

## PHYSICS 225W: “QUANTUM PHYSICS AND APPLICATIONS” — FALL 2008

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<http://sitemason.vanderbilt.edu/physics/haglund/courses/225a/>

*Course format and philosophy.* This course is devoted to developing quantum physics concepts and applying them atomic, molecular and condensed matter physics. It will be taught in seminar format, with extensive student participation in discussions, oral presentations on selected topics, and problem-solving. Thus you will need to prepare for each class session. (*Plain text:* Study the textbook!)

*Course Aim and Scope.* This course is a transition from introductory physics, with its broad and rather shallow coverage, to the frontiers where quantum physics and applications meet. The course objective is to help you to become fluent with the concepts, models and mathematics of 21<sup>st</sup> century physics: uncertainty, wave-particle duality, wave functions and operators, spin and statistics ... and the application of these tools to the phenomena of atomic, molecular and condensed-matter physics. The laboratory will introduce you to the hardware and software you need to participate in undergraduate research.

*Textbooks.* The textbook for the course is *Modern Physics for Scientists and Engineers* (3<sup>rd</sup> edition) by Stephen T. Thornton and Andrew Rex. It is available in the bookstore, or you may order it from any of the booksellers on the Web. *We will not cover the reading assignments exhaustively in class; it is expected that you will have read the material prior to each class!* In addition, there will be occasional assigned readings from books or other material on the Physics 225W reserve shelf.

*Class Schedule.* Our regular class meeting time is Tuesday-Thursday, 11:00-12:15, in 6105 Stevenson. Laboratories are on Tuesday afternoons, and there will be a problem session Wednesdays, 5-7 p.m.

*Contact and Course Information.* My office is in 6422 Stevenson; office phone is 322-7964 and my e-mail address is [richard.haglund@vanderbilt.edu](mailto:richard.haglund@vanderbilt.edu). Administrative and academic information — such as supplementary readings, information about examinations, and solutions to homework problems — will be posted on our course pages on OAK. Announcements will be made through the OAK e-mail service, so be sure to check in at least a couple times per week.

*Office Hours.* I will hold regular office hours on Wednesdays, 1-3, in 6401 Stevenson, except when research commitments take me away from campus. Given on-campus research and service commitments, you are unlikely to find me in my office at other times if you just drop by, though you are always welcome to do so. The easiest way to get together at times other than office hours is to set up an appointment through e-mail, which I check frequently even on weekends.

*Course requirements and grading.* There will be two written take-home examinations during the semester (see course schedule), and a final examination covering the last few weeks of the course. Regular problem sets and a class presentation will be assigned. Each of these four components — the two take-home exams, the homework and presentation, and the final examination — will count a total of 25% toward your final grade. Class participation and preparation will be used as a “tie-breaker” if the letter grade is “on the edge” after all written work is in.

*Honor Code.* All written assignments, including the take-home examinations, are to be carried out in strict accordance with the Vanderbilt Honor Code. You are free to work with your colleagues on homework and class presentations, as long as you acknowledge their assistance; examinations, on the other hand, must be entirely your own work. *Plagiarism, presenting the work of others as your own, and other kinds of cheating will not be tolerated. If you are unsure about what constitutes a violation of the Honor Code, please ask. Ignorance is not an excuse!*

SCHEDULE OF TOPICS — PHYSICS 225W — FALL SEMESTER 2008

<i>Week</i>	<i>Topic</i>	<i>Reading</i>
25 Aug	Historical perspective and a little bit of special relativity	Thornton, Chapters 1-2
1 Sept	Experimental evidence of the need for quantum physics	Thornton, Chapter 3
8 Sept	Successes and failures of Bohr's quantum theory	Thornton, Chapter 4
15 Sept	Wave properties of matter: the particle in a box	Thornton, Chapter 5
22 Sept	The Schrödinger equation	Thornton, Chapter 6
29 Sept	Harmonic oscillators and barrier potentials	Thornton, Chapter 6
	<i>First take-home exam, up to hydrogen atom I, due 16 Oct</i>	Thornton, Chapters 4, 5, 6
6 Oct	Hydrogen atom I: solving the radial Schrödinger equation	Thornton, Chapter 7
13 Oct	Hydrogen atom II: spin, Zeeman effect and photon emission	Thornton, Chapter 7
20 Oct	Quantum rules, atomic structure and the periodic table	Thornton, Chapter 8
27 Oct	Classical and quantum statistics	Thornton, Chapter 9
3 Nov	From atoms and molecules to the laser	Thornton, Chapter 10
	<i>Second take-home exam, through spin/statistics, due 20 Nov</i>	Thornton, Chapters 7, 8, 9
10 Nov	Condensed matter: structural, thermal, magnetic properties	Thornton, Chapter 10
17 Nov	Electron correlations and superconductivity	Thornton, Chapter 10
24 Nov	<i>Thanksgiving Break. No classes held.</i>	
1 Dec	Physics of semiconductors and semiconductor devices	Thornton, Chapter 11
8 Dec	Nanoscale condensed-matter physics	Thornton, Chapter 11
19 Dec	<i>Final examination, in class</i>	Thornton, Chapters 10, 11