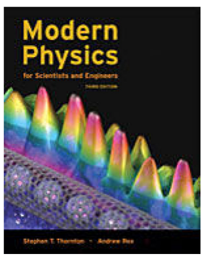
PH 351-4B & PH 351L-G7: Modern Physics I

Fall Semester 2007

Time and location:
PH 351-4B (Lecture): Tuesdays & Thursdays 5:30 – 6:45 PM (CH 304)
PH 351L-G7 (Lab): Mondays 5:30 – 8:30 PM (CH 460)

Instructor and office hours:
Dr. Renato Camata, camata@uab.edu
CH 306, (205) 934-8143
Tuesdays & Thursdays 4:30 – 5:30 PM
(Other times by appointment)

Required Textbook:



Modern Physics for Scientists and Engineers
Thornton & Rex, 3rd Ed., 2006
Publisher: Thomson-Brooks/Cole
ISBN: 0534417817
ISBN13: 9780534417819

Other Books and Resources Suggested:

Special Relativity *A. P. French* *M.I.T. Physics Series*	**Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles** (2nd Edition) *J. Eisgerg & R. Resnick* *Wiley*	**Modern Physics** (2nd Edition) *K. S. Krane* *Wiley*

Catalog Description: Atomic, molecular, solid-state physics; quantum mechanics, lasers and nanotechnology. Theoretical and experimental studies to understand observable properties of matter in terms of microscopic constituents.

Prerequisite: PH 222

Last Day to Withdraw with "W": October 22.

Course Activities: This course will comprise lectures, classroom discussions, written problem-solving exercises assigned by the instructor (problem sets), and weekly laboratory activities.

Related UAB core learning outcomes: Students successfully completing this course will demonstrate knowledge of fundamental concepts in modern physics including special relativity and quantum mechanics and will be able to apply this knowledge to solve problems. Students will also demonstrate a working knowledge of physics-related technical and laboratory skills including data analysis.

General course learning objectives:

By successfully completing this course a student should be able to:

(1) Define the major 20th century developments in Physics.
(2) Compare and contrast Modern Physics with Classical Physics.
(3) State the fundamental tenets of the Theory of Special Relativity.
(4) Apply Special Relativity to the solution of problems involving time dilation, length contraction, simultaneity, relativistic momentum, and relativistic energy.
(5) Define the experimental basis of the Quantum Theory of Matter.
(6) Command elementary and intermediate quantum methods.
(7) Apply quantum methods in the solution of problems involving atomic spectra, blackbody radiation, the photoelectric effect, X-ray emission, the structure of the atom, and one-dimensional potentials.
(8) Quantitatively defend the assertions of Modern Physics theories.
(9) Perform experimental work with atomic and subatomic particles and photons.
(10) Communicate scientific ideas and physical concepts in writing clearly and effectively.
(11) Define and explain at least **5** areas of cutting edge 21st century Physics and its relation to Modern Physics theories developed in the 20th century.

Measurement of learning outcomes. Documented completion of laboratory activities, laboratory reports, problem sets, in-class tests, and a final exam will be used to measure attainment of learning objectives.

Course Grade:

Laboratory Activities	15%
Problem Sets	25%
Average of Tests	30%
Final Exam	30%

- **Three Tests.** Non-cumulative closed book tests during regular class periods (75 min).

- **Final Exam.** Open book comprehensive exam (2½ hours).

- **Problem Sets.** Problem sets featuring a variety of activities to foster learning will be regularly assigned by instructor. Activities must be completed and turned in by the due date.
  Policy regarding late Problem Set without proper justification:
  - ½ credit while solutions have not been discussed in class
  - 0 credit after solutions have been discussed in class

- **Student collaboration policy.** Discussions and exchange of ideas among students are strongly encouraged during studying and working of problem sets. Copying and verbatim rendering of solutions from other students ***are not appropriate***. These practices constitute violation of the University honor code and may result in academic disciplinary action including dismissal from the degree program. Collaboration among students ***is not allowed*** during tests and exams.

Letter grades will be assigned according to the following table:
(All calculated grades will be rounded up to the nearest 0.1%.)

88.0% to 100% inclusive	**A**
76.0% to 87.9% inclusive	**B**
63.0% to 75.9% inclusive	**C**
50.0% to 62.9% inclusive	**D**
0.0% to 49.9% inclusive	**F**

Turning in all assigned work is a necessary condition for an **A** grade

Important Test & Exam Dates:

- **Test 1:** **Tuesday, September 18; 5:30-6:45 PM**
- **Test 2:** **Tuesday, October 16; 5:30-6:45 PM**
- **Test 3:** **Tuesday, November 13; 5:30-6:45 PM**
- **Final Exam:** **Tuesday, December 11; 4:15-6:45 PM**

Special accommodations:
Please contact Dr. Camata for an appointment to discuss special accommodations.

Web Page: http://www.phy.uab.edu/~rcamata/PH351.htm
(Class information and grades will be posted on this web page)

Topical Outline

1. **The Special Theory of Relativity**
   a. The Michelson-Morley Experiment
   b. The Lorentz Transformation
   c. Space-time; Time dilation; Length contraction; Simultaneity
   d. Relativistic Momentum & Energy

2. **The Experimental Basis of Quantum Mechanics**
   a. The Discovery of X-rays
   b. The Electron and Charge Quantization
   c. Blackbody Radiation
   d. The Photoelectric Effect
   e. X-ray Production
   f. The Compton Effect
   g. Pair Production and Annihiliation

3. **The Structure of the Atom and the Old Quantum Theory**
    a. The Thomson and Rutherford Models
    b. The Bohr Model
    c. Successes and Failures of the Old Theory
    d. Critical Review of the Old Theory

4. **Quantum Mechanics I – Wave Properties of Matter**
    a. X-ray and Electron Scattering
    b. The de Broglie Postulate
    c. Wave-Particle Duality
    d. The Uncertainty Principle
    e. Wave Functions and Probability Densities

5. **Quantum Mechanics II – Schrödinger's Theory**
    a. Schrödinger's Wave Equation
    b. Expectation Values
    c. Solution for Infinite Square-Well Potential
    d. Solution for Finite Square-Well Potential
    e. Solution for 3D Infinite Potential Well
    f. Solution for the Harmonic Oscillator Potential
    g. Barriers and Tunneling

6. **Schrödinger's Theory Applied to the Hydrogen Atom**
    a. Solution of Schrödinger's Equation for Coulomb Potential (Z=1)
    b. Quantum Numbers
    c. Orbital Angular Momentum and Intrinsic Spin
    d. Magnetic Effects
    e. The Hydrogen Energy Spectrum and Probability Distributions

7. **Many-electron Atoms**
    a. Solution of Schrödinger's Equation for Coulomb Potential (Z>1)
    b. Survey of Multi-electron Effects
    c. Spin-Orbit Coupling
    d. The Periodic Table of the Elements: The Quantum Physics Perspective