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Office hours: Tue, Thu 11 – 12:30, or by appointment

Learning Assistant: Salvatore Pace, e-mail: space20@bu.edu; Office hours: W12 pm- 1:pm
F 3pm- 4pm in SCI 122

Graders: Yi Zhang; zhangyi@bu.edu, Bowen Zhao; bwzhao@bu.edu

Prerequisite: PY 451 (Quantum Physics I) or Equivalent


Exams: Two in class midterm and final exams

Tentative schedule for midterm: Midterm I – Thursday, October 17

Midterm II – Thursday, November 14

Lecture notes will be posted once a week.

Reading assignments: The weekly reading assignments will cover most of the lecture material of each week.

Problem sets: Weekly problem sets will be posted on Fridays and they are due on the following Friday at 6:00 pm. There will be a PY452 homework box. Solutions will be posted after the due date. No credit will be given for late HW and there will be no exceptions to this rule. However, your lowest grade will be dropped. You are encouraged to discuss homework problems with others, but you have to submit your own work. Homework grading questions should be directed to the grader within one week after the graded homework is returned.

Grading: The course grading will be based on the following components:

- Homework 20 %
- Midterm I, II 25 % each
- Final Exam 30 %

Note: It is the responsibility of all students to know and understand the provisions of the CAS Academic Conduct Code.
Course Outline

This course is continuation of PY 451, which covered the following topics:

General structure of quantum mechanics; Quantum dynamics; Two-state systems; Operator (algebraic) methods; Harmonic Oscillator; Angular momentum; Hydrogen atom

Topics and tentative schedule for PY452

Part I: Theory

1. Review of Angular momentum (2 lectures; Reading: Griffiths, Ch. 4)
   1a. Eigenvalues of AM from commutation relations
   1b. Addition of angular momenta

2. The quantum mechanics of identical particles (2 lectures; Reading: Griffiths, Ch. 5)
   2a. N–particle systems; indistinguishability of identical particles
       Exchange symmetry postulate; Bosons and fermions and their wave functions
   2b. Pauli exclusion principle
       Exchange force: a first look at helium atoms.

3. Degenerate Fermi systems (2 lectures; Reading: Lecture Notes and Griffiths, Ch. 5)
   3a. Free Electron Gas: Fermi energy; degenerate pressure.
   3b. Application to stars: White dwarf stars (fate of our sun); Chandrasekhar limit, neutron stars.

4. Electromagnetic Interactions (2-3 lectures; Reading: Lecture Notes, Griffiths Ch. 4; also excellent treatments by Gasiorowicz, Liboff, Shankar)
   4a. Classical Hamiltonian for a charged particle in electric and magnetic fields:
       Gauge invariance; Schrodinger equation; Landau levels and their degeneracy
   4b. Aharonov-Bohm effect
Part II: Application

5. **Time-independent perturbation theory** (5 - 6 lectures; Reading: Griffiths, Ch.7)
   
   5a. Non-degenerate perturbation theory: energy and wave function through second order
       Degenerate perturbation theory: diagonalizing perturbations and lifting degeneracies
   
   5b. Simple examples: perturbing a two-state system, a simple harmonic oscillator
   
   5c. Fine structure of hydrogen: relativistic and spin-orbit effects
   
   5d. Hydrogen atom in a magnetic field: weak Zeeman effect
   
   5e. Hydrogen atom in an electric field: Stark effect

6. **Variational methods** (2 Lectures; Reading: Griffiths, Ch. 8)
   
   6a. Variational principle; simple examples
   
   6b. Ground state of helium

7. **Quantum Dynamics** (4 - 5 lectures; Reading: Griffiths, Ch. 11)
   
   7a. Time-dependent perturbation theory; Transition rate
   
   7b. Sinusoidal perturbations; Fermi’s Golden Rule
   
   7c. Emission and absorption of light
   
   7d. Spontaneous emission: Einstein’s A and B coefficients. How excited atoms decay.

8. **Symmetry and Conservation Laws** (2-3 lectures; Reading: Griffiths Ch. 6)
   
   8a. Translations in space and time
   
   8b. Rotation and space inversion

If time allows we will discuss the following topics.

9. Adiabatic approximations and **Berry’s phase** (2 lectures; Reading: Griffiths, Ch. 11)

10. **EPR (Einstein-Podolsky-Rosen) paradox, Bell’s Theorem** (Reading: Griffiths Ch. 12)

**Note:** Schedule for lectures is subject to change.