MODERN PHYSICS

Lecture:TTh 11:00 a.m. to 12:15 p.m., Room 109 Lewis HallInstructor:Dr. Ostrovskii, IgorOffice:Room 207 Lewis Hall, Tel: 915-1536; Email: iostrov@phy.olemiss.edu

Office Hours: MWTh 3:00 – 4:00 p.m. (207 Lewis Hall)

Texts*: 1) [L]: Principles of Modern Physics, by Robert B. Leighton, McGraw-Hill Book Company.

2) [K]: Introduction To Solid State Physics, by Charles Kittel, 7-th edition, 1996.

3) [B]: Concepts of Modern Physics, by Arthur Beiser, 6-th edition, McGraw-Hill, 2002/3.

4) [M]: Condensed Matter Physics, by Michael P. Marder, John Wiley & Sons, 2000.

* - 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%

• <u>Homework:</u>

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).

> <u>Circle the finale answers that you want to be graded.</u>

✤ <u>Tests and Final exam schedule:</u>

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

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 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] \rightarrow 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 Schroedinger 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} [lclass] • 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. • Thursday, December 9, 2004, 8 a.m. FINAL EXAMINATION: \rightarrow

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

1. THE THEORY OF RELATIVITY {L=Ch.1, B=Ch.1}

- The principle of relativity, postulates of special relativity, transformations.
- Relativistic kinematics. •
- Relativistic mechanics and electrodynamics, energy units, classical electron.
- Requisites of QM: wave properties of particles, uncertainty principle, quantized states, selection rules.

[3.5 classes]