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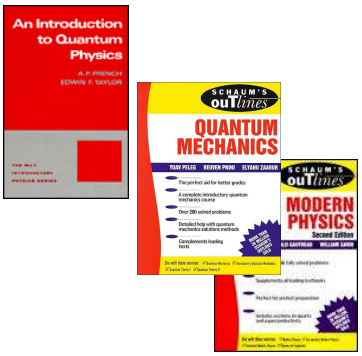
PHY 401
Introduction to Quantum Mechanics
Dillard University - Fall 2005

Meeting Times:
STERN 315 M W F 1:00p – 1:50p

Instructor: **Rob Salgado** **Assistant Professor of Physics** Office: **Stern 307A** Voice: **(504)-816-4510**	E-mail: **rsalgado@dillard.edu** Instant-Messengers: AOL, MSN, Yahoo: **dillardphysics** (do *not* email here)	Office hours: **-to be announced**

Catalog Description:

PHY 401 Introduction to Quantum Mechanics (3 credits)
The Schrodinger equation and eigenfunctions, wave functions, uncertainty principle; one dimensional problems; the hydrogen atom, harmonic oscillator, Angular momentum, introduction to perturbation theory. Class meets three hours per week for lecture.
[Prerequisite: PHY 306 or 390, or permission of instructor.]



Required Textbook:

"An Introduction to Quantum Physics" A.P. French and E.F. Taylor
(published by W.W. Norton: ISBN: 0393091066)
(Highly Recommended) **"Schaum's Outline of Quantum Mechanics"** by Eliahu Zaarur, Phinik Reuven
(published by McGraw-Hill: ISBN: 0070540187)
(Optional) **"Schaum's Outline of Modern Physics"** by Ronald Gautreau
(published by McGraw-Hill: ISBN: 0070248303)
**I will probably draw homework problems from these Schaum's Outlines, as well as from our textbook.

Electronic Materials:

The main website is on ***Blackboard***: **`http://dillard.blackboard.com/`** *(Physics/ Introduction to Quantum Mechanics (F401F001))*.
Use of our ***Blackboard*** course website is **REQUIRED**, as described below.
Some helpful information concerning Blackboard will be made available to you.

I will maintain a website (for now: **`http://physics.syr.edu/~salgado/401/`**) that lists the assigned problems and solutions. I will also try to make available the whiteboard/PowerPoint notes and any computer source code (e.g., Python, Maple) that I use for simulations or computations.

Course Goals:

A. To introduce basic concepts in quantum physics.
B. To reinforce important concepts in physics and mathematics.
C. To further develop physical intuition, mathematical reasoning, and problem solving skills.
D. To further prepare students for the necessarily rigorous sequence in physics and engineering.

Course Requirements:

Come to class **ON TIME and AWAKE**. Attendance is **REQUIRED.**
"The University recognizes that a student may miss a class for legitimate reasons. In such cases these absences are excusable; however, the student must complete the Student Absence Form." An absence may be excused within 2 weeks of the absence using a form issued only by the Division of the Natural Sciences.
"A professor may drop a student with 3 or more unexcused absences from a course." (2003-2005 University Catalog, page 15)
Note that your attendance is recorded on the official midterm and final grade sheets.
"Academic dishonesty will not be tolerated." (2003-2005 University Catalog, page 15)
Come to class PREPARED and EQUIPPED, having read or written any assignments.
Treat each other with RESPECT. Limit all discussions to the PHYSICS topic under discussion.
Turn OFF all phones, pagers, radios, and other disruptive devices. Put away newspapers, magazines, and materials from other courses.

Course Procedure:

Three 50-minute lecture meetings.

Exams and Quizzes:

To encourage you to keep up with the work that YOU must do in order to learn the subject matter,
QUIZZES may be announced **and may also be given at any time, without warning.**
The MIDTERM and FINAL exams are cumulative and are part take-home and part in-class:
one-hour for the MIDTERM exam and two-hours for the FINAL exam.
Be on-time. Quizzes and exams end when "time is called". There are **no** makeup exams or quizzes. There are **no** exceptions.

Absences:

DON'T BE. But, if you are absent for an exam or quiz, you have one (1) week to obtain a Division excuse form.
Only if that excuse is valid, **your final exam will carry the weight of your missed exam or quiz**.

Otherwise, you will get no credit for the missed exam or quiz. When you are absent, you are, of course, still responsible for any work and any course material that you missed.

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Homework (assigned periodically):

Some homework will be REQUIRED pre-class ***Blackboard***-based assignments, which are graded for conscientious effort and contribute to your PARTICIPATION grade. This will be used as a mechanism to

prepare you for class [You'll be thinking about the physics before class and will get some computer-based feedback] and
prepare me for class [I'll be getting feedback on your understanding from reading some of your answers and can act accordingly].

Some textbook problems will be assigned but will not be collected. You should discuss homework with your friends. We will discuss some [but not all] of the homework in class. After you have made a genuine effort on the assignment, you are encouraged to consult the posted homework solutions and visit office hours to discuss the rest of the homework.

