

Syllabus for Physics 212: Modern Physics, Fall 2012

Basic information:

•**Course prerequisites:** passing grades in PHYS 111 and in MATH 231 or its equivalent. If you do not meet these prerequisites and haven't talked to me yet, please see me soon! Also, if you have any intention/possible interest in continuing on in physics or engineering, you should really be taking MATH 234 (Differential Equations) at the same time with this course; it is only offered in the fall semester.

•**Instructor for lecture:** Ms. Yumi Ijiri
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•**Instructor for lab:** Mr. John Scofield
Wright 208 office/012 lab
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•**Class hours and location:** 11:00-11.50 am, MWF in Wright 201.

•**Lab hours and location:** 1:30-4:30 pm W or Th in Wright 214.

•**Extra session:** Tentatively scheduled for Monday evening beginning sometime around 7 or 8 pm. This is an extended time to discuss strategies for the problem sets, work on issues with Mathematica and the like.

•**Office hours:** TBA

•**Course website:** Information about assignments and the like will be available on the course website on Blackboard.

•**Textbook:** The required textbook for this class is *Modern Physics* by Taylor, Zafiratos, and Dubson, 2nd edition. We will also make use of *Fundamentals of Physics*, by Halliday, Resnick, and Walker, 9th edition (from your PHYS 110-111 days). Note for the lab section, you will also need a copy of Taylor's error analysis book. See as well a list of books placed on reserve for PHYS 212 for additional help with this material.

•**Software:** Because of Oberlin's site license, you are entitled to have a free copy of Mathematica on your own computer. To get the installation disk, contact Melinda Keller in Room W206. Mathematica is also installed on campus computer labs, particularly those within the department. Note: declared physics majors are allowed to have a dept. key which allows you off-hour access to dept. computers. The course website on Blackboard has additional information about Mathematica.

•**Evaluation:** Grading will be based on three components:

-weekly problem sets (25%: I will drop your lowest score)

-lab work (25%: see Mr. Scofield for details-there are lab notebook, error analysis, and report assignments), and

-exams (50% total: two in-class exams counting equally (12.5% each), two hour final exam counting 25%).

You must receive passing grades in each component in order to pass the course in total (i.e. you can't fail the lab and still pass the course.)

Detailed description:

•**Objectives:** In this course, we will study a number of interesting physical phenomena, first investigated in the 20th century (“modern” by convention). Topics include relativity and its relation to matter (think $E=mc^2$), scattering, wave behavior, the Schrodinger equation, quantum mechanics, atomic physics, statistical physics, nuclear physics, and particle physics. As suggested by this laundry list, this is definitely a survey course! In the lab, you will gain more experience with these phenomena as well as the act of performing experiments and analyzing the resulting data. You will also gain some exposure to computational methods using a very powerful program called Mathematica. In summary, then, the specific objectives of the course are as follows:

- 1) increase your knowledge of the major advances in physics
- 2) increase your mathematical and computational sophistication
- 3) increase your experimental skills and skills in data analysis
- 4) increase your problem-solving skills (developing skills in estimating and troubleshooting)

•**Course design:** This course emphasizes problem solving in the belief that "you learn by doing" and that you can't really understand some concept unless you can apply it and discuss it. With this in mind, the course has several important features:

1. *Problem sets:* Problem sets will be due **at the start of class on Wednesdays** (except for the third assignment due Fri. Sept. 28 due to Yom Kippur). **Late homework will not be accepted unless prearranged and then only for rather good reasons (i.e. sick, illness in the family...)** Problem set assignments and later solution sets will be posted on Blackboard. As you've probably figured out by now, it is very important to keep on top of the material. You are encouraged to talk and work with others about the problems, especially after you've made a first attempt at them by yourself. In addition, on Monday evening, there will be a problem session devoted to discussing the week's homework as well as additional questions that have arisen from the material. Your final writeup, however, should reflect YOUR understanding and be YOUR work--and in it, you should name your collaborators or sources you've used (e.g. "I worked with student Al Einstein"), as well as write and sign the honor code "I affirm that I have adhered to the honor code in this assignment."

2. *Lab:* Mr. Scofield will describe the lab portion of the course in more detail in a separate handout with the PHYS 212 lab manual. Unlike in PHYS 110 and PHYS 111, the labs for this class are not as specifically tied to course subject and lecture (although some accommodations have been made to try to get certain topics close to the lab time). Note, in the second part of the course, you will be rotating through a series of different experiments, so other students in your class can serve as additional sources of help! You will spend a significant amount of time learning about error analysis and how to analyze the data you take.

