PHYS 632: Quantum Mechanics II (Winter 2021)

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Office hours: walk-in and by appointment (best to email first). But see the COVID-19 information below.  
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Course home page: https://atomoptics-nas.uoregon.edu/~dsteck/teaching/21winter/phys632

Schedule: MT 5-6:30p, meetings on Zoom (see course notes and exercises page for meeting link)  
Course reference number: 24590  
Credits: 4  
Prerequisites: none  
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 set of online notes 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:

This would normally be a relatively traditional lecture course, but due to the ongoing COVID-19 pandemic, online meetings are required by the UO. Lecture courses are not optimal by Zoom, to say the least. There are alternatives to lectures that work well, but since this is the first course in a year-long sequence, it’s good for me to get to know you, and having at least some lecture time helps me to do this. This is especially true if you all keep lots of questions in class. I’ll (try to) keep lectures down to around 1 hour during each meeting, after which I’ll have you work on exercises related to the material for the day in small breakout groups.

One of the main challenges of a remote course is that it’s more difficult to have a sense of community as a class, which is particularly important for the first-year Ph.D. students among you to develop a support network that will last throughout your graduate career. So when you’re attending class meetings on Zoom it’s particularly important for you to keep your video feed on so people can see your smiling face. It’s okay to disable video for a bit if your cat is jumping on your head, but please try to be maximally present as much as you can.

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 to set up a Zoom meeting outside of regular class hours; generally I’ll advertise these to the class on the course notes page so anyone can listen in, unless you request otherwise (we’ll use the same Zoom meeting that we use for regular class meetings). These meetings will replace in-person office hours (where the disadvantages of being masked and only one person allowed in my office would seem to outweigh the advantages of meeting in person).

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%  
- Exercises: 10%  
- Midterm exam: 30%  
- Final exam: 35%

COVID-19 considerations: You’ll submit all documents electronically (via a web submission system). This includes solutions for homework, exercises, and exams. This means you will either need to type out solutions (preferably in LaTeX), or scan your handwritten solutions. In the case of the dead-tree method, please make legible, data-efficient scans. You may or may not have access to department scanners, so if you have a scanner at home use that; otherwise, use a scanner app for your phone or tablet (I’ve used Scanner Pro on iOS, which is cheap and works well, but there are many other options available). Having this capability will serve you well beyond this class and the pandemic.

Homework: about 8 problem sets will be assigned during the term. You’ll submit these online, see the homework page for the upload link.

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 notes page) your exercise solutions for each week all together, by the following Monday. 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 (8-12 February), details to be finalized.

Final exam: The final exam is scheduled for Monday, March 15, 7:15-9:15p. Since the exam is remote, the time is flexible (details to be finalized).

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

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