PHYS 632: Quantum Mechanics II (Winter 2024)

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Course home page: https://atomoptics.uoregon.edu/~dsteck/teaching/24winter/phys632

Schedule: MT 5-6:50p, 318 Willamette
Course reference number: 24401
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.

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.

Study groups:

I highly encourage you to join/form a study group. If you need help in finding a study group, or you have already formed a group and you can take on more people, just let me know and I'll be happy to facilitate this.

While I encourage study groups, you must still work through problems on your own and turn in your own solutions—these groups work brilliantly for brainstorming, getting unstuck, clarifying, etc., but ultimately you have to work through the physics or you won't learn anything.

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%

Electronic submission: 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 Friday, 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 Friday. 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 (13-17 February), details to be finalized.

Final exam: The final exam is scheduled for Wednesday, March 22, 12:30-2:30p. 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. WKB Approximation
IV. Angular momentum, spin, rotations, Wigner-Eckart theorem
V. Spin 1/2
VI. Entanglement, Bell theorem
VII. Density operator
VIII. Cloning, teleportation
IX. Indistinguishable particles
X. POVMs, quantum state discrimination, Bayesian inference