Physics 2220 General Information

Instructor: Dr. Daniel Schroeder
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Office hours: MTWF 10:30–noon, Th 1:30–2:30. I'm often in my office at other times as well; my full schedule is posted next to my office door.

Text: Your choice of: Knight, *Physics for Scientists and Engineers with Modern Physics*; Halliday, *et al.*, *Fundamentals of Physics, Extended*; or a similar text.

Required Materials: Everyone will need a scientific calculator. You will also need a ruler and protractor for a few homework assignments and tests.

Course Web Page: http://physics.weber.edu/schroeder/phsx2220/. Here you will find copies of homework assignments, homework solutions, and most other class handouts.

Course Outline

1. **Electrostatics.** We begin this semester with an intensive study of the most important forces in nature: the electromagnetic forces between charged objects. The simplest case, called *electrostatics*, is where the objects exerting the forces are at rest. Even here, the applications are ubiquitous and nontrivial. To deal with these applications, we will introduce a new auxilliary concept: the electric field, which fills the space around charged objects and mediates the force between them.

2. **Electric Currents and Magnetism.** Electric charges in motion are even more interesting than those at rest. Here we study the motion of charges ("electric currents") through wires and other devices, as well as the new forces (called *magnetic* forces) exerted by moving charges on each other. Again we will think of these forces as being mediated by a field, the magnetic field.

3. **Electrodynamics.** When electric currents fluctuate, or when isolated charges accelerate, the surrounding electric and magnetic fields take on a life of their own. A changing magnetic field is always accompanied by an electric field; similarly, a changing electric field is always accompanied by a magnetic field. These phenomena have practical use in tuning circuits and transformers. The most interesting application, however, is to electromagnetic waves: pieces of the electromagnetic field that break free and travel away on their own, at the speed of light.

4. **Optics.** Light is enormously important and surprisingly subtle. Sometimes we can assume it will travel in straight lines, but at other times its wave nature becomes apparent.

5. **Elements of Quantum Mechanics.** Amazingly, light doesn't always behave as a wave—under some circumstances it behaves as a stream of tiny particles. On the other hand, small particles (such as atoms and electrons) often can behave like waves. We'll learn when things behave like what, and use the wave nature of particles to understand why atomic energy levels are quantized.

6. **Relativity.** Puzzling over some apparent paradoxes in electromagnetic theory, Einstein in 1905 proposed that Galileo's principle of relativity might apply even to light—that light might travel at the same speed with respect to *all* observers. But this implied that most of our assumptions about space and time were wrong.

7. **Nuclear Physics.** Quantum mechanics and relativity can be applied in many contexts, but one of the most interesting and most important is the study of the atomic nucleus. We'll investigate nuclear structure, radioactivity, nuclear reactions, and several of the applications of nuclear physics.

There's a problem with topical outlines, though: They tend to give the impression that the course is *merely* a list of topics, one after another. Does this course have any coherent story line or unifying themes?

One major theme is electromagnetism, the subject of about 3/4 of the course. Why spend so much time studying "just one" of the types of forces found in nature? The answer is that our modern theory of electromagnetism accounts for nearly *all* of the phenomena we see around us. It includes the electrostatic forces that hold atoms together, push nuclei apart, and cause your clothes to stick together in the dryer. It describes the electric current that flows through a light bulb, the light that the bulb gives off, and the magnetic generator that caused the current to flow. It explains how you can see yourself in a mirror, talk to a friend on the phone, and watch a television broadcast from a distant city. We'll discuss all of these applications in this course.

Another major theme of the course, though, will be a progression away from the world that we directly perceive and into the universe of extremes: tiny particles, unseen fields, and unthinkably high speeds. Physics encompasses *all* of the physical universe, not just what our limited senses can directly observe. And in seeking to explain matter and energy under more and more extreme conditions, physicists have been forced to cast away prior conceptions of how nature works and replace them with ideas more fantastic than any science fiction writer could have invented.

Goals of the Course

Physics is not so much a collection of facts as a *way* of looking at the world. My hope is that this course will not only teach you many of the *ideas* of physics, but will also improve your *skills* in careful thinking, problem solving, and precise communication. In this course you will gain lots of experience with qualitative explanations, rough numerical estimates, and careful quantitative problem solving. When you understand a phenomenon on all of these levels, and can describe it clearly to others, you are "thinking like a physicist" (as we like to say). Whether or not you choose to become a professional physicist, these skills will serve you well for the rest of your life.

Policies and Procedures

Class sessions will be spent on lecture, demonstrations, example problems, and—most importantly—discussion. *Please feel free to interrupt with questions at any time.* Attendance is not required but is strongly encouraged.

Labs are an integral part of this course. You must register for a section of Physics 2229, the laboratory component of this course. There will be 14 lab exercises during the semester, plus a lab practical exam. (There is no lab session during Thanksgiving week.) In computing lab grades I will use only the highest 13 scores, so you may miss one lab session without penalty. I will also make adjustments, if necessary, to account for differences in grading between lab instructors.

