Physics 420: Atomic Physics & Quantum Mechanics

Spring 2014

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, 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.

<u>This is an extremely challenging course</u>: 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.

<u>Instructor</u>: Prof. Robert Thornton
Office: Merion 129
rthornton@wcupa.edu
Office hours: MWF 10:00-11:30 a.m.; TuTh 1:00 – 2:00 p.m.; also by appointment

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

<u>Grading:</u>
Exam 1 (90 min): 20%; Exam 2 (90 min): 20% ; Exam 3 (90 min): 20%
Homework: 10%
Final Exam: 30%
Total: 100%

<u>Exam Policy:</u>
There are no make-up exams. If you are going to miss an exam for a university excused absence (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.

Intellectual Property Statement:

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Tentative Schedule (might be revised as the semester progresses)

Week	Lecture	Date	Day	Content
1	1	Jan 22	W	Problem with classical physics 1.1 Schrödinger equation 1.2 Statistical interpretation 1.3 Probability
	2	Jan 24	F	• 1.3 Probability (cont) • 1.4 Normalization
	3	Jan 27	M	1.5 Momentum 1.6 The Uncertainty Principle
2	4	Jan 29	W	• 2.1 Stationary States
	5	Jan 31	F	• 2.2 Infinite Square Well
	6	Feb 3	M	• 2.2 Infinite Square Well
3	7	Feb 5	W	• 2.3 Harmonic Oscillator
	8	Feb 7	F	• 2.3 Harmonic Oscillator
	9	Feb 10	M	• 2.4 The Free Particle
4	10	Feb 12	W	• Exam #1 (Ch1, Ch2 sections 2.1, 2.,2 2.3)
	11	Feb 14	F	• 2.4 The Free Particle
	12	Feb 17	M	• 2.5 Dirac delta function in general (not quantum) • Particles and barriers of finite heights
5	13	Feb 19	W	• Particles and barriers of finite heights
	14	Feb 21	F	• Appendix A
	15	Feb 24	M	• Hilbert space, inner products, orthonormality
6	16	Feb 26	W	• Observables and Hermitian operators
	17	Feb 28	F	• Eigenfunctions of a Hermitian Operator
	18	Mar 3	M	• Generalized Statistical Interpretation
7	19	Mar 5	W	• The Uncertainty Principle
	20	Mar 7	F	• Dirac Notation
	21	Mar 10	M	• Finding energy states using linear algebra
8	21	Mar 12	W	• Schrödinger Equation in Spherical Coordinates
	23	Mar14	F	• Exam #2 (Ch2 Sec 2.4, 2.5, 2.6 & Chapter 3)
	24	Mar 17	M	NO CLASS – Spring Break
	25	Mar 19	W	NO CLASS – Spring Break
	26	Mar 21	F	NO CLASS – Spring Break
8	24	Mar 24	M	• Schrödinger Equation in Spherical Coordinates
9	25	Mar26	W	• Hydrogen Atom
	26	Mar 28	F	• Hydrogen Atom
	27	Mar 31	M	• Hydrogen Atom
10	28	Apr 2	W	• Angular momentum: eigenvalues
	29	Apr 4	F	• Angular momentum: eigenfunctions
	30	Apr 7	M	• Angular momentum: eigenfunctions
11	31	Apr 9	W	• Spin
	32	Apr 11	F	• Pauli Spin matrices
	33	Apr14	M	• Stern Gerlach/Larmour Precession

12	34	Apr 16	W	• Addition of Angular Momenta
	35	Apr 18	F	• Exam 2 review
	36	Apr 21	M	• Clebsch-Gordon coefficients
13	37	Apr 23	W	• Exam #3: Chapter 4
	38	Apr 25	F	• 1st order perturbation theory
	39	Apr 28	M	• 1st order perturbation theory
14	40	Apr 30	W	• 1st order perturbation theory
	41	May 2	F	• 2nd order perturbation theory
	42	May 5	M	• 2nd order perturbation theory