Course Syllabus

Ve540
Applied Quantum Mechanics I
Fall 2018

Course description

The course introduces the formalism of quantum mechanics in a standard approach based on the concept of the wave function and its probabilistic interpretation. The postulates of quantum mechanics are formulated and applied to discuss one- and three-dimensional problems, with an emphasis on those relevant to applications in atomic and solid state physics/optics. A range of approximate methods of quantum mechanics is introduced and illustrated.

Instructor

Mateusz KRZYZOSIAK (m.krzyzosiak@sjtu.edu.cn)
Office: room 439C (JI building), Phone: 021-34206765 ext. 2111
Office hours: Tuesday 10.50-11.50, Wednesday (weeks 1-5) 16.30-17.45, Thursday 10.50-11.50, Friday 10.30-11.30 (weeks 6-12, this office hour will be held in SJTU Physics Lab room 202); and by appointment.

Textbooks

Main textbooks: R.L. Liboff, *Introductory Quantum Mechanics*, 4th edition, Addison Wesley (2002)
D.J. Griffiths, Introduction to Quantum Mechanics, 2nd edition, Prentice-Hall (2005) – selected excerpts
Additional (optional) recommended reading:
L.D. Landau, E.M. Lifshitz, *Quantum Mechanics: Non-relativistic Theory*, 3rd edition, Butterworth-Heinemann (1981)

Course Pre-requisites

Physics II (or Honors Physics II); Applied Calculus IV (or Honors Mathematics IV)

Course Website

Canvas

Grading Policy

- Coursework (25%)
- Quiz (10%)
- Midterm Exam (30%)
- Final Exam (35%)

Honor Code

Oral discussion of homework problems with other students is allowed and encouraged on the level of general ideas, not specific solutions. It is not allowed to show any written work to other students. If any references to academic textbooks or research journals are made, they should be properly identified with the bibliographical data. No references to Wikipedia entries are allowed.

Additional information

Lectures – Students are encouraged to read the relevant chapters in the textbook ahead of the lecture. Students are required to read and review the relevant chapters after the lecture. Additional teaching materials will be uploaded to Canvas. Students are expected to attend lectures.

Homework – Homework will be assigned in the form of problem sets to be solved by each student individually. Problem sets will have a due date, by which solutions have to be handed in for grading. Please plan your time well, late homework will be accepted with the following late-submission penalties: 20% for submissions after the due time but no later than 24 hrs and 40% for submissions 24-48 hrs after the due time. No credit will be given for homework submitted more than 48 hrs after the due time.

Quiz – There will be three pre-announced short quizzes based on review lists given to the students after each week's lectures.

Exams – There will be one midterm exam and a final exam. The exams are closed book.

Teaching Schedule

Midterm exam: week 7; Final exam: the last week of the semester

1. Introduction: experiments and theories – towards quantum mechanics (black-body radiation; photoelectric effect; Compton scattering; Bohr's model of the hydrogen atom; de Broglie hypothesis and wave matters; Young's double-slit experiment); **chapter 2**
2. Postulates of quantum mechanics (wave function and its interpretation; time-evolution and the Schrödinger equation; observables and Hermitian operators; Dirac's notation; stationary Schrödinger equation; quantum-mechanical measurement); **chapters 3, 4 (part), 6 (part)**
3. Schrödinger equation in the position representation – bound states: analytically solvable models in one dimension (infinite quantum well; harmonic oscillator), other one-dimensional models (finite quantum well; double quantum well)**; chapter 7 (part), 8 (part)**
4. Schrödinger equation in the position representation – unbound states in one dimension (free particle; quantum wave packets; scattering; quantum tunneling); **chapter 7 (part)**
5. Schrödinger-Robertson uncertainty principle (special case: Heisenberg uncertainty principle) and its consequences; complete sets of observables; **chapter 5**
6. Three dimensional problems (bound states in a 3D quantum well; harmonic oscillator) and the hydrogen atom; **chapter 10**
7. Orbital angular momentum (eigenfunctions and eigenvalues of L_z and L^2; spherical harmonics; uncertainty principle for components of the angular momentum); **chapter 9; Griffiths 4.3**
8. Spin and total angular momentum; introduction to quantum mechanics of multi-particle systems; bosons and fermions; **chapter 11 (part), 12 (part); Griffiths 4.4**
9. Approximate methods in quantum mechanics I: perturbation theory for stationary states (non-degenerate and degenerate case) **chapter 13**
10. Approximate methods in quantum mechanics II: Time-dependent perturbations and Fermi's golden ule; interaction of light with matter and selection rules; Rayleigh--Ritz variational method; **chapter 13**
11. Quantum mechanical fundamentals of solid state physics: Krönig-Penney model of a one-dimensional crystal; band structure of solids; Fermi gas (time permitting); **chapter 7 (part), 12 (part)**

Address: #800 Dong Chuan Road, Shanghai 200240 Tel: 86-21-34206190
Homepage: www.umji.sjtu.edu.cn Fax: 86-21-34206525