3. *Exams:* There will be three exams for this class--two during the semester and one final exam. The two during the semester will be in class, scheduled on **Fri. Oct 12th** and **Wed. Nov. 21th** while the third and final exam is during the scheduled exam period of **Tues. Dec. 18th**. The final is cumulative, but with much more emphasis on materials from the uncovered part of the course. **Note Wed. Nov. 21st is the Wednesday before Thanksgiving; please see me if you have already booked travel plans that conflict with the class time.** For each exam, I will allow you to bring in a sheet of paper (8 1/2" x 11") on to which you have written whatever you think would be useful. You must write and sign the honor code: "I affirm that I have adhered to the honor code in this assignment."

•**Course topics:** A tentative list of topics and schedule is given below:

Dates	Topics	Assignments
Sep. 5, 7	Relativity review: Lorentz transformation/ other extensions (CH 1)	
Sep. 10, 12, 14	Relativity dynamics: Energy & momentum/ mass and force/comments on general relativity (CH 2)	W: PS on CH 1
Sep. 17,19, 21	Quantization of light: Blackbody radiation/ Photoelectric effect, Compton effect (CH 4)/ start of the atom (CH 3)	W: PS on CH 2
Sep. 24, no class ,28	The atom: Rutherford scattering (CH 3)/ no class / and the Bohr model (CH 5)	F: PS on CH 4 (due to Yom Kippur)
Oct. 1, 3,5	Atomic x-ray spectra (CH 5)/ Waves I: Characteristics of single waves/ multiple waves (HRW CH 16,17)	W: PS on CH 3,5
Oct. 8,10, 12	Waves II: Interference (HRW CH 35)/ Diffraction (HRW CH 36)/ EXAM 1	F: EXAM on CH 1-5
Oct. 15,17,19	Matter waves: de Broglie wavelength/ wave packets/ and uncertainty (CH 6)	W: PS on WAVES
	FALL BREAK	
Oct 29, 31, Nov. 2	The Schrodinger equation: formulation/ square well/ harmonic oscillator (CH 7)	W: PS on CH 6
Nov. 5,7,9	Tunneling (CH 7)/ 3D Schrodinger equation/ angular momentum (CH 8)	W: PS on CH 7
Nov. 12,14,16	The hydrogen atom (CH 8)/ electron spin and the Zeeman effect (CH 9)/ building up atoms (CH 10)	W: PS on CH 7,8
Nov. 19, 21, no class	Atomic transitions (CH. 11)/ EXAM 2/ no class	W: EXAM 2 on waves, 6-7
Nov. 26,28,30	Aspects of statistical physics (CH 15)	W: PS on CH 9,10,11
Dec. 3,5,7	Aspects of nuclear physics (Taylor CH 16,17)	W: PS on CH 15
Dec. 10,12,14	Aspects of particle physics (Taylor CH 18)	W: PS on CH 16,17
TUES. Dec. 18	EXAM 3 –9 am-11 am	T:FINAL EXAM

●**Other information:** If you are a student with a learning disability or other special needs, I encourage you to talk with me early in the semester about the course. We may need some advance notice to work with Jane Boomer in Student Academic Services to assure that the proper paperwork is in place so that necessary accommodations can be made.

●**Additional resources:** I encourage you to look for other references that will explain the material in a better fashion for you. As a warning: a quick look on Amazon.com will reveal that there's not much consensus on a good Modern Physics book!! Below are other texts, the majority will be placed on reserve in the science library:

Modern physics books:

- Rohlf, Modern physics from alpha to Z^0 . Last year's required book. Nice section on scattering, but watch for typos in this first edition book. This is a pretty non-traditional presentation ordering—with the advice from last year: choose another book!
- Serway, Modern physics. Also a classic.
- Tipler, Modern physics. The year before last year's required book. This is somewhat more historical, outlines a little more the reason for one approach vs. another.

Mathematica books:

- Don, Mathematica (available online, the Schaum's outline series book--see the BB link)
- Mangano, Mathematica cookbook (available online—see the BB link)
- Wolfram, The Mathematica book (the classic reference to Mathematica)
- Zimmerman, Mathematica for physics (geared more to the things we might encounter)

Error analysis books:

- Bevington, Data Reduction and Analysis for the Physical Sciences. This is a classic error analysis book. A little more concise than Taylor, which sometimes buries things into the problems...