Physics 143 Syllabus

Fall 2010, Duke University, *Prof. Joshua Socolar*

September 3, 2010

This course will introduce you to two mind-boggling theories at the heart of our current understanding of the physical world: special relativity and quantum mechanics. As it happens, the groundbreaking work on both was done in the early 20th century. The theories we will study were largely understood by about 1925, which is "modern" in the sense that it comes after 1685 (Newton) and 1860 (Maxwell). It is also modern in the sense that the full theory of relativistic quantum mechanics is perfectly correct, as far as we know, and many truly modern devices and bizarre phenomena discovered after 1925 are well explained by it. There is one catch: though we now understand how to construct quantum theories consistent with special relativity, we cannot deal with the mathematical complexities of such theories in this class. We will be content to study special relativity by itself and non-relativistic quantum mechanics by itself. Still, we will learn much about spacetime and mass/energy, and much about atoms, light, and the physics underlying much of chemistry and materials science. Along the way, questions about all sorts of physics can be entertained, from elementary particle physics to materials physics and cosmology.

The course has three essential components. First, there are class meetings MWF in which I will lecture and lead discussions. Second, there are lab meetings in which you will work in pairs to perform experiments and report the results in written form. Finally, there is the part where you work outside of class – doing homework problems, reading, discussing physics with classmates, and talking to me. To be successful (i.e., to really learn the material) you have to do all of these well.

In all of your work for this course you must adhere to the **Duke Community Standard**. I will try to be exlplicit about what you are or are not allowed to do, but I expect you to ask me if any case arises that requires clarification.

1 Weekly schedule

- Classes will be held MWF 10:20-11:10 in Room 130 of the Physics Building.
- Each student will attend lab every week for two hours with their designated section (Wed, Thurs, or Fri) in Room 005 of the Physics Building. A detailed schedule can be found at http://www.phy.duke.edu/ socolar/phy143/schedule09.html.

2 Texts

- "Bertlmann's socks and the nature of reality," by J. S. Bell (available in Blackboard).
- "Is the moon there when nobody looks?" by D. Mermin (available in Blackboard).
- "QED," by R. P. Feynman.
- "Modern Physics," by Bernstein, Fishbane, and Gasiorowicz (a.k.a. BFG). This is the primary text for the course.
- Two articles on a topic of your choosing.

3 Homework

- There will be weekly homework sets consisting of several problems. Solutions to these problems may be available on the web or elsewhere, **but you are not allowed to look at them**. You may talk with classmates about homework problems and work together, but you must write your own solutions in your own words. The math associated with each solution should be carefully annotated so that all relevant physical theories or assumptions are clearly noted. All solutions must be turned in on time for full credit (25 points). Solutions turned in up to 48 hours late will incur a penalty (5 points). After that, solutions will not be accepted for credit. For the purposes of computing your final grade, the lowest weekly homework grade **other than the last one (HW 11)** will be dropped.

- **HW 11**. During the last two weeks of the course, you will choose one of the following chapters of BFG to study on your own and do homework problems from it:
  - Chapter 11 – Complex Atoms and Molecules;
  - Chapter 13 – Decays, Radiation from Atoms, and Lasers;
  - Chapter 14 – Conductors, Semiconductors, and Superconductors;
  - Chapter 15 plus Sections 16-1,2,3 – The Atomic Nucleus plus Antiparticles and QED; or
  - Chapter 17 plus Sections 18-1,4 – General Relativity plus Microwave Background.

  There will be opportunities to discuss your chosen chapter in groups during the last week of classes.

4 Labs

Each student will complete five labs plus two short warm-up labs. There will be two sessions devoted to each lab and a complete writeup will be due one week after the second session. Students will work in pairs, with each pair producing a single writeup. Guidelines will be explained in the first lab sessions.

There are eight experiments available. Students will sign up during the second lab session for the five that they will perform.

5 Grades

Component	**Percentage of Course Grade**
Homework	25%
Labs	25%
Two Midterms	12.5% each
Final Exam	25%