Course information, Physics 251/252, Fall 2009
Prof. Chris Jacobsen

Jimmie Dugan (Tom Hanks) to Dottie Hinson (Geena Davis) on baseball in the movie *A League of Their Own* (Columbia, 1992): "It's supposed to be hard. If it wasn't hard, everyone would do it. The *hard* is what makes it *great*."

1 Introduction

In the late 1800s, some people viewed physics as a completed story. Good working descriptions of classical mechanics, thermodynamics, and optics existed, and the mid 1870s had seen Maxwell's remarkable unification of the theories of electricity and magnetism. One could forgive a certain feeling of smugness!

This, however, would soon change. On the cusp of the turn of the century, Max Planck came up with what he thought of as a somewhat desperate solution to a problem concerning the details of the infrared emission spectrum of hot objects: perhaps atomic radiation was somehow quantized with a fixed relationship between frequency and energy. In 1905, a junior Swiss patent examiner named Albert Einstein exploded whatever complacency might have remained by providing convincing proof of the reality of atoms, the reality of Planck's quanta, and the reality of Maxwell's equations concerning the speed of light. The next three decades found physics entering an entirely new world, as if Hamlet's admonition that "There are more things in heaven and earth, Horatio, Than are dreamt of in your philosophy" [Shakespeare, *Hamlet, Prince of Denmark*, I, *v*, 166] was really a retrospective on earlier physics.

This course marks a watershed in your education in physics. While you may have heard of relativity and quantum mechanics before, we're going to dive into it. You won't come out of this course knowing all; physics majors will get a more detailed course in their junior year, and those who go on to graduate school will likely take yet another even more detailed course on quantum mechanics. That's not even the end! Quantum measurement theory and relativity are still active areas of legitimate physics research, and there are also legions of cranks out there with theories that claim to show how quantum mechanics or relativity is wrong.

The schedule for the course, and contact info for the instructors, is given on the PHY 251/252 web page. A shortcut to this page is `http://tinyurl.com/ltk8qr`, which points to

`http://xray1.physics.sunysb.edu/~jacobsen/phy251f2009/index.html`

2 PHY 251: the lecture and recitation course

From the undergraduate bulletin, which has the official text:

> *PHY 251 Modern Physics*
> A survey of the major physics theories of the 20th century (relativity and quantum mechanics) and their impact on most areas of physics. It introduces the special theory of relativity, the concepts of quantum and wave-particle duality, Schrödinger's wave equation, and other fundamentals of quantum theory as they apply to nuclei, atoms, molecules, and solids. The Laboratory component, PHY 252, must be taken concurrently; a common grade for both courses will be assigned. Three hours lecture and one hour recitation per week.
> *Prerequisite*: PHY 122, or 126 and 127, or 132 and 134, or 142
> *Pre- or Corequisite*: MAT 203 or 205 or AMS 261

Corequisite: PHY 252
3 credits

2.1 Lecture notes

The lecture notes consist of Adobe Acrobat `.pdf` files; if you print them, you might use the print layout option in Acrobat to put two file pages on one printed output page (see Fig. 1). For the cognoscente, these notes have been generated using the Hannover theme in the `beamer` package in LaTeX, which is a typesetting language frequently used by mathematicians and physicists. For those who want to play around with it, LaTeX is available for free for nearly any computing platform; MacTex is a good package for the Mac, MikTeX is one of the packages available for Windows, and most Linux distributions provide an automatic installation mechanism (`rpn`, `apt-get`, etc.) for installing LaTeX.

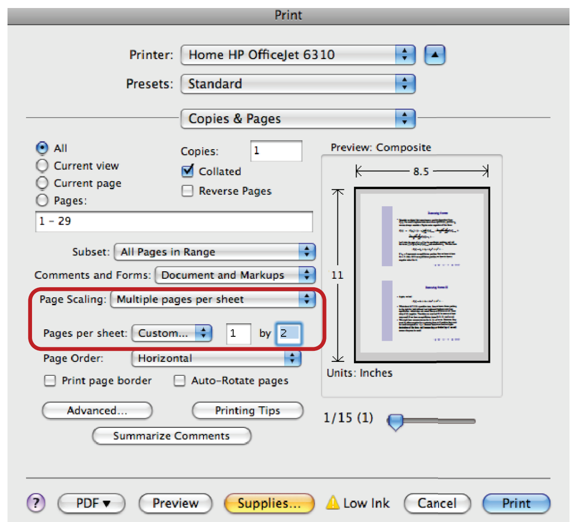

Figure 1: The course lecture notes use extra large fonts for easy viewing on a 1024×768 pixel projector. However, if you print out the notes you're burning through lots of paper unnecessarily since a 300 dpi printer produces the equivalent of about 2400×3000 pixels. Therefore if you want to print the lecture notes out, you might consider using the *Multiple pages per sheet* option in Adobe Acrobat.

2.2 Textbook and other resources

The text for the course is *Modern Physics*, by Serway, Moses, and Moyer (3$^{\text{rd}}$ edition, Thomson Brooks/Cole, 2005, ISBN 0534493394). This book has a student book companion web site which you can find on the `www.brookscole.com` web page. We will frequently supplement the book with lecture notes provided in class.

