Low Energies
H. Resonance at a Quasi-Discrete Level
I. Quasi-Discrete Level Close to Zero
J. Collisions of Like Particles

VIII. MULTI ELECTRON ATOMS

A. Electron States in Multi Electron Atoms
B. The Helium Atom
C. Atomic Energy Levels
D. The Fine Structure of Hydrogen Atom
E. Fine Structure of Atomic Levels
F. Atom in Magnetic Field
G. Lande g-factor
H. Rare Earth Ions
I. Van Vleck Paramagnetism
J. Diamagnetism

Prerequisites:

The prerequisite for the course is the course Quantum Mechanics I.

Course mandatories:

To pass the exams the student will have to show his/her ability to solve the problems similar to those which were taught at the lectures and/or assigned as a home task.

Grading:

The exams will consist of 4 problems assigned to the student. Correct solution of all problems will correspond to the grades 100. There will be an additional bonus problem (more difficult than the above-mentioned ones), which can bring additional points in case the grading of the 4 problems was less than maximal.

Bibliography:

(Recommended textbooks)

J. S. Townsend, A modem approach to quantum mechanics;

Landau and Lifshitz, Quantum mechanics;

R. Feynman, Feynman's Lectures on Physics, vol. III.