If you delay making a genuine effort on the assignment to wait for the solutions, you've missed a valuable learning opportunity.

Exam and quiz problems are generally based on assigned homework problems, unassigned textbook problems, and worked-examples from your textbook. I'll tell you now: I sometimes ask worked-examples straight out of your textbook to see if you are using the textbook well.

Most of the learning you do in this course is done by your doing homework problems outside of class! (I am merely a guide for you.)
(*"Trying to learn physics without doing problems is like trying to learn how to ride a bicycle by reading a book."* –MIT 8.01 syllabus)
You are strongly encouraged to work on the homework with other students.
However, be sure that you can do the homework problems *by yourself* since you'll be working on quizzes and exams *by yourself*.

If you need help with your homework, please visit the Learning Center in Stern 301 [where you can also earn EFFORT-points] or visit me (with your textbook, your notebook, and with proof that you have tried the problems) during Office Hours… the sooner the better.

****** In addition to the regular notebook you use for this class, you must maintain a dedicated "**PHY 401 Homework Notebook**" (spiral-bound notebook with at least 180 sheets). It will be periodically collected, browsed over, graded-for-effort, and promptly returned. You must bring the notebook to each class and to office hours.

How you will use this: (the essential points---a detailed description will be provided on another sheet.)

- You are basically creating your own personal "solution manual" to the assigned homework problems.
- You should want to WRITE DOWN A CLEAR (i.e., logical and legible) AND COMPLETE SOLUTION that you really understand.
  Start a new problem on a new sheet with the problem number in the upper-right corner…*for organizational purposes.*
  Try your best to solve the problems by yourself *since this will be an indication of how well you understand the material.*
  Write down your thoughts on the problem. *What is it really asking? What is it trying to get me to do? What is it trying to teach me?*
  It's okay if you don't understand at first, but you can understand it if you give it a good and honest try.
  If you're stuck, work together with others in a group. *Don't blindly copy the work of others. Try to understand what you write down.*
  To help make this your work, add your own comments and fill in any missing steps to the group effort.
  If you're still stuck, raise questions during class or office hours *then try again.*
- It is possible that you (with possibly the help of your group) were unable to solve the assigned problem by the due date. In that case, you should obtain a copy of my solutions (made available on the web). You must TRANSCRIBE [in your own handwriting] the solution *(adding your own comments and filling in any missing steps)* into your notebook.
- The notebook is expected to be in your handwriting. There should be no loose pages in your notebook.

How I will evaluate your notebook:

- I may or may not announce when I collect the notebooks. (It will be at least once every two weeks.)
- I will be looking to see that you are keeping the notebook up to date. I will only spot-check, not grade, your work.
- I will be looking to see that you are following the rules regarding organization. *(Again, start a new problem on a new sheet.)*
- I will assign a score (to form part of your final grade) and make comments on any deficiencies. You are expected to resolve any deficiencies (including rewriting, if necessary) to avoid further penalties. The original score will not be adjusted.
- Some examples of deficiencies: *missing problems, incomplete problems after solutions are made available, improper format (improper labeling, more than one problem on a sheet, etc.), illegibility, inclusion of non-PHY 401 problems.*

Grades (for the lecture portion), roughly weighted as follows:

20% HOMEWORK NOTEBOOK (FORMAT: see above)
20% QUIZZES (FORMAT: multiple-choice questions, a short problem, and vocabulary definitions; some may be ***Blackboard***-based)
20% MIDTERM EXAM (FORMAT: (TAKE-HOME PART) textbook problems; (IN-CLASS PART) simplified variations of take-home part, multiple choice and definitions)
20% FINAL EXAM (FORMAT: like MIDTERM) [REQUIRED. Not taking the final exam may result in a final grade of F.]
20% PARTICIPATION (INCLUDES: ***Blackboard***-based pre-class quizzes and assignments and EFFORT)

Needless to say, but I'll say it: ***Your course grade is determined solely on the quality of the work you have done for this course.***
A≥88%, B≥76%, C≥64%, D≥50%, F<50%. This class is not graded on a curve.
Borderline cases (between two letter grades): If your exams show an upward trend, your grade may be nudged upwards.

Some advice:

Physics is a **challenging** subject that requires your dedicated attention, but rewards you with skills that you can apply in ***any*** discipline!
In addition to understanding the physical world, Physics teaches you ***how to think and reason*** and ***how to be a problem solver***.
Since Physics is challenging, your doing well in it distinguishes you (especially for summer research programs and Graduate School!).

Physics is **cumulative**: For example, understanding Ch 5 requires you understand all of the chapters before it.
You must not fall behind! If you find yourself falling behind, you must get some help. Visit the LEARNING CENTER in Stern 301!

Physics is written and spoken in a **Mathematical** language.
At this stage, Algebra, Trig, Geometry and Pre-Calculus are more important than Calculus. *Review your basic mathematics NOW!*

Physics is about "understanding **relationships** between physical quantities", which we uncover by experiment and by mathematical reasoning.

