

Department of Physics and Astronomy
PHY 520 Introduction to Quantum Mechanics
Spring 2009

I. The Course

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Office hour: Monday 10:00-10:50 p.m.

Time: Monday, Wednesday, and Friday 12:00-12:50 a.m.
Place: CP 183

Course web page: <http://www.pa.uky.edu/~kwng/spring2009>

Text book: Quantum Physics – Concepts and Applications
Nouredine Zettili
Published by John Wiley.

Quantum Physics 3rd edition
Stephen Gasiorowicz

II. Goal

Quantum mechanics is one of the most fundamental subjects in modern physics. All physicists are required to master this subject well in order to unlock the mystery of the microscopic world. The technological world is progressing rapidly towards smaller and smaller size, and ultimately at the molecular level. Quantum mechanics is essential to understand how things work in this modern world. For example, how does laser work? Quantum mechanics can even manifest itself in the macroscopic world through the coherence of many particles. A good example is superconductivity. If you look at things surrounding you, it is not difficult to see many processes that involve quantum phenomena. Don't be surprised to find an "h" inside your computer!

There were many experiments (like the black body radiation and photoelectric effect) at the beginning of last century (20th) that led to the fall of the classical physics. Planck suggested the quantization of electromagnetic wave and introduced the famous Planck's constant h . Since then, h is always there as long as the process is quantum mechanical. Bohr had quantized the electron orbit in hydrogen atom, and successfully explained the discrete nature of hydrogen atom. It is cleared that the concept of quantum physics was gradually forming at that time. You have probably learnt all these in a previous modern physics class. However, all these "models" targeted only on separate problems. It was not until physicists like Schroedinger and Heisenberg formulated the concept

mathematically, the idea was general enough to be useful as a tool to investigate a broad range of problems. For example, the hydrogen atom under the new quantum mechanics is far more complex and accurate than the simple Bohr's model. In this class, we will study the quantum mechanics after Borh era. We will learn the mathematical formulation, and pick up new concepts. You will find what you learn in this class very interesting and useful for your future study in physics.

III. Grading Policy

There will be about one homework set of six to seven problems every week. The homework is due on the dates indicated. Late homework will not be accepted. The solutions handed in should be complete and comprehensive. They should also be neat and legible, with the solutions presented in an ordered and logical fashion. Solutions not satisfying these criteria will suffer a severe reduction in grade. The homework will count for 40% of your total grade. Each homework problem will be weighted equally.

There will be two hourly tests, listed in the class schedule below. Each test will contribute 15% towards your total grade. This component will therefore constitute 30% of the final grade. The tests will cover all materials covered prior to their schedule dates, but after the previous test. This material will include what is covered in the readings, in the lectures, and in the assigned homework.

There will be a two hours final examination that will be comprehensive, covering all materials studied in this course this semester. This final examination will constitute 30% of your final grade. The examination will take place on Wednesday, May 6, from 1:00 to 3:00 pm in CP 183. If there is any discrepancy between this syllabus and the school announcement, you should always follow the latter one.

In general, all tests and the final examination will be closed book. You will need to bring your own scientific calculator, and your own writing tools. You are not allowed to use any programs stored in the memory of the calculator.

Homework	40%
Test I	15%
Test II	15%
Final Examination	30%
Total	100%

Undergraduate and graduate students will be graded on the same scale. However, graduate students are expected to be able to provide more rigorous mathematical proof, make more logical argument, and present the concept in a clearer manner. Their work will be graded accordingly at a higher standard.

IV. *Course evaluation*

Course evaluations are an important component of our Department's instructional program. An on-line course evaluation system was developed to allow each student ample time to evaluate each component of the course and instructor, thus providing the Department with meaningful numerical scores and detailed commentary while minimizing the loss of instructional time in the classroom. The evaluation window for Spring 2009 will open on Monday, 13 April 2009 and close on Wednesday, 29 April 2009. To access the system at the time when the evaluation window is opened, simply go the Department of Physics Web page at <http://www.pa.uky.edu> and click on the link for Course Evaluations; then follow the instructions. You will need to use our student ID# to log into the system, and this will also allow us to monitor who has filled out evaluations. However, after you log-in you will be assigned a random number that will keep all your comments and scores anonymous. If you cannot complete the evaluation in one time, make sure you remember the assigned number for the next log in.

V. *Class schedule*

This schedule is set up as a general guideline. It will be adjusted according to our pace of study.

