PHYSICS 346: Quantum Mechanics Fall 2015

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Office Hours: MWF 9:30–10:30
– My other teaching schedule: MWF 8:00
I will be in the labs and available for brief questions M 12:40–2:40, F 1:50–3:50
I will be busy nearly every M 3:30–4:30, and nearly every TuTh I will be at CSB in the morning. Otherwise I am usually on campus and in my office. Please make an appointment if you are concerned about finding me at a particular time.

Basic Information

Meetings: MWF 11:30–12:25 PENGL 319
Textbook: *Introduction to Quantum Mechanics (2nd Ed)*, D. Griffiths
Website: http://www.physics.csbsju.edu/∼syost/346p1516/

Why Do We Study This?

Why study quantum mechanics? It's not only to know about the physics governing interactions at teeny-tiny scales, *understanding results at small scales enables us to understand and predict results at "everyday" scales as well.* Allowed energies for atoms and molecules and the rules about transitioning from one quantum state to another explain the locations and strengths of spectral lines. The required properties of quantum wavefunctions lead to observed properties of solids, semiconductors, superfluids and the like.

You were introduced to quantum physics in your modern physics course; this semester we have the opportunity to review and broaden your knowledge of our old friend the wavefunction. The wavefunction is an odd thing, its weirdness all too easily ignored in order to use it to calculate properties of particles and particle systems. *Griffiths* makes sure to point out at the outset the strange thing measurement becomes with the standard interpretation of quantum mechanics. After working with a wide set of techniques, applications and approximation methods to get at the wavefunction and its observable properties, the book finally returns to the argument about whether the system has the measured property before the measurement (answer: no - the universe really is that weird).

Time will not always allow us to go into a great deal of depth in all the topics presented. However, you should end the semester with a much greater understanding of the power and applications of quantum mechanics. You will also have learned to use some approximation methods that extend the applicability of "simple" quantum calculations to more complex situations. These are the beginnings of the types of calculations that scientists develop to model full quantum systems.

How is the class structured?

– The first 5 minutes of any class are usually a graded in-class activity, which I can quickly check to gauge understanding.
– Review of previous class or a check on the expected reading.
– *Between classes, work on the previous topic and check the reading for the next section.*

structure, continued:
– Development of the concepts or mathematical techniques related to the concept, usually referencing problems in the book

– Most classes should have "goal" questions that the discussion, work, and techniques of the day would allow you to solve.

– To reinforce this, short homework sets are given **every class**, usually due at the end of the next class day.
You are expected to ask for homework clarifications or help between classes, not as part of class time.

– People learn by doing. Homework will often have suggested extra problems ("goal" problems are related to these).

– Homework is a form of studying for the assessments.

– When you find a concept difficult, it is essential to try extra problems to check your understanding. Ask me about whether you're doing them properly.

Approximate Course Schedule **Each class ≈ 1 or 2 chapter sections**

Mod A: Wavefunctions, 1D time-independent Schrodinger equation, (linear algebra review): Ch 1, Ch 2, (Appendix A)
Mod B: Formalism, 3D Quantum Mechanics: Appendix A, Ch 3, 4
Mod C: Identical Particles, Time-independent perturbation theory: Ch 5, 6
Mod D , Intro to approximation methods (variational, WKB), time-dependent perturbation theory (Ch 9), (quantum scattering, the EPR paradox): 7, 8, 9 (11, 12)
If we absorb the material more quickly at the beginning, there will be more time at the end for the interesting discussion of the quantum mechanical nature of reality in Ch 12.

Tests: Will be after Ch 2, Ch 4, and Ch 6. Based upon past results, the first two should be approximately on Sept. 25 and oct 28, but TBD as we discuss the material. **Test 3 will be on Nov. 23, the day before Thanksgiving Break.**

Quiz: There will be a short (approx 15 minute) formal quiz concerning Ch. 9, to help ensure students are prepared for the final. It will be announced and scheduled ahead of time.

GRADE SCALE

In-class activities: Cannot be made up or excused. Graded on whether or not satisfactory understanding / serious attempt to complete the problem is demonstrated: **3%**

Formal, Mod D Scheduled Quiz: **3%**

Homework: You are encouraged to work together on the homework but you must write up and understand your own solutions to the problems.: **19%**

Tests: 3 in-class tests.: **3x15%**
For each, you can bring a single-sided sheet on which you have written relevant formulas and physical constants. **No worked out problems or examples (showing steps) are allowed.**

Final Exam: As set by the registrar: Dec 16 3:30–5:30PM: **30%**
Comprehensive. You may bring a double-sided formula sheet, as for the tests

Letter Grade Conversion: A ≥ 90 B ≥ 80 C ≥ 67 D ≥ 55 (F < 55)
Intermediate grades TBD; will be adjusted if necessary to account for too-difficult assessments.

Academic Honesty

Among other forms of academic misconduct, CSBSJU's academic catalog defines cheating to include *copying the work of another student* and plagiarism as *the act of appropriating and using the ideas, writings, or works of original expressions of another person as one's own without giving credit to the person who created the work.* If suspected, the burden of proof rests with the faculty. If proven, the consequence for a first offense is failure of the course.

Please note that it is quite helpful to work in groups at times to solve homework problems, and this collective effort is **not** copying or plagiarism. A good way to be sure that you've *learned* how to do a problem with a group (rather than copying an idea without making it your own) is whether you can explain the concept / outline math steps without looking at somebody else's notes. When you can, try to check this. In any case, when asked to explain something you must find a way to say it in *your own words.* This is particularly true of ALL homework explanations.

Any unauthorized use of solution guides (particularly "Instructor's Guides") constitutes academic dishonesty. Presenting work assisted by such items is acedmic misconduct.

Homework Format

Homework Schedule : Expect homework to be assigned every class, due 1 or 2 class meetings later. **In either case, working the homework before the next class meeting is essential as the next topic will often build on a previous one.** Solutions will then be promptly released (emailed as PDFs).

Late work incurs a penalty and homework cannot be accepted at all once the solutions are released. Any arrangements for late work must therefore be made with me before the due date. Homework will be excused for serious reasons.

Homework Structure : Quantum physics is decidedly "odd", and it's important to learn what concepts apply to which situations and why. Therefore, unless indicated otherwise, homework answers must start with an explanation **in your own words**.

EVERY homework question that isn't marked "no explanation required" must clearly include what the basic concept / idea is, why you select equations to use, and why you do substitutions, set equations equal to each other, or set something to zero. Algebra, calculus and mathematical simplification do not require explanations.

I neither want nor expect essays. Annotations / pointform are good. Remember that you are making these notes for your own review later.

The explanation is ordinarily worth **3 points out of a 10pt scale**.

Due to time constraints, these full explanations will NEVER be expected on tests and quizzes.

Apart from including explanations, homework sets must:
1. Have all the mathematical work required to show how you arrived at the answer
2. Be legible and organized. This includes having no more than two problems per page *(and that would be very short problems! most require at least one page side to show all the work)*
3. Be SECURED together (passing the "shake test")