University of Maryland
Department of Physics

Fall 2022 Prof. Steven Anlage Physics 402

Title:
Physics 402: Quantum Physics II: Quantum states as vectors; spin and spectroscopy, multiparticle systems, the periodic table, perturbation theory, band structure, etc. The second semester of the two-term sequence on introduction to quantum physics for physics majors. This is a 4-credit course.

Prerequisite:
PHYS 401. Also, a good working knowledge of linear algebra and differential equations is important.

Instructor:
Prof. Steven Anlage, Room 1363 (Physics/QMC). You can find the QMC either by 1) going through the blue door labeled "Quantum Materials Center" in the basement of the Toll physics building, or 2) entering QMC from the plaza between the Math and Toll Physics buildings.
Phone: 5-7321, e-mail: anlage@umd.edu, web site: anlage.umd.edu

Schedule:
Two lectures weekly, MW..... 10:00am - 11:50am (PHY 1402) which includes a 1 hour lecture/discussion.

Required Text:
David Griffiths and Darrell Schroeter, Introduction to Quantum Mechanics **3rd Edition** (Cambridge University Press, 2018) ISBN-13: 978-1107189638.

Other Texts:
Here are four other reference texts that cover similar material at three different levels. Quantum mechanics at a lower level: Kenneth Krane, Modern Physics, 2nd Edition (ISBN: 0-471-82872-6); and Paul A. Tipler and Ralph A. Llewellyn, Modern Physics, 5th Edition (ISBN-13: 978-0-7167-7550-8, ISBN-10: 0-7167-7550-6). Quantum mechanics at roughly the same level as Griffiths: Richard L. Liboff, Introductory Quantum Mechanics, 4th Edition (ISBN: 978-0805387148). Quantum mechanics at a more advanced level: J.J. Sakurai, Modern Quantum Mechanics, revised edition, 1993 (ISBN-13 9780201539295).

Lectures:
The plan is to deliver this class in person in a traditional lecture format. Questions are encouraged during the lectures. You will be responsible for material presented in lecture that is not in the book. The lectures will not be recorded. If you miss a lecture you can check out the lecture summary posted on the open class web site (given below). Both of the mid-term exams will be held during the class period. The final exam will be given during the 2-hour time period allocated for this class. The office hours will be held in the conference room of the Quantum Materials Center in the Toll Physics Building, room 0360.

Homework:
The homework assignments will be given on the (open) class website and on ELMS. The assignment will be due at the beginning of class on Wednesdays. Please upload your homework paper in a single **pdf format** (only) to ELMS. Homework turned in by any other means will not be counted. Two homework problems will be graded quantitatively (0-10) and the rest will be graded qualitatively (0-1-2). The choice of the two problems to grade quantitatively will be made *after* the homework is collected.

There will be one or two extra credit problems given on each homework assignment. These problems are designed to challenge you, and go beyond the material covered in class. Solutions to the extra credit problems will not be provided. The extra credit points are not part of the regular grading scheme, but may be used for fine adjustments to the final grade.

Doing the homework is a very important part of this course! Homework will be graded by the following week. Late homework will not

be accepted. As compensation, the two lowest homework grades from the semester will be dropped.

Quizzes:
There will be weekly in-class quizzes on the day that the homework is due (Wednesdays). The quiz will cover topics in the homework assignment due that day, and should be considered as part of the homework assignment. The quizzes are a further inducement to do the homework problems thoroughly and carefully. The quiz is CLOSED book, notes, internet, etc. There will be no makeups for these quizzes! As compensation, the two lowest quiz scores from the semester will be dropped.

Exams:
There will be two "mid-term" exams and a final exam. The exams are CLOSED book, notes, internet, etc., unless otherwise noted. All exams will count towards your final grade. Make-up exams (for any of the exams) must be requested well in advance of the exam; the reason for the absence must be documented and in accord with University policy (see p. 109 of https://catalogundergraduate.umd.edu/files/2017-2018-UGCatalog.pdf).

