Syllabus and Course Notes for SCI 2130

Modern Physics

Instructor: Prof Stephen S Holt
Coordinates: Office MH 268, Telephone 781-292-2587
Meeting Schedule : 10-11:50 PM on Mondays and Thursdays in AC113
Office Hours: I will usually be in my Olin office before class from 7 -10 AM on Mondays and Thursdays, and can also be available by appointment.
Grader/TA: Luke Zinnen

Brief Course Description – The term "Modern Physics" is generally applied to physical concepts that go beyond (and may even contradict) the "classical" concepts of Newtonian Mechanics. This course will introduce concepts in Modern Physics with particular emphasis on those that have specific engineering applications. Key topical areas that will be covered include Quantum Mechanics and Statistical Mechanics, with applications to solids, gases, atoms and molecules. Notice that Special Relativity, General Relativity, Nuclear Physics and Elementary Particles are not specifically included in depth, since there aren't many direct engineering applications of these areas (but we introduce some of this material here, too, just for fun).

Textbook – There are lots of good books that cover most of the material that we will be discussing, and even more that cover only specific parts of it. I have chosen a textbook that is a solid reference for most of the course content, and I will also use it as an outline for the general ordering of the course material: Modern Physics for Scientists and Engineers (2^{nd} edition) by John R. Taylor, Chris D. Zafiratos, and Michael A. Dubson.
You are responsible for what we cover in class, even if it's not in the book.

Course Philosophy – I am assuming that everybody who signs up for the course has chosen it because (s)he is interested in learning about the most important ideas in physics, and understands that the pedagogy that I will employ is (mostly) lecture. I will introduce most of the main subject areas of the textbook; some material in the textbook (and elsewhere) will be assigned as independent study, and some will just be skipped (but you are certainly encouraged to read the skipped parts). Assigned reading will not be quizzed but assigned homework will be graded: this is an upper level course in which you are expected to work without constant adult supervision, but it would advisable for you to use the homework as an irritant to keep from falling behind . It is **essential** that you provide yourself with sufficient self-discipline to actually **attend** class and to at least skim the text material that will be covered prior to class – quantum mechanical concepts are not intuitive (Einstein didn't believe that they were fundamentally correct, and Feynman claimed that nobody really understands them). If you start to fall behind, it will be difficult for you to catch up. I will try to keep the syllabus current so that you can plan your time accordingly.

I take the Olin Honor Code very seriously. The Honor Board has requested that each instructor address class policy with regard to a few items for which there might be some differences in the manner in which they are treated in various classes. So that there are no misunderstandings:

Attendance is mandatory

Tardiness (by either instructors or students) is disrespectful

Laptops and smartphones are generally not needed in class, so please don't use them there unless I specifically indicate otherwise

Cooperation on homework is encouraged, but……

It is plagiarism not to acknowledge help from others if work is submitted that might otherwise be assumed to be entirely your own.

Homework – The homework problems in the book are rated with respect to relative difficulty in accordance with a one-to-three-star (*) system. One-star problems are relatively trivial, and should take you almost no time to do: they are just to alert you the fact that you will have no chance of being able to do the two-star problems if you can't do these. Two-star problems are meant to be reasonable measures of a working understanding of the subject (i.e., pretty straightforward - the kinds of problems that might be considered to be relatively easy test problems). Three-star problems are for those of you who are interested in tackling "challenge" problems – they will generally not be assigned, but feel free to try them. The assigned homework is meant to help you to effectively apportion the majority of your time outside of class; since you should not have to spend more than 8-10 hours per week outside of class for this course, you should not be spending more than 3-4 hours on the assigned homework (per se) – you should be spending a larger fraction of your time reading, studying, and doing more interesting problems. Homework will be assigned about a week before it is nominally due (it will usually be due on Mondays). An evening or weekend problem session with the grader may be set up if there is sufficient interest.

Grading – Homework will count for 15% of your grade. There will be three take-home exams, each of which will count 25% of your grade. There will <u>not</u> be a comprehensive final exam. The remaining 10% of your grade will be determined subjectively, based on class attendance, participation and my perception of your commitment to learning.

Learning Objectives: a very brief summary of some key concepts that all of you who pass the course should be able to explain to your friends and family members can be found on Blackboard in Course Information as an entry called Learning Objectives.

Starting syllabus (subject to modification) – I am assuming that we can expose the most important concepts by covering approximately 1.5 book chapters per week. A typical chapter is about 30 pages (not including problems), so that even though we will skip some sections you will have to do some reading on your own. You will learn that it really pays to at least acquaint yourself with material that we will be covering <u>before</u> we discuss it in class.

#	date	Topical area	Chapter
1	9/2	Introduction to atoms	3
2	9/9	Introduction and Special Relativity (overview)	1,2
3	9/13	Quantization of light	4
4	9/16	Quantization of atomic levels	5
5	9/20	de Broglie and matter waves	6
6	9/23	Heisenberg Uncertainty Relation	6
7	9/27	Schroedinger Equation	7
8	9/30	Simple one-dimensional applications of the Schroedinger Eq	7
9	10/4	Review for Exam #1	
10	10/7	Schroedinger Equation in three dimensions	8
11	10/13	The hydrogen atom	8
12	10/14	Electron spin	9
13	10/18	Pauli Exclusion Principle and the Periodic Table	10
14	10/21	Atomic transitions	11
15	10/25	Lasers	11
16	10/28	Molecular Bonds	12
17	11/1	Review for Exam #2 and Bell's Inequalities	
18	11/4	Classical Statistical Mechanics	15
19	11/8	Quantum Statistical Mechanics	15
20	11/11	Solids	13
21	11/15	Conductivity	13
22	11/18	Semiconductors	14
23	11/29	Superconductivity	14
24	12/2	Nuclear Physics (overview)	16, 17
25	12/6	Elementary particles (overview)	18
26	12/9	Review for Exam #3	

Tentative exam schedule (exams will be take-home, due about one week after finishing the material):

Exam #1 – Introduction to Quantum physics (essentially Ch 3-7)

Exam #2 – Application of quantum physics to atoms and molecules (Ch 8-12)

Exam #3 – Statistical mechanics and solids (Ch 13-15 +)