Problem sets will be assigned roughly once a week, as indicated on the syllabus. The purpose of the problem sets is *not* to test you; rather they are an opportunity for you to practice and learn. I *strongly* encourage you to discuss the homework with classmates. In this way you can learn from each other, prevent careless errors, practice putting ideas into words, and work in an environment more like the "real world". Of course, in the end each of you will be tested individually, so it's best not to rely on classmates *too* much.

I will also make official **solutions** to the problem sets available on the course web site. You are free to consult these solutions at any time as you prepare your own. However, I recommend that you use them only to *check* your own solutions, and when you are truly stuck. In any case, all work that you turn in must be in your own handwriting.

Normally, I will not have time to read your problem solutions in much detail. Grading will be based mostly on the amount of work completed and the apparent effort expended. It is important that you turn in full solutions, with verbal explanations wherever appropriate (see the official solutions for examples). I will not simply count the number of correct answers.

Late homework will not be accepted. However, your homework grade will be based only on the highest 13 (out of 15) problem set scores, so you may miss two problem sets without penalty. This policy should give you enough flexibility to deal with most illnesses, family emergencies, term papers, unexpected romances, and the like; exceptions will be granted only in the case of a long-term crisis lasting more than two weeks (and then only if you discuss the situation with me at the earliest opportunity).

Quizzes will be given at the end of class on the same dates that problem sets are due. Each quiz will consist of one or two problems covering the same topics as that day's problem set. Before each quiz we will have a half-hour question-and-answer session to discuss the homework and prepare for the quiz. No make-up quizzes will be given, but again I will drop the two lowest scores in computing your final grade. All quizzes will be closed-book with no notes allowed. Calculators will be permitted when necessary for doing difficult arithmetic, but may not be used to store any information.

We will have four **midterm tests**, given in class. Like the quizzes, they will be closed-book with calculators permitted only for doing arithmetic.

Our **final exam** will be on Wednesday, December 9 at 12:30 pm. It will be comprehensive, with some additional emphasis on material covered after the fourth midterm.

No make-up exams will be given without *advance* permission.

Grades will be computed according to the following weights:

problems sets (highest 13)	10%
quizzes (highest 13)	13%
lab reports (highest 13)	13%
four midterms @10%	40%
final exam	20%
lab practical exam	4%

In deciding borderline grades I may also consider class attendance and participation. (It is your *effort* at participation that matters; how much knowledge you demonstrate makes no difference at all.)

Although it is rare for a student who completes all the assignments to fail this course, I am occasionally forced to give non-passing grades for various reasons. You should be aware that WSU has two different non-passing grades: E and UW. When a student stops attending but does not officially withdraw from the course, the appropriate grade is UW. I normally give a UW to any student who does not pass the course and who has not taken the final exam.

Please stop by my office sometime next semester to pick up your graded final exam. It'll go into the recycling bin if I still have it by the end of spring semester.

Academic dishonesty, though rare, occasionally does occur in physics classes, so the following policies are necessary. Dishonesty on a homework assignment or quiz will result in a zero grade for that item on the first occurrence and failure in the course thereafter. Dishonesty of any sort on a test, if clearly documented, will result in automatic failure in the course. In serious cases, evidence of dishonesty may also be presented to the appropriate hearing committee for possible further sanctions.

Special notice: Any student requiring accommodations or services due to a disability must contact Services for Students with Disabilities (SSD) in room 181 of the Student Service Center. SSD can also arrange to provide course materials (including this syllabus) in alternative formats if necessary.

Hints and Suggestions

The ideas of physics are the most fundamental and universal in science, but they are also the most abstract. It is crucial, in physics, that you learn each fundamental principle thoroughly. Fortunately, there aren't that many of them: In electromagnetism, the *most* important formulas are the basic definitions (of the electric and magnetic fields, voltage, etc.). Also important are the general methods of calculating fields—the laws of Coulomb, Gauss, Biot and Savart, Ampere, and Faraday. If you understand these basic principles, there is no need to memorize every formula in the textbook. The fundamental principles of optics, quantum mechanics, relativity, and nuclear physics are similarly few in number.

Since the ideas of physics are closely linked to each other, the material of this course will be highly sequential. It is therefore crucial that you not fall behind. If you don't understand something I say in class, ask immediately. Read the text regularly, and don't put off homework until the last minute.

Extensive research in recent years has shown that the students who do best in physics (and other subjects) are those who involve themselves *actively* in the learning process. This involvement can take many forms: jotting questions in the margins of the book; asking questions in class or in my office or by e-mail; discussing physics with classmates; inventing your own examples; writing careful English explanations in homework assignments. Try to do things like these as often as possible!

Finally, try to enjoy the course. Although you may not be completely thrilled by the formula for the electric field of a charged cylinder, there are sure to be other applications that do interest you. Even those sterile electrostatics problems can be fun if you think of them as puzzles to challenge your intellect. To me, the universal principles of physics are truly awe-inspiring, and the conceptual tools that physics develops are immensely powerful. I hope that, as you learn the principles and develop the tools yourself, you will find physics to be as enjoyable, useful, and liberating as I have found it to be.

Best wishes as you continue your study of physics!