

Physics 2710 General Information

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Office hours: MWF 9:30 – 10:20 am, and TTh 1:30 – 2:30 pm. I'll often be available at other times as well. My complete schedule is posted next to my office door. Feel free to make an appointment if you need to talk with me at a particular time.

Textbooks: For the relativity portion of the course (during the first four weeks), our text will be *Six Ideas that Shaped Physics, Unit R*, by Thomas A. Moore (McGraw-Hill, 2002). For the remainder of the course you'll need a more traditional “modern physics” textbook. I especially recommend *Modern Physics for Scientists and Engineers* by Taylor and Zafiratos (Prentice Hall, 1991 or 2004).

Course Outline

The theories of relativity and quantum mechanics, together with their many applications, are often called “modern physics,” as opposed to the “classical physics” that preceded them. Now that these subjects are 100 years old, the word “modern” is becoming a bit of a misnomer. Still, relativity and quantum mechanics continue to serve as the foundations of 21st-century physics. And these subjects are truly revolutionary: They defy common sense, forcing us to re-think our most basic assumptions about space, time, and motion. The purpose of this course is to study these subjects in as much depth as is possible in a semester-long course with a year of calculus as a prerequisite.

1. **Relativity.** You already know what relativity is all about. In this course you will master the theory—both its kinematic (time and space) and dynamic (energy and momentum) portions. You'll learn to apply relativity to precision measurements, electromagnetism, subatomic physics, and interstellar travel.
2. **Quantum Mechanics in One Dimension.** Quantum physics is mathematically harder than relativity, but in this course you'll master most aspects of quantum mechanics in one dimension: wavefunctions, probabilities, energy quantization, and tunneling.
3. **Quantum Mechanics in Three Dimensions.** Quantum mechanics in 3-D gets more complicated, so we'll have to pick and choose our topics and often rely on a more pictorial approach. Our goals will be to understand angular momentum (including spin), the hydrogen atom, and the qualitative features of multi-electron systems.
4. **Seminar in Contemporary Physics.** We don't have time to cover all the rest of modern physics in depth, so the last part of the course will instead be organized in seminar format, with presentations by guest speakers and by you and your classmates. Advanced theoretical topics may include general relativity, foundations of quantum mechanics, nuclear physics, and elementary particle physics. Further applications may include multi-electron atoms, chemical bonding, properties of solids, lasers, and selected topics in nanotechnology, biological physics, and astrophysics.

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 relativity and quantum mechanics, but will also improve your *skills* in careful thinking, problem solving, and clear 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 for the first 3/4 of the course will be spent on lecture, demonstrations, example problems, and discussion. *Please feel free to interrupt with questions at any time.* Suggested reading assignments from our textbooks are indicated on the class schedule; you may decide whether you benefit more from reading this material before or after class. Class attendance during this portion of the course is not required, but is strongly recommended. The last 1/4 of the course will be run as a “seminar” in contemporary physics, with presentations by students and guest speakers. Attendance at these sessions *is* required and will count toward your grade.

Problem sets will be assigned roughly once a week, as indicated on the daily schedule, and will be due (in my office or mailbox) at 4:00 p.m. 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 work with classmates on problem sets. 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.” You are also welcome to ask me for hints at any time. However, the work that you turn in must be entirely your own. While you may discuss the problems with others as much as you like, you may *not* look at anyone else’s written solution until after you have written your own. When you receive significant help from a classmate on a particular problem, you must give that person credit in your written solution.

I will grade each problem set on a scale of 0 to 4, with the score based not only on your getting the right answers but also on the completeness of your solutions and on how well you communicate on paper. Your solutions should be written so that any classmate could read and understand them. Solutions that are incomplete, illegible, or poorly organized will receive significantly less credit, even if the answer is correct. I will make official solutions to each problem set available soon after the due date.

Late problem sets will not be accepted. However, your homework grade will be based only on the highest 8 (out of 9) problem set scores, so you may miss one problem set 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 very serious illness or other long-term crisis, and then only if you contact me as soon as possible.

Projects

During the last two weeks of the course, each of you will make a 10-minute presentation to the class, on a modern physics topic or application of your choice. You will also write an appropriate homework problem on your topic, and an official solution to this problem. Finally, you will write a formal paper on your project topic. For more details on the project assignment, please see the attached page.

Tests

We will have three **midterm tests**, given in the science testing center (SL 228). They will be closed-book, but you may use a calculator for doing arithmetic. The time limit on each test will be 90 minutes, and you will have a two-day time period during which to take the test.

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

Grades will be computed according to the following weights:

Problems sets (highest 8)	32%
Three midterms @14%	42%
Project presentation	9%
Project paper	9%
Seminar attendance and problem solutions	8%

In deciding borderline grades I may also consider class attendance (during the first 3/4 of the course) and participation. It is your *effort* at participation that matters; how much knowledge you demonstrate makes no difference at all.

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 relativity and quantum mechanics are the among most interesting and fundamental in physics, but they are also extremely abstract, far from our common experience. Nobody is born with an intuitive understanding of these ideas; the only way to develop intuition is to *practice* repeatedly with each new concept. Your best chance to do this will be on the problem sets, but I also advise you to wrestle actively with the concepts as you read the textbooks, ask questions during class, and discuss physics outside of class.

Because of the abstractness, and the sequential nature of the course material, it is crucial that you not fall behind. If you don't understand something I say in class, ask immediately. Read the texts regularly, and don't postpone homework until the last minute. This is not a course in which you can successfully procrastinate for weeks and then learn everything the night before the test. A bit of rote memorization might be necessary at times, but it won't help you at all with the major principles.

Nobody finds it easy to learn relativity or quantum mechanics: remember that even the greatest theoretical physicists never dreamed that the universe could be so bizarre, until these ideas were forced upon them by experimental evidence. Fortunately, like all ideas in physics, relativity and quantum mechanics are *not* all that difficult, once you understand them. I hope that, by the end of this course, you will recognize much of the underlying simplicity of the most basic laws that govern our universe.