PHYS 632: Quantum Mechanics II (Winter 2022)

Instructor: Daniel A. Steck  
Office: 277 Willamette  
Phone: 346-5313  
email: dsteck@uoregon.edu  
Office hours: walk-in and by appointment (best to email first). But see the COVID-19 information below.  
Teaching Assistant: Aria Radick  
Office: WIL 445  
Office hours: Th 1-2p (contact first by email to arrange meeting)  
email: aradick@uoregon.edu

Course home page: https://atomoptics.uoregon.edu/~dsteck/teaching/22winter/phys632

Schedule: MT 5-6:50p, 318 Willamette  
Course reference number: 20729  
Credits: 4  
Prerequisites: PHYS 631  
Links: news, course notes, homework sets and keys.

Course overview

This course is a more-or-less standard introduction to quantum mechanics at the graduate level, one of the core components of your Ph.D. studies. This is the second of a 3-quarter sequence.

Recommended Texts:

There is no required textbook to purchase for this course. The main reference for this course is the online text posted here.

Philosophy of This Course:

This is one of the core courses of your graduate physics training. This second course in the QM sequence transitions to material that you may have seen as an undergraduate, but probably not in a lot of detail, such as angular momentum and perturbation theory. Again, a major goal of this class is to develop mathematical techniques (in linear algebra, differential equations and boundary-value problems, approximation methods, regularization), and to develop problem-solving skills at a high level.

COVID-19 considerations:

We are now in the omicron-rising phase of the pre-post-COVID-19 era, which (apparently) means that this will be an in-person class despite the newly surging COVID-19 pandemic. What exactly this means is not clear at the moment, but things will be probably be more or less like last term.

This course will in part be a traditional lecture course. But I'll also have work on exercises related to the material for the day (in small groups, but details may evolve). These group exercises will happen in the last 30-45 minutes of each class. They will give you a chance to review/practice/discuss the material, and to have a chance to ask me more questions.

Of course, you will have questions on the material, homework problems, and exercises outside of the class meeting times. I highly encourage you to contact me with questions:

- in walk-in office hours. Whenever I'm in my office you're free to show up and ask questions. You can email me to see if I'm there to save you the trouble of walking over to see if I'm there. I'll definitely be around MT afternoons, and we'll discuss other times depending on what's good for class. Normally I'd have an open office door, but in the pre-post-pandemic era it will be mostly closed.
- in zoom office hours (see the notes page for zoom meeting info). Contact me to set these up; generally I'll advertise these to the class on the news page so anyone can listen in, unless you request otherwise. These meetings have the advantage that everyone can see each other's faces, and I can accommodate many more people than in my office.
- by email. If you have a fairly straightforward question, or a question at an oddball hour, you can just email me. I try to respond to these pretty quickly.

Please also read the university's COVID-related resources (which you should consider to be part of this syllabus):

- Academic council guidance
- COVID containment plan
- Guidance/FAQ

Grades

Grades for the course will be based on homework, a midterm exam, and a final exam. The relative weights will be as follows:

- Homework: 25%
- Excerises: 10%
- Midterm exam: 30%
- Final exam: 35%

COVID-19 considerations: like last term, you'll submit all documents electronically (via a web submission system). This includes solutions for homework, exercises, and exams.

Homework: about 8 problem sets will be assigned during the term. You'll submit these online, see the homework page for the upload link. The due dates for the homework assignments will be every Tuesday, to keep things simple (including exam week, but not during week 1 or midterm week/week 6).

Exercises: These are relatively simple (compared to homework problems) related to the lecture material. These will be assigned during each lecture, when you'll start working on them, and they'll be posted on the notes page. You should turn in (online, see the notes page) your exercise solutions for each week all together, by the following Tuesday. I'll grade these on completion (i.e., if you do a reasonable job, you'll get full credit).

Midterm exam: The midterm exam will be an at-home exam, held during the sixth week of class (7-11 February), details to be finalized.

Final exam: The final exam is scheduled for Monday, March 14, 7:15-9:15p. We'll work out the details in class towards the end of the term.

Pass/fail grading option: Since this is a core graduate course, you should take the graded option.

Syllabus

This is a tentative list of topics we will cover in this and the following course(s) in the sequence. Note that it is likely we won't get through all of this in one term.

I. Harmonic oscillator (finishing up)
II. Ehrenfest theorem
III. Angular momentum, spin, rotations
IV. Radial potentials, hydrogen atom
V. Time-independent perturbation theory
VI. Variational method
VII. Entanglement, Bell theorem
VIII. Time-dependent perturbation theory
IX. Fermi Golden rule