Physics 420: Atomic Physics & Quantum Mechanics

Spring 2012

Course Objective: This is essentially an introductory quantum mechanics course, with a bit of atomic physics mixed in. The goal is for you to acquire a firm grasp of the fundamentals: the Schrodinger Equation, solutions to the time-independent Schrodinger equation (square well, harmonic oscillator, etc.), mathematical formalism (operators, Dirac notation), the Hydrogen atom, spin and angular momentum, atoms & solids, and perturbation theory. You will likely find yourself at times, learning about things that seem too strange to possibly be true, and ask yourself where it came from:

"*If you are not confused by quantum physics then you haven't really understood it***"**
- Niels Bohr

"*I think I can safely say that nobody understands quantum mechanics***"**
- Richard Feynman

Unfortunately, the bottom line is: as mind-boggling as it may sometimes seem, no experiment yet has proven quantum mechanics wrong. Therefore, instead of understand what quantum mechanics *means*, we will simply *do* quantum mechanics and accept it as is.

This is a very challenging course: Not only are the concepts challenging, but there is a lot of math. You will be using things from calculus, linear algebra, differential equations, and even learn some 'new' math. Also, much of the information is cumulative. Translation: Do NOT fall behind in this class! As SOON as you are lost, ask for help – from classmates, from the instructor, or from other professors.

Prerequisites: PHY 240, PHY 300, and MAT 343 (or PHY 370). Linear Algebra, although is not technically a prerequisite, might as well be one. If you have not taken all of these courses, it is not a disaster, but you should see me as soon as possible so that we can get you up to speed.

Instructor: Prof. Robert Thornton
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Office hours: MWF 3:30-4:30 PM; TuTh 11:00 AM – Noon; also by appointment

Required Text:
Griffiths, D. J. 2005. *Introduction to Quantum Mechanics* (Second Edition).
Upper Saddle River, NJ: Pearson Prentice Hall.

Grading:
Exam 1 (2 hours): 25%; Exam 2 (2 hours): 25%;
Homework: 20%
Final Exam: 30%
Total: 100%

Exam Policy:
There are no make-up exams. If you are going to miss an exam for a university excused absences (this requires a signed note) you must notify me one week before the exam is going to be offered. An alternate time to take the exam will be determined. This time would most likely be the day before the exam.

Problem Set Policy:
Problems will be assigned almost every class period and due the following class period **during the first five minutes of class**. **No late problem sets will be accepted.** All problem sets will be graded (to varying degrees) and returned the next class period. If you fail to turn in a problem set because of absences (excused or unexcused) then you will receive a zero for that problem set grade. The problem sets will be graded only roughly. It is your responsibility to check your work with the solution set.

Attendance and Lateness Policy:
If you can pass this class without attending it, I'll be very impressed. Attendance is not mandatory, but if you miss class, I'm not going to go out of my way to help you if you're lost.

Disability:
We at West Chester wish to make accommodations for persons with disabilities. Please make your needs known by contacting the Office of Services for Students with Disabilities at extension 3217 as well as myself. Sufficient notice is needed in order to make the accommodations possible. The University and I desire to comply with the ADA of 1990.

Public Safety:
The Emergency Communication Committee has made the recommendation that the emergency phone number for WCU's Department of Public Safety be listed on all course syllabi. That number is 610-436-3311. This specific recommendation is made to help the campus be prepared in case of an emergency situation.

Tentative Schedule (might be revised as the semester progresses)

Week	Lecture	Date	Day	Content
	January			
1	1	Jan 23	M	• Problem with classical physics • 1.1 Schrödinger equation • 1.2 Statistical interpretation • 1.3 Probability
	2	Jan 25	W	• 1.3 Probability (cont) • 1.4 Normalization
	3	Jan 27	F	• 1.5 Momentum • 1.6 The Uncertainty Principle
2	4	Jan 30	M	• 2.1 Stationary States
	5	Feb1	W	• 2.2 Infinite Square Well
	6	Feb 3	F	• 2.2 Infinite Square Well
3	7	Feb 6	M	• 2.3 Harmonic Oscillator
	8	Feb 8	W	• 2.3 Harmonic Oscillator
	9	Feb 10	F	• 2.4 The Free Particle
4	10	Feb 13	M	• 2.4 The Free Particle
	11	Feb 15	W	• 2.5 Dirac delta function in general (not quantum) • Particles and barriers of finite heights
	12	Feb 17	F	• Particles and barriers of finite heights
5	13	Feb 20	M	• Exam #1: Chapters 1 and 2
	14	Feb 22	W	• Appendix A
	15	Feb 24	F	• Hilbert space, inner products, orthonormality
6	16	Feb 27	M	• Observables and Hermitian operators
	17	Feb 29	W	• Eigenfunctions of a Hermitian Operator
	18	Mar 2	F	• Generalized Statistical Interpretation
7	19	Mar 5	M	• The Uncertainty Principle
	20	Mar 7	W	• Dirac Notation
	21	Mar 9	F	• Schrödinger Equation in Spherical Coordinates
	21	Mar 12	M	• Schrödinger Equation in Spherical Coordinates
	23	Mar14	W	NO CLASS – Spring Break
	24	Mar 16	F	NO CLASS – Spring Break
8	25	Mar 19	M	NO CLASS – Spring Break
	26	Mar 21	W	• Hydrogen Atom
	27	Mar 23	F	• Hydrogen Atom
9	28	Mar26	M	• Angular momentum: eigenvalues
	29	Mar 28	W	• Angular momentum: eigenfunctions
	30	Mar 30	F	• Spin
10	31	Apr 2	M	• Spin: Precession
	32	Apr 4	W	• Spin Addition
	33	Apr 6	F	• Exam #2: Chapters 3 and 4
11	34	Apr 9	M	• 5.1 Two-Particle Systems (pg 206-210)
	35	Apr 11	W	• 5.2 Atoms
	36	Apr13	F	• 5.3 Solids
12	37	Apr 16	M	• 5.3 Solids
	38	Apr 18	W	• 5.4 Quantum Statistical Mechanics
	39	Apr 20	F	• 5.4 Quantum Statistical Mechanics
13	40	Apr 23	M	• 6.1 Non-degenerate perturbation theory
	41	Apr 25	W	• 6.1 Non-degenerate perturbation theory
	42	Apr 27	F	• Catch up
14	43	Apr 30	M	• Catch up
	44	May 2	W	• Catch up
	45	May 4	F	• Final Exam Review