In grading, we are looking more at the reasoning that you use, rather than the final number you arrive at. So remember to carefully set up the problem on paper, even if you cannot see the way through to the solution.

The final exam is Tuesday, December 20, from 8 to 10 AM.

Numerics
Developing a working knowledge of numerical techniques in the context of physics problem solving is an important skill. You are encouraged to solve problems using programs such as Mathematica and WolframAlpha. Note that a student version of Mathematica is available for download from TERPware: http://terpware.umd.edu/Windows/Title/1837 This course makes heavy use of integration and you are encouraged to solve these integrals by computer so that you can focus on higher level issues.

Final Grade:
Based *approximately* on homework (~25%), quizzes (~15%), mid-terms (~40%), and final (~20%).

Academic Dishonesty (cheating):
Academic dishonesty is a serious offense that may result in suspension or expulsion from the university. In addition to any other action taken, the normal sanction is a grade of "XF", denoting "failure due to academic dishonesty," and will normally be recorded on the transcript of the offending student. Note that general university course policies are posted at http://www.ugst.umd.edu/courserelatedpolicies.html.

Undergraduate Policies and Rights
Here is a link to the Office of Undergraduate Studies Course Policies for Undergraduates http://www.ugst.umd.edu/courserelatedpolicies.html

Office Hours
You are strongly encouraged to attend the in-person office hours to ask questions, discuss the homework problems, and talk about physics in general. The office hours will be held 4:00-5:30 PM on Tuesdays, just before the homework is due. I plan to run the office hours in a hybrid in-person/remote format. The office hours will not be recorded.

(Open) Class Web Site (containing lecture summaries):
http://www.physics.umd.edu/courses/Phys402/AnlageFall22/

ELMS web site:
The ELMS web site will be used mainly to post homework, discussion, and exam solutions. ELMS also has a record of your homework and exam scores (you should check that they are accurate). Note that the gradebook page is NOT an estimate of your grade, and should not be used that way, it is simply a record of the scoring for each assignment.

Tips For Doing Well In This Course:
1) Read the assignment in the book *before* and *after* the material is covered in lecture.
2) Freely ask questions in lecture, after lecture, and during office hours. Also discuss problems with your friends and classmates.
3) Work all of the homework questions and problems. You are allowed and encouraged to discuss homework with anyone you wish. However, in

order to really learn, don't just copy solutions from somewhere or someone else; rather, work through them in detail yourself. Afterwards, make use of the solution sets, your TA's office hours, and me to make certain you understand all of the solutions. The exams may sometimes involve homework problems.

4) Seek help immediately if you do not understand the material or can't solve the problems. Help is available from your TA, and from me. Don't wait until just before the exams! If you are experiencing difficulties in keeping up with the academic demands of this course, contact the Counseling Center for Academic Concerns/Learning Difficulties (https://counseling.umd.edu/cs/commonconcerns/academic). Their educational counselors can help with time management, reading, note-taking and exam preparation skills.

5) Remember that you are responsible for material discussed in class, even if it does not appear in the textbook.

What Should You Learn in this Class?

Physics 401 has given you the background about why we need quantum mechanics, and a few basic tools to work with. Physics 402 uses these tools to solve problems that befuddled classical physicists for years (i.e. just about every interesting problem in physics). In this course, you should learn how to "think quantum" and assimilate the new concepts of quantum mechanics. Specifics covered will include atomic and molecular structure, radiation from atoms, time dependent and time independent perturbation theory, identical quantum particles, elementary condensed matter physics (including band structure, superfluid He and superconductivity), and some treatment of advanced topics such as quantum scattering.

Physics GRE

There is an emphasis on both historical aspects of quantum physics, as well as many general concepts from one-dimensional quantum mechanics on the Physics GRE exam. The textbooks by Krane or Tipler/Llewellyn or Taylor/Zafiratos/Dubson will be of great help in preparing for the historical aspects, while Griffiths is ideal for the analytical part of the exam. The more practice you have solving problems in quantum mechanics, the better you will do on the Physics GRE.