Quantum Mechanics

PHY 420 - Spring 2008

(Version 4)

"*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

Course Objective:

In this course, we will examine the fundamental phenomena associated with quantum mechanics. In addition, we shall explore how these phenomena relate to atomic physics. Our aim will be to develop a quantitative description of these phenomena. In particular, to learn how to *do* quantum mechanics, rather than what quantum mechanics *means*.

Topics which will be covered in this course are the Schrödinger Equation, solutions to time-independent Schrödinger equation (square well, harmonic oscillator, etc.), mathematical formalism of quantum mechanics (operators, Hilbert space, etc.), multiple-particle systems, and applications to atomic physics.

This is a challenging course. Given the complexity of the ideas and concepts in this course as well as the required level of mathematical background, you will need to do a fair amount of work outside the classroom. Please set aside time during the week to focus on this course. In addition, try to be efficient with your time. Don't hesitate to ask me, other professors, or other students questions about material you are struggling with. Everyone has holes in both their physics and math background. Use this course as an opportunity to fill in some of those holes. If you apply yourself to this course, you will find it to extremely rewarding.
Good luck!

Prerequisites: PHY 240 and PHY 300 and MAT 343 (or PHY 370)

Instructor Information:
Dr. Kevin Aptowicz
128 Boucher Laboratory
phone: 610.436.3010
kaptowicz@wcupa.edu

Office Hours:
MWF 8 am – 9 am
MW 1 pm - 2 pm
or by appointment

Required Text:

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

Recommended Texts:

Zettili, N. 2005. *Quantum Mechanics: Concepts and Applications* (First Edition), West Sussex, England: John Wiley and Sons.

- A lot of worked examples.

Greenstein, G. and Zajonc, A.G. 2006. *The Quantum Challenge: Modern Research on the Foundation of Quantum Mechanics* (Second Edition), London, England: Jones and Bartlett Publishers International.

- Discusses modern research in the field.

Grading: Two methods will be used to calculate each student's grade. The resulting highest grade will be the grade for the course.

Method #1	Method #2
40% - Homework	10% - Homework
30% - Two Exams (15% each)	60% - Two Exams (30% each)
30% - Final Exam	30% - Final Exam

Notes

(1) None of the exam grades will be dropped, however four problem-set grades will be dropped.

(2) If your average homework grade **with no dropped grades** is in the top 10% of all homework grades for the class, you will receive a perfect score for your homework grade.

Exams Policy:

There are no make-up exams. If you are going to miss an exam for a university excused absences (this requires a sign 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 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 not be graded only roughly. It is your responsibility to check your work with the solution set.

Note: I have office hours MWF from 8 am – 9 am. Make use of them as much as you need. This will be a good time to ask last minute questions before turning in the problem set later in the day.

Attendance and Lateness Policy:

If you can pass this class without attending it, I'll be extremely impressed.

Tentative Schedule (might be revised as the semester progresses)

Lecture	Date	Day	Content
			JANUARY
1	14th	M	• 1.1 The Schrödinger Equation • 1.2 Statistical Interpretation
2	16th	W	• 1.3 Probability → 1.3.1 Discrete Variables • 1.3 Probability → 1.3.2 Continuous Variables • 1.4 Normalization
3	18th	F	• 1.5 Momentum • 1.6 The Uncertainty Principle
	21st	M	NO CLASS – MLK Day
4	23rd	W	• 2.1 Stationary States
5	25th	F	• 2.2 The Infinite Square Well (pg 30-33)
	28th	M	NO CLASS
6	30th	W	• 2.2 The Infinite Square Well (pg 34-38)
			FEBRUARY
7	1st	F	• 2.3 The Harmonic Oscillator (pg 40-47)
8	4th	M	• 2.3 The Harmonic Oscillator (pg 47-50)
9	6th	W	• 2.3 The Harmonic Oscillator (pg 51-59)
10	8th	F	• 2.4 The Free Particle (pg 59-63)
11	11th	M	• 2.4 The Free Particle (pg 64-66)
	13th	W	SNOW DAY
12	15th	F	• 2.5 The Delta-Function Potential (pg 68-73)
13	18th	M	• 2.5 The Delta-Function Potential (pg 73-76)
14	20th	W	• 2.6 The Finite Square Well (78-82)
15	22nd	F	• A.1 Vectors • A.2 Inner Products • A.3 Matrices • A.4 Changing Bases
	25th	M	Review
	27th	W	**Exam #1:** Chapter 2
16	29th	F	• A.5 Eigenvectors and Eigenvalues • A.6 Hermitian Transformations
			MARCH
17	3rd	M	• 3.1 Hilbert Space • 3.2 Observables
18	5th	W	• 3.3 Eigenfunctions of a Hermitian Operator
19	7th	F	• 3.4 Generalized Statistical Interpretation
	10th	M	NO CLASS – Spring Break
	12th	W	NO CLASS – Spring Break
	14th	F	NO CLASS – Spring Break
20	17th	M	• 3.5 The Uncertainty Principle
21	19th	W	• 3.6 Dirac Notation
22	21st	F	• 4.1 Schrödinger Equation in Spherical Coordinates (pg 131-135)
23	24th	M	• 4.1 Schrödinger Equation in Spherical Coordinates (pg 135-145)
24	26th	W	• 4.2 Hydrogen Atom (pg 145-159)
25	28th	F	• 4.3 Angular Momentum (160-166)

26	31st	M	• 4.3 Angular Momentum (167-170)
APRIL			
27	2nd	W	• 4.4 Spin (pg 171-178)
28	4th	F	• 4.4 Spin (pg 178-183)
29	7th	M	• 4.4 Spin (pg 184-189)
	9th	W	Review
	11th	F	**Exam #2:** Chapter 3 and 4
30	14th	M	• 5.1 Two-Particle Systems (pg 206-210)
31	16th	W	• 5.2 Atoms (pg 210-217)
32	18th	F	• 5.3 Solids (pg 218-223)
33	21st	M	• 5.3 Solids (pg 224-229)
34	23rd	W	• 5.4 Quantum Statistical Mechanics (pg 230-239)
35	25th	F	• 5.4 Quantum Statistical Mechanics (pg 239-245)
36	28th	M	• 6.1 Nondegenerate Perturbation Theory (249-254)
	30th	W	Review
MAY			
	7th	W	**FINAL EXAM** 8:00 am - 10:00 am

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.