

Quantum Mechanics

Fall 2013

Physics 346

9:10 A.M. MWF

Instructor:

Name: Dr. Tom Kirkman

Office: PEngel 111

Phone: 363-3811

email: tkirkman@csbsju.edu

Informal Office Hours: 7:30 A.M. – 5:00 P.M.

Note: I'm in lab/class all day Friday, but I can often answer questions during lab time

Texts:

- *Introduction to Quantum Mechanics*
by David Griffiths (Prentice Hall, 2005)
Chapters: 1–11
- <http://www.physics.csbsju.edu/QM/>
<http://www.physics.csbsju.edu/346/>

Grading:

Your grade will be determined by averaging six scores: total homework score, three exam scores, and the final exam score (which is double-counted). Assigned homework is due at the beginning of the next class period. Late homework (i.e., turned in after I've graded the set) is generally not accepted. I encourage you to work together on homework and to seek help/hints from me. The exams will consist of a few (~ 4) problems. You may use a single-sided $8\frac{1}{2} \times 11$ "formula sheet" to assist you on the exam. The formula sheet should be limited to formulas and definitions—no worked examples. Examples of previous exams are posted on the class web site. Approximate exam dates are: 27 September (Friday), 25 October (Friday) and 25 November (Monday), but I can often adjust these dates to avoid real conflicts. The final exam will be comprehensive and have a structure similar to the other exams. The final exam is scheduled for 17 December (Tuesday) at 10:30 A.M..

Questions:

There is no such thing as a dumb question. Questions asked during lecture do not "interrupt" the lecture, rather they indicate your interests or misunderstandings. I'd much rather clear up a misunderstanding or further develop a topic of interest than continue a dull lecture. No one has a natural gut-level understanding of QM. This class should constantly boggle your mind. If you sit back and just let the lecture wash over you, you will fail to really appreciate the material. You should wrestle with QM because it's only by fighting with QM that you'll understand how strange it is.

Remember: you are almost never alone in your interests, your misunderstandings, or your problems. Please help your classmates by asking any question vaguely related to physics. If

you don't want to ask your question during class, that's fine too: I can be found almost any time in my office (PEngel 111) or the nearby labs. Drop in any time!

Topics:

This course covers nonrelativistic quantum mechanics. I'll start out by telling you that what we taught you about how the world works (e.g., that particles have changing positions which can be determined by calculating how the velocities are affected by forces) is wrong. Instead of having a position, a particle (like a wave) must actually be spread out—at least a wavelength or so. (Wavelength of a particle?) The *field* $\psi(\vec{\mathbf{r}}, t)$ (think of it kind of like an electric potential), which describes this spread-out-ness, changes in time (how else could particles seem to move?). The time development of ψ is determined by Schrödinger's equation. (This is all analogous to E&M: the fields $\vec{\mathbf{E}}$ and $\vec{\mathbf{B}}$ show where the electromagnetic stuff is in space and Maxwell's equations show how the electromagnetic stuff changes in time.) We'll spend a lot of time finding the possible energies that a particle can have and how to apply wave superposition to a particle. (Much of this is analogous to the wave motion from 211: standing waves in organ pipes and superposition of those waves via Fourier series.) I will heavily rely on the mathematical abilities you've been building the last few years, particularly Linear Algebra (239) (matrix operations through eigenvectors), Differential Equations (337), and Fourier transforms (341) (Complex Analysis (348) is also useful). As in 191, we'll start with motion on a line (1-d) for highly simplified forces (nothing as complex as constant acceleration). While I'll try to connect the QM answers with the answers from classical mechanics, in fact, the methods and answers will look totally different. After we cover the fundamentals, we'll go on to approximation methods, 3-d solutions, angular momentum and spin.

While everything we taught you in classical mechanics (339) “is wrong”, it's a close approximation to reality. We'll make connections to classical mechanics via the Hamiltonian.

One final point: Quantum mechanics is weird and wonderful; I hope you'll spend 110% of your time on it. However, remember your Senior Thesis!

References:

Understanding Quantum Physics by Michael Morrison (QC174.12)

Quantum Physics by Stephen Gasiorowicz (QC174.12)

Elementary Quantum Mechanics by David Saxon (QC174.1)

Quantum Mechanics by Richard Robinett (QC174.12.R6)

Notes on Quantum Mechanics by Enrico Fermi (QC174)

Introductory Quantum Mechanics by Richard Liboff (QC174.12)

Quantum Mechanics by C. Cohen-Tannoudji (QC174.12)

Quantum Mechanics by Leonard Schiff (QC174.1) — graduate text