Physics is **NOT about formulas** and merely plugging-in numbers.
Formulas are often only "special cases of expressions of those relationships". *"Knowing a formula without knowing when it applies" is generally useless.* The act of "plugging-in numbers" measures your ability to do Arithmetic or use a calculator.

The resulting number is only useful when you interpret it physically. *"The right number with wrong physics" is just plain wrong.*

YOU CAN understand and succeed in Physics only if YOU put in the required work.

Just attending lectures and labs… Just taking good notes… Just doing the homework…

Just memorizing formulas and definitions… Just reading the textbook… Just reading the solutions… …is not enough.

There are no shortcuts. ***YOU HAVE TO DO IT ALL.. and YOU CAN, only if YOU put in the required work.***

At a minimum, (as the rule of thumb goes)

for every credit hour, you should be spending three (3) out-of-class hours on the course per week.

Note, however, that merely logging-in the 9 hours per week does not guarantee a good grade. That time must well-spent.

How should you spend your time? Some ideas…

- Homework, homework, *homework,* homework, and, finally, more homework. *(The riding-a-bicycle analogy above is quite true.)*
- Read and re-read your textbook and your class notes. Keep your notes neat and organized.
- Rewriting notes (interjecting your thoughts and comments) is one way to "re-live" the lecture and re-process the concepts and ideas.
- Mark up (with specific questions) anything that you don't understand.
  Merely saying "I'm confused" isn't very helpful. (Can you narrow down the problem? Is it really a Physics issue? Or a Math one?)
- When you've identified a specific problem, try to resolve the problem yourself. If you can do that, that's great!
  If not, get help from others! Don't be discouraged, ashamed, or shy. There are lots of people to help you. Find them!
- Talk to your friends. Some of them may have had the same problem. (I learned a lot from my friends.)

- Learn more from teaching your classmates! (That why I like to teach… each time I learn a little more. Questions from students often bring up fine points that I never considered. Fielding those questions helps me fill in the gaps of my knowledge.)
- Get help in the Learning Center (Stern 301). You can earn some EFFORT-points by spending well-spent time here.

Sequence of PHY 401 topics and the learning objectives: (Homework will be assigned during each chapter.)

Ch 1 Simple models of the atom

Explain the Bohr model of the atom, including its constituent particles and the order of magnitude of its physically important quantities. Discuss some of the important experiments in atomic physics that confirm the Bohr model and its extensions.

Ch 2 The wave properties of particles

Explain the de Broglie Hypothesis on the wave-nature of matter.
Discuss some of the important experiments in atomic physics that confirm this wave-nature of matter.

Ch 3 Wave-particle duality and bound states

Explain and interpret the Schrodinger equation and the wave function.
Solve the "particle in a box" problems and interpret their solutions.

Ch 4 Solutions of Schrodinger's equation in one dimension

Set up, analyze, and solve the Schrodinger equation for important one-dimensional cases: the finite square well and the harmonic oscillator.

Ch 5 Further applications of Schrodinger's equation

Set up, analyze, and solve the Schrodinger equation for the three-dimensional square well and for sphericaly symmetric potentials. Calculate and interpret the expectation value of physically interesting observables.

Ch 8 The time dependence of quantum states

Explain and interpret the superposition of quantum states and the wave-packet.
Explain and interpret the Uncertainty Principle.

Ch 9 Particle scattering and barrier penetration

Solve the Schrodinger equation for scattering off a square well and off a square barrier. Explain and interpret quantum tunneling.

(* time permitting)

***Ch 10 Angular momentum**

Distinguish spin angular momentum and orbital angular momentum. Explain, interpret, and calculate the components of the Angular Momentum operators. Set up and analyze a system with "degeneracy".

***Ch 11 Angular momentum of atomic systems**

***Ch 12 Quantum states of three-dimensional systems**

Set up and analyze the three-dimensional central-force problem, including the special case of the Coulomb potential.

Throughout the semester, I will try out **new teaching techniques and activities** (being developed by various Physics Education Research groups) that have been successfully integrated into Physics courses throughout the country. Your participation in these techniques and activities and your patience with our attempts at implementation will be appreciated.

2005

August

Su	Mo	Tu	We	Th	Fr	Sa
22	24		26			
29	(31)					

September

Su	Mo	Tu	We	Th	Fr	Sa
						2
	H*		7		9	
	12		14		16	
	19		21		23	
	26		28		30	

October

Su	Mo	Tu	We	Th	Fr	Sa
			3		5	7
	10=		=12=		=14	
	17		19		21	
	24		26		28	
	31					

November

Su	Mo	Tu	We	Th	Fr	Sa
					2	4
	7		9		11	
	14		16		(18)	
	21		23	H*	H*	
	28		30			

December

Su	Mo	Tu	We	Th	Fr	Sa
						2
	5	6	7	8		

Midterm Week

The Final Exam is offered once during Finals Week at a specific date and time (to be assigned by the University). Do not plan to travel until after Dec 8.