

Physics 222 – Introduction to Modern Physics

Summer 2009

Daily 12:00-1:50 p.m., C247 ESC

Two major theories were discovered in the twentieth century: quantum mechanics and relativity. As relativity is introduced in physics 123, we will focus on quantum mechanics, including the fundamentals as well as atomic, molecular, nuclear, solid-state, and particle physics.

Physics 121, 123, 220 or approved equivalents are prerequisites for this course. Students will also be expected to know the mathematical methods used in these courses.

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Office Hours: 2-3 p.m. MWF (or by apt.) in underground lab study area
Final Exam: Wednesday Aug 12, 1-2:50 p.m.
Grade: 25% Homework, 10% Labs, 20% Exams,
25% Final, 10% Quizzes, 10% Writing

Class URL:

<http://www.physics.byu.edu/faculty/durfee/courses/Summer2009/physics222/>

Important Disclaimer: Many aspects of quantum mechanics will go against your intuition. So it is very important, right from the start, to put away your prejudices about the physical world.

As humans we have a limited range of senses. In every day life we deal with objects moving slowly compared to the speed of light. As such, it wasn't until Einstein came along that we realized that our intuition for mass, momentum, and energy was incorrect. Similarly, we can only "see" things that occur on time scales longer than a few milliseconds and on length scales larger than a few micrometers. The "Newtonian intuition" for physical law that you develop by throwing balls, accelerating in cars, etc., is based on observations on these scales.

But Newton's laws emerge from more fundamental laws occurring on smaller scales. The nuances of the more fundamental laws mostly get "washed out" when making larger scale observations, and as such Newton's laws usually do a pretty good job describing "everyday" things. But there are ways in which the more fundamental laws make themselves known. Phenomena such as the discrete spectrum of light emitted by atoms gave scientists early clues that Newton didn't have the full story.

An understanding of the more fundamental laws of quantum mechanics allows us to understand and manipulate a larger range of physical systems than we could do with classical physics. But to gain this understanding we must cast aside our classical intuition. So before you read any further, consider this question: "Why should I expect an atom (which is only about 0.0000000001 meters wide), to yield to my intuition of physical law (which was developed by interacting with things on the scale of a meter)?"

Quantum mechanics is currently the globally accepted explanation of how the world works. It has been tested with countless experiments. There are still unanswered questions, and eventually we will likely find an even more fundamental set of laws (which will probably be even weirder than quantum). But until that time quantum is the name of the game.

Say "**I believe in quantum mechanics!**" out loud.

Office Hours and Study Groups: Studies have shown that two of the most important factors in what a student learns in college are the time spent working with classmates and personal contact with faculty members. As such, I will do whatever I can to help you to establish study groups and to make myself available to you. Students who have taken advantage of these opportunities in the past have formed friendships which have helped their learning (and their grades) in not only this course but future courses as well.

In addition to the group study time you will have during TTh classes, I will hold office hours from 2-3 each MWF in the underground lab study area. This study area will also be available for you to use at other times to do homework, study, work on your term paper, etc. My lab (where I can usually be found) is conveniently located right next to this study area.

This may be the hardest class you take at BYU. I have done a considerable amount of work trying to make it as easy as possible for you to learn the material we will cover, and if you put forth a good effort, you will do well and have fun. Nevertheless, I expect that this will be a challenging course for all of you. You will also have to discipline yourself and study perhaps harder and with greater focus than you ever have.

Class Goals: One of my goals is for each of you to gain the ability to use the ideas and mathematical formalisms of quantum mechanics to understand and solve real problems. In addition to this, I want you to develop intuition for quantum mechanics and, as it were, re-wire your brains to think in terms of a new set of rules. This course will also teach you mathematical methods, reasoning, and general problem solving skills.

My understanding of math and science has affected all aspects of my life, from the way I manage my finances to my understanding and appreciation of the gospel. It has sharpened my reasoning skills and awakened a fascination of the universe we live in and of the power that math and science give us to understand and appreciate all of the wonders that surround us. It is my hope that, in addition to learning specific skills in this class, you will also broaden your interest in and understanding of, well... life, the universe, and everything!

Lecture and Review Days: We meet every day for about 2 hours. On MWF we will introduce new physics. The TTh time will be used to discuss your term paper, teach writing skills, catch up if we fall behind, do demonstrations, etc., as well as to work in groups on your homework, get help from the T.A., or do other studying related to Physics 222.

Text: The reading assignment to be completed *before* each lecture is listed on the class schedule. Most of the reading comes from the text *Modern Physics* (Sixth Edition) by Arthur Beiser. There are a few other assignments from sources available online. You will be quizzed on the assigned reading material. It is of great importance that the assigned reading be done before class discussion of the material.

Homework: Assignments are due on their listed due date any time before the building closes. Assignments are to be dropped off in the slot labeled "physics 222" in the boxes near room N375 ESC. You will be assigned an ID number for this course. Be sure to fill this ID number in at the top of each assignment or I will not be able to give you credit for your work. Homework will be returned to the slots next to the box where homework is handed in. It is sorted by the first two digits of your class ID. Other students will have access to your graded homework, so if you don't want others to know your scores, you should not put your name on the assignment (you may if you wish, however).