Date	Topics	Reading assignments
Jan 14 (W)	Particle aspect of radiation	1.2
Jan 16 (F)	Wave aspect of particle	1.2-1.4
Jan 19 (M)	♥ MLK day. No Class. ♥	
Jan 21 (W)	Uncertainty principle and Bohr's model	1.5-1.7
Jan 23 (F)	Wave packets	1.8
Jan 26 (M)	Origins of quantum mechanics	Summary: Chapter 1
Jan 28 (W)	Linear space and Dirac notation	2.2-2.3
Jan 30 (F)	Operators	2.4
Feb 2 (M)	Representation in discrete bases	2.5
Feb 4 (W)	Representation in continuous bases	2.6
Feb 6 (F)	Matrix and wave mechanics	2.7
Feb 9 (M)	Mathematical tools of quantum mechanics	Summary: Chapter 2
Feb 11 (W)	Basic postulates of quantum mechanics. Observables and operators.	3.2-3.5
Feb 13(F)	Time evolution of the system's state.	3.6-3.7
Feb 16 (M)	Symmetries and conservative	3.7-3.8

	laws. Connecting quantum to classical mechanics.	
Feb 18 (W)	Postulates of quantum mechanics	Summary: Chapter 3
Feb 20 (F)	Free particle. Potential step.	4.2-4.4
Feb 23 (M)	Potential barrier and well	4.5
Feb 25 (W)	Test 1	Test 1
Feb 27 (F)	Infinite and finite square well	4.6-4.7
Mar 2 (M)	Harmonic oscillator	4.8
Mar 4(W)	One-dimensional problems	Summary: Chapter 4
Mar 6 (F)	Orbital angular momentum	5.2-5.3
Mar 9 (M), Midterm	Matrix representation of angular momentum	5.3-5.4
Mar 11 (W)	Spin	5.5-5.6
Mar 13 (F)	Eigenfunctions of orbital angular momentum	5.7
Mar 16 (M)	☺ Spring break. No class ☺	
Mar 18 (W)	☺ Spring break. No class ☺	
Mar 20 (F)	☺ Spring break. No class ☺	
Mar 23 (M)	Angular momentum	Summary: Chapter 5
Mar 25 (W)	3D problems in Cartesian coordinates	6.2
Mar 27 (F)	3D problems in spherical coordinates	6.3
Mar 30 (M)	3D problems in spherical coordinates	6.3
Apr 1 (W)	Three-dimensional problems	Summary: Chapter 6
Apr 3 (F)	Test 2	Test 2
Apr 6 (M)	Rotations in classical and quantum mechanics	7.1-7.2
Apr 8 (W)	Addition of angular momentum	7.3
Apr 10 (F)	Rotation and addition of angular momenta	Summary: Chapter 7
Apr 13 (M)	Many-particle systems	8.1-8.2
Apr 15 (W)	System of identical particles	8.3-8.4
Apr 17 (F)	Identical particles	Summary: Chapter 8
Apr 20 (M)	Time independent perturbation theory	9.2
Apr 22 (W)	Variational method	9.3
Apr 24 (F)	WKB method	9.4
Apr 27(M)	Approximation methods for stationary states	Summary: Chapter 9
Apr 29 (W)	Review	Chapter 1-9
May 1 (F)	Review	Chapter 1-9
May 6 (W)	Final examination. 1:00 to 3:00 pm in CP 183	

VI. Important dates

Feb 25 (W)	Test 1
Mar 9 (M)	Midterm
Apr 3 (F)	Test 2
Apr 13 (M) - Apr 29 (W)	Online course evaluation
May 6 (W)	Final Exam. (1:00-3:00 pm)

VII. Reference books

You may find the following reference books useful for this course:

1. Quantum Physics by Stephen Gasiorowicz (John Wiley)
2. Introduction to Quantum Mechanics by David Griffiths (Prentice Hall)
3. Quantum Mechanics by Leonard Schiff (McGraw-Hill)
4. The Feynman's lectures on Physics Vol. 3 by Richard Feynman (Addison Wesley)
5. Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles by Robert Eisberg (John Wiley)
6. An Introduction to Quantum Physics by A. P. French (MIT press)
7. Schaum's Outline of Quantum Mechanics by Eliahu Zaarur and Phinik Reuven (McGraw-Hill)

Previous course webpage:

<http://www.pa.uky.edu/~kwng/spring2008/>