PHYSICS - 617: MODERN PHYSICS

Lecture: TTh 11:00 a.m. to 12:15 p.m., Room 109 Lewis Hall
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Office Hours: M W Th 3:00 – 4:00 p.m. (207 Lewis Hall)

* - Textbooks [L, K] are for main reading and [B, M] are recommended for additional reading.

Course requirements and course content:
The course of Modern Physics is devoted to the main results in physics, which were achieved in the 20-th century. The PHYS-617 (Modern Physics-I) gives a basic knowledge in special relativity and quantum mechanics of atoms and molecules. The applications of quantum mechanics to the atoms, molecules and spectroscopy are discussed. The basic knowledge of calculus based General Physics, Differential Equations and Math-Methods are required.

The goals: 1) To give main results in the special relativity, quantum mechanics, and atomic and molecular spectroscopy. 2) To show a connection between quantum mechanics and some contemporary tasks in physics. 3) To improve the critical thinking skills of the graduate students.

Grading scale and evaluation:
• Grading Scale: A’s --- 90 – 100%; B’s --- 80 – 89%; C’s --- 70 – 79%; Etc.
• Grades will be based on homework, tests, and the final examination:
  Homework --------- 20%
  Three tests -------- 45% (#1=15%, #2=15%, #3=15%)
  Final exam -------- 35%

Homework:
Problems will be assigned after some sections are covered. In solving homework problems, teamwork is possible, but solutions must be handled in independently. Your answers will be graded (counting 20 % for the final grade).

Circle the finale answers that you want to be graded.

Tests and Final exam schedule:
Test 1, Chapters 1 2, 3 [L] ----------- Tuesday, September 28
Test 2, Chapters 4, 5 [L] ----------- Thursday, October 28
Test 3, Chapters 7, 8, 9 [L] ----------- Thursday, November 18

Final examination ----------- Thursday, December 9, 2004, 8 a.m.
Phys 617 - COURSE SYLLABUS

1. THE THEORY OF RELATIVITY \{L=Ch.1, B=Ch.1\} [3.5 classes]
   • The principle of relativity, postulates of special relativity, transformations.
   • Relativistic kinematics.
   • Relativistic mechanics and electrodynamics, energy units, classical electron.

2. QUANTUM MECHANICS \{L=Ch.2, B=SEC.2.2, 3.1 – 3.5\} [3.5 classes]
   • Background: Zeeman effect, black-body radiation, photoelectric effect, atom
   • Requisites of QM: wave properties of particles, uncertainty principle, quantized states, selection rules.
   • Basis of QM: the postulates of QM, QM-state of a system, operators, properties, theorems.

3. THE ONE-DIMENSIONAL HARMONIC OSCILLATOR \{L=Ch.3, B=Sec. 5.11\} [3 classes]
   • The Schrödinger equation and its solution.
   • The energy levels and wave functions.

   ➢ TEST #1 (class 11), Chapters 1 – 3 [L] ⇒ Tuesday, September 28

4. THE FREE PARTICLE \{L=Ch.4, B=Sec. 3.6 – 3.9\} [3 classes]
   • The Schrödinger equation, boundary conditions, motion, energy, momentum.
   • Transmission and reflection at a barrier.
   • The rectangular potential well, free particle in 3 dimensions, particle in a box.

5. THE ONE ELECTRON ATOM \{L=Ch. 5, B=Ch. 6\} [5 classes]
   • Simple model; the Schrödinger equation, solution, wave functions.
   • Electron spin, spin-orbit forces, quantization of angular momentum.
   • Spin-orbit fine structure; Relativistic corrections.
   • Hydrogen fine structure, spectroscopic terms, selection rules, nuclear spin.

   ➢ Test #2 (class 20), Chapters 4, 5 [L] ⇒ Thursday, October 28

6. THE PAULI PRINCIPLE \{L=Ch. 7, B=Sec. 7.1 – 7.3\} [2 classes]
   • Exchange symmetry of wave functions.
   • The many electron atoms.

7. ATOMIC SPECTROSCOPY \{L=Ch.8, B=Sec. 7.5 – 7.8\} [2 classes]
   • Hamiltonian of a complicated atom, L-S and j-j couplings.
   • Selection rules, energy-level diagrams for complex atoms.
   • Complex spectra, Zeeman Effect, excitation of atoms, spectral line breadth.

8. MOLECULAR SPECTRA \{L=Ch. 9A, B=Ch. 8\} [1 class]
   • Hydrogen molecule.

   ➢ TEST #3 (class 26) , Chapters 7, 8, 9A [L] ⇒ Thursday, November 18

8. MOLECULAR SPECTRA \{L=Ch. 9B, B=Ch. 8\} [1 class]
   • Energy states and spectroscopy of diatomic molecules.
   • Nuclear spin, Ortho- and Para- hydrogen.

9. X-RAYS \{L=Ch.12, K=Ch. 1, M=Chs. 1, 2\} & REVIEW \{Last class # 28, Dec. 2, 2004\} [1 class]
   • X-rays production, interactions of x-rays with matter.
   • X-rays diffraction, refraction, reflection.
   • Atomic and crystal structure.

FINAL EXAMINATION: ⇒ Thursday, December 9, 2004, 8 a.m.

* - The dates are tentative, and may be changed (but not Final exam!).