When your grade is computed at the end of the semester, your lowest two homework scores will be dropped and ***late homework will not be accepted***. I will bend this rule *only* if circumstances out of your control prevent you from turning in ***more than two homework set*** on time. Students are ***strongly encouraged*** to discuss homework problems and to help one another understand the homework, but any assignment handed in must be entirely your own work.

Homework must be legible, and all steps must be clear. If the grader has difficulty following your work you *will* lose points. All homework should be done symbolically as far as possible. When numerical results are required, do not put numbers into your equations until the end. Unless otherwise noted, numerical answers should be given in standard SI (mks) units, and should be given to ***three digits*** of precision.

Walk-In Labs: Throughout the semester you will be assigned to perform several short laboratory experiments. Some of the experiments will be set up in room S415 ESC and will be available for one week (Monday through Friday). You may do the experiment at any time you wish until the building closes on Friday, but I encourage you to avoid the rush and do the experiments as soon as possible. The rest of the labs are computer simulations. These labs are available on the class web page, and you can work them on your own computer or any reasonably up-to-date computer you have access to. Please don't wait until the last minute to find out if it will run on your computer or not.

A worksheet for each lab is available on the web. This worksheet is to be filled out as you do the lab and then handed in. The lab worksheets may be handed into the homework drop box at any time on or before the last day of the lab (make sure you hand them in before the building closes!). You are strongly encouraged to work and discuss the labs in groups, but everyone must participate when collecting data and all analysis must be your own work.

Exams: There will be two unit exams during the semester and a final exam during finals week. Unit exams will be given in the testing center. There will be no time limits, other than the closing time of the testing center. You will be allowed one 8 1/2" x 11" page of hand written (not photocopied) notes (and, of course, a calculator, pencils, erasers, and scratch paper).

The final exam will be given in the classroom at the date and time given above. The final exam will be comprehensive. You will be allowed to use your textbook, any course handouts, your graded homework, exams, labs, and any notes that you yourself have written. You will also be allowed to use a calculator. Unless otherwise noted, all exam problems should be worked according to the guidelines given above for homework.

Quizzes: There will be several "quiz" and "thought" questions presented in each class period (even sometimes on TTh classes). The first question will be given at the beginning of class, so it is important for you to be on time. In order to participate in the quizzes, you will need to purchase an iclicker and register it on the class web page. *Quiz questions* will check your preparation for each class, and should not be very difficult if you are caught up on the reading. You will be awarded three points for every correct answer to a quiz question, and one participation point for every wrong answer. *Thought questions* will be used to help me see how well the class is following the material and to encourage discussion. A participation point will be given for any answer on a thought question, regardless of whether your answer is right or wrong. At the end of the day, the total score for your quiz and thought questions will be tallied. Your lowest daily quiz score will be dropped when computing your final grade. As with homework, quizzes cannot be made up. Talk to me ASAP if you have a problem which will result in missing more than one quiz.

Writing Assignments: You will be writing a term paper this semester. It will be done in small groups. In addition to handing in a final draft you will do a group presentation on your chosen topic, comment on other group's drafts, and several other things to help you progress toward a well written paper at the end of the term and to help your writing and presentation skills develop. More information on the term paper is included in a separate document.

In addition to the formal term paper, we will also be doing short in-class writing assignments. At various times during class I will give you a minute or two to write a short paragraph answering a question. I will then randomly pick one student to *read what they wrote* to the class. This will help you to internalize concepts and improve your ability to think and write logically and concisely. At the end of the semester you will receive ten writing points if you make an honest effort – even if your summaries contain incorrect information. If you don't write or refuse to *read what you wrote* when called upon you will lose points. However, I will do everything I can to accommodate those with special circumstances.

Grading: Your scores will be recorded and available online through the class web page. Please regularly check that your scores are recorded correctly. Your letter grade will be determined from your total percentage, according to the breakdown below. I reserve the right to soften the grading scale, based on my perception of this class's performance relative to other semesters, but I will not raise it.

A:	93-100	B-:	77-80	D+:	60-63
A-:	88-92	C+:	73-76	D:	56-59
B+:	84-87	C:	69-72	D-:	50-55
B:	81-83	C-:	64-68	E:	0-49

Physics Majors Handbook: I strongly suggest that all physics majors and minors take a good look at the department's major's handbook. It can be found at <http://www.physics.byu.edu/Undergraduate/handbook.aspx>

University Policy: BYU encourages teachers to include the following statements in each class syllabus. In addition, I urge you to review the honor code of the University, found at <http://www.byu.edu/stlife/campuslife/honorcode/>

BYU's policy against sexual harassment extends not only to employees of the university but to students as well. If you encounter sexual harassment, gender-based discrimination, or other inappropriate behavior, please talk to your professor, contact the Equal Employment Office at 422-5895 or 367-5689, or contact the Honor Code Office at 422-2847.

BYU is committed to providing reasonable accommodation to qualified persons with disabilities. If you have any disability that may adversely affect your success in this course, please contact the University Accessibility Center at 422-2767. Services deemed appropriate will be coordinated with the student and instructor by that office.

The study of (insert discipline) requires a degree of concentration and focus that is exceptional. Having small children in class is often a distraction that degrades the educational experience for the whole class. Please make other arrangements for child care rather than bringing children to class with you. If there are extenuating circumstances, please talk with your instructor in advance.