Sometimes it is very useful to consult other modern physics textbooks to see an alternative explanation of a particular subject. There are a number of them out there. You owe it to yourself to become acquainted with the *Feynman Lectures on Physics* (Feynman, Matthews, and Sands; Addison-Wesley). Richard Feynman was one of the key developers of quantum field theories, an outrageous and entertaining character, and a giant in physics in the second half of the twentieth century. He taught the freshman physics class at CalTech for several years, and legend has it that many of his faculty colleagues would drop by for his insightful and entertaining lectures. (Legend also has it that students found the lectures a bit frustrating because Feynman never solved example problems in them, leaving that entirely to recitation). Where his lectures shine is in describing the ideas of physics, such as the conundrum of wave-particle duality. Also, if you enjoy his lectures, you might also want to check out *Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character* (Norton Publishing, 1997) to learn of some of his outrageous antics such as safe-cracking at Los

Alamos during the Manhattan Project, lunches at stripper joints near CalTech, and playing bongo drums in Brazil.

2.3 Recitations and homework

Recitations (following the schedule on the course web page) are meant to give you guidance on homework problems, and to offer a smaller group within which one can ask questions. Homework problems will typically be assigned on Thursday, and due the following Thursday in lecture, so your recitation section on Wednesday gives you a chance to ask about the questions you are haveing particular struggles with.

You will not get a good grade in this course if you try to cram the night before exams, or simply read through the textbook. You learn physics by *doing* physics, and you learn more by doing more. Doing the homework is crucial to doing well in the course. Regarding homework, I absolutely encourage you to work on homework with a classmate or classmates. Just keep in mind that exams are solo efforts (as a sports coach would put it, "practice like you play"). Even if you work with someone else to make initial sense of the problem, sit down by yourself to write up your homework solution so that you practice what you need to do on an exam.

2.4 Book report

Your first and almost-last assignment in the class is to pick a semi-popular book on quantum mechanics or relativity, or on some aspect of their historical development. You must first produce a 1–2 paragraph typed report on your "first impressions" of reading the book; this report is due on Thursday, September 17. The purpose of this "first impressions" report is to give me an idea of what book you have selected, to make sure it matches the spirit of the assignment. You should look at the book throughout the semester, and then on Thursday, December 3 you must hand in a 8–10 page typed report on what you think of the book you chose after you've learned more about modern physics. Interested students should consult with the undergraduate program director to see if they can expand their report to meet the Upper-Division Writing Requirement:

`http://www.physics.sunysb.edu/Physics/ugwebpage/ug/node6_mn.html`

Here are some suggestions for books to consider:

- *The Making of the Atomic Bomb* by Richard Rhodes (the first quarter of the book is really an excellent history of modern physics).
- *The Fly in the Cathedral* by Brian Cathcart. This is a wonderful story of the early developments in nuclear physics.
- Abraham Pais' biographies of Albert Einstein and Niels Bohr. These are biographies written by a noted physicist, complete with equations! They're excellent, though they require a bit more effort to read.
- *In search of Schrödinger's Cat* by John Gribbin discusses the history of quantum mechanics, its interpretation, and some of the personalities.

These are suggestions; you should go to your favorite bookstore and browse around to find something which describes the history and ideas of modern physics (or just quantum mechanics). Don't go too overboard in the direction of fluff, and don't pick a textbook.

Need an example for how to write the book report? Look at the book reviews in the Book section of the Sunday New York Times.

2.5 Exams

The exams will all be in-class exams on the dates indicated in the lecture schedule on the course web page. I will provide you with an equation sheet a few days before the exam, and you will be able to use calculators. If you miss an exam, you will receive a zero for that test unless the absence is due to medical reasons, which must be justified by a written note from your doctor or dentist. In this case, you will be allowed to take a make-up exam as soon as the medical condition permits.

2.6 Grades: whadyagottadoo?

Grades are what you earn, rather than what your instructor gives. You have to do well on exams, homework and quizzes, and the reading/writing assignment. The grade split for PHY 251 is as follows:

Exam I	15%
Exam 2	15%
Final exam	20%
Recitation (homework)	15%
Book report	10%
Lab (PHY 252)	25%

3 PHY 252: the laboratory course

From the Undergraduate Bulletin (which has the official text):

> *PHY 252 Modern Physics Laboratory*
> Must be taken concurrently with lecture component PHY 251; a common grade for both courses will be assigned. Students perform some of the pivotal experiments of the 20th century. The Lecture component, PHY 251, must be taken concurrently; a common grade for both courses will be assigned. Two hours of laboratory per week.
> *Corequisite*: PHY 251.
> 1 credit

Labs give you a chance to get a glimpse at some of the classic experiments which have either led to or confirmed important understandings in modern physics. Your lab instructor will describe the lab more, including when lab notebooks must be handed in and the penalties for late reports. The laboratory manual will be provided week-by-week on the course web page. Print out a copy for yourself before each lab.

The grade for the lab (PHY 252) is earned separately from the course grade, and will be based on the average of your best 8 lab scores. You must hand in a report on all 9 labs to earn a passing grade; a make-up lab day is on the schedule. Your lab instructor will sign off in your book before you leave each lab. Failure to complete 9 labs will lead to a grade of I (incomplete) or F, depending on the scores on the labs that have been handed in.

4 Information for both PHY 251 and PHY 252

The following information applies to both PHY 251 and PHY 252.

4.1 Help!

Make use of office hours. Do not hesitate to ask for appointments outside of office hours. Come see me on your own, or if you think I'm too scary, come see me with a classmate.

4.2 Special requirements

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, 128 ECC Building, (631) 632-6748:

`http://studentaffairs.stonybrook.edu/dss/`

They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the campus EHS web site:

`http://www.sunysb.edu/facilities/ehs/fire/disabilities.shtml`

4.3 Academic honesty

Please read the statement on the undergraduate physics web page on student ethics and academic honesty:

`http://www.physics.sunysb.edu/Physics/ugwebpage/ug/node25_mn.html`

We will apply those standards to this class.