PHYSICS 274 – GENERAL PHYSICS III
INTRODUCTION TO MODERN PHYSICS

Fall Semester 2009 MWF 8:30-9:20 WAT 420
Instructor: Eric B. Szarmes, Associate Professor
Office: Watanabe Hall, Room 212

Course Description: This course is the third installment of the University of Hawai‘i introductory physics program, and provides an introduction to the two cornerstones of modern physics, quantum mechanics and the theory of relativity. Because wave motion comprises a fundamental aspect of quantum phenomena, and also provides the impetus for a rubric known as “mathematical methods of physics,” the course begins with a study of physical optics based on the wave equation and the wave nature of light.

Textbook (required):
1) Thomas A. Moore, *Six Ideas That Shaped Physics, UNIT Q*, 2nd ed., McGraw Hill, 2003
2) Thomas A. Moore, *Six Ideas That Shaped Physics, UNIT R*, 2nd ed., McGraw Hill, 2003

Grading:
40% daily / weekly problem sets
40% quizzes / midterm exams
20% final exam

Approx. Letter:

A+ 92 >	B+ 76 – 84	C+ 62 – 68	D 40 – 50
A 84 – 92	B 68 – 76	C 56 – 62	F < 40
		C– 50 – 56	

COURSE OUTLINE

1.	Review of Waves	- the wave equation; principle of superposition	Ch. E15
		- harmonic waves; boundary conditions	Ch. Q1
		- standing waves; Fourier analysis	
		- resonance	
2.	Physical Optics	- the wave nature of light	Ch. Q2
		- interference	
		- diffraction	
3.	Quantum Mechanics	- the particle nature of light	Ch. Q3
		- the wave nature of matter	Ch. Q4
		- ‘wave-particle’ duality	Ch. Q5
		- principles of quantum mechanics	Ch. Q6
		- the wavefunction and bound systems	Ch. Q6,7
		- atomic structure and spectra	Ch. Q8,9
		- the Schrödinger equation	Ch. Q10,11
		- nuclear physics	Ch. Q12
4.	Theory of Relativity	- review of coordinate transformations and vectors	supplement
		- 3-dimensional structure of space; Newtonian relativity	Ch. R1
		- nature of space and time	Ch. R2,3
		- 4-dimensional structure of spacetime; Einsteinian relativity	Ch. R4,5
		- Lorentz transformation and kinematic consequences	Ch. R6,7,8
		- 4-vector mechanics and the mass-energy equivalence	Ch. R9,10

Daily Homework

At the beginning of each class, you will hand in solutions to two homework problems associated with the assigned reading. These problems will be graded according to the following guidelines:

5: a good effort with correct results *and* reasoning;
4: a good effort with minor errors, or a fair effort with no conceptual or math errors;
3: a good effort with modest conceptual errors and/or math errors, or a fair effort with minor errors;
2: a fair effort involving modest conceptual errors, or a good effort involving serious conceptual errors;
1: a poor effort;
0: no initial effort.

A good effort involves at least *some* English explanation and/or use of appropriate diagrams along with calculations, and/or some recognition of an implausible result. Be sure to write something for every part of a problem, even if only to indicate where you may be stumped.

Corrections

Up until one week after each problem is due, you may use the posted solutions (online, or outside my office in Watanabe 212) and a red or colored pen to turn in a *corrected version* of any problem, even if you did not submit an initial effort. Be sure to correct effort deficiencies as well as math or conceptual errors. Your corrections will be evaluated on 2-point scale:

2: everything is suitably corrected;
1: some items remain uncorrected;
0: major issues remain uncorrected.

These correction points will be added to your initial score to yield your final score for that problem (up to a maximum of 5).

Weekly Homework

In addition to the daily problems, a weekly problem set consisting of several problems will be due in class each Monday. Please make an effort on these weekly problems to write solutions that are coherent and clear as well as correct. These problems will be graded out of 8, with up to 3 additional points to be given for presentation. Corrections will be credited to the weekly problems in the same manner as for the daily problems.

Guidelines for Problem Sets

For presentation:

1. Solutions should be written in complete English sentences.
2. Proper units must accompany all final numerical results.
3. Draw diagrams whenever possible, and label them clearly.
4. Do not insert numerical values until the *final step* in a calculation.
   (Physics is learned symbolically. If you simply insert numbers at the start of a calculation and crunch away, nothing will ever make sense.)

In general:

5. Regarding significant figures: Do not round the results of any intermediate calculations. Leave at least three significant figures when rounding final results.
6. Form the habit of checking the dimensions of any equations that you derive. Many times, this simple exercise will reveal whether you made an error somewhere along the line.
7. If possible, ask yourself whether an answer makes sense.

Student Learning Objectives

After completing this course, students will be expected to be familiar with the following:

1) the fundamentals of the superposition principle in wave motion, and how it is used to describe interference and diffraction; the role of boundary conditions;
2) the fundamental properties of light waves and the mathematical analysis of single- and two-slit diffraction;
3) the fundamentals of "wave/particle duality" (eg. photons and deBroglie waves) in the description of photons, electrons, or any type of quanton; the fundamental role and interpretation of foundational experiments such as the photoelectric effect, the Davisson-Germer experiment, and the Stern-Gerlach experiment;
4) fundamental properties of quantum phenomena including "collapse of the wavefunction", quantum interference, and the statistical nature of quantum measurements;
5) introduction to the mathematical apparatus of quantum mechanics in terms of complex state vectors; the description of spin and the interpretation of the "wavefunction";
6) the basic QM solutions to simple bound systems (particle-in-box, harmonic oscillator, hydrogen atom);
7) the origin of atomic spectra; and the QM description of real atoms;
8) the meaning of the Schrodinger equation and its application to bound systems (stationary states and tunneling);
9) the QM description of nuclear structure;
10) the meaning of the principle of relativity;
11) the nature of time and the distinction between coordinate time, spacetime interval, and proper time;
12) the metric structure of flat spacetime;
13) the Lorentz transformation and its implications: Lorentz contraction, time dilation, relativity of simultaneity;
14) the four-dimensional nature of spacetime and the hierarchy of 4-vectors;
15) the energy-momentum 4-vector and mass-energy equivalence.