Phys 5402 Course Syllabus: Quantum Mechanics II

Professor Richard Jones
Physics 5402, Fall Semester 2018, University of Connecticut
(Dated: August 27, 2018)

I. LECTURE AND EXAM SCHEDULE

- Lectures will be held in GW-121 on Monday and Wednesday at 9:00-10:15 AM.
- There will be one midterm exam and the final. The schedule for the midterm will be set during the semester, but will take place right around the semester midpoint. The schedule for the final exam is set by the Registrar.

II. CONTENT AND PREPARATION

- PHYS 5401 is a core graduate course devoted to the theory and applications of quantum mechanics. Concepts covered include bound and continuum solutions to the Schrodinger equation in 3 dimensions, and an introduction to relativistic quantum mechanics with the Dirac equation. Applications include the harmonic oscillator, the hydrogen atom with and without perturbations, and elastic scattering from finite-range potentials. Several useful approximation schemes are also introduced and applied.
- Students should have already successfully completed Phys 5101 (Math Methods), Phys 5201 (Classical Mechanics), and Phys 5401 (Quantum Mechanics 1) before taking this course. A working knowledge of multi-variable calculus, linear algebra, and differential equations is required.
- The goals for the course are that students demonstrate their ability to
    1. derive all results starting from the basic principles and axioms of quantum mechanics;
    2. gain familiarity with the solution to a few common potentials, and be able to explain how qualitative features of their energy spectra and eigenstates are related to their symmetries;
    3. set up the solution to novel systems for which quantum theory is applicable, and carry out the solution to the extent that exact mathematical treatment is possible;
    4. understand the power and limitations of series expansions to approximate solutions in cases where exact solutions are not available;
    5. master the use of a set of approximation methods to solve quantum problems, understand their limitations, and estimate their errors;
    6. be able to explain how the Schrodinger equation breaks down above a certain excitation energy, and the conceptual changes to quantum mechanics theory that were required in order to make it consistent with special relativity.
    7. recognize the Dirac equation and its solutions in free space, how electromagnetic interactions are implemented in Dirac theory, and how to apply perturbation theory in this context.
    8. pass exams at the level required for the Quantum Mechanics PhD preliminary exam.

III. COURSE MATERIALS

- **Text book:** Eugen Mertzbacher, "Quantum Mechanics", Third Edition. Students are expected to own or have access a copy of this textbook. The topical sequence in that book, together with problems and exercises contained therein, will be assigned reading for this course. In addition to that text book, the following books may also prove useful in their varied presentation and styles.
    1. Leonard I. Schiff, "Quantum Mechanics", 1968.
    2. P.A.M. Dirac, "The Principles of Quantum Mechanics", 1959.

3. Claude Cohen-Tenoudji, Bernard Diu, Franck Laloe, "Quantum Mechanics", (2 volumes) 1977.
4. J.J. Sakuri, "Modern Quantum Mechanics", 1994.
5. Stephen Gasiorowicz, "Quantum Physics", 1974.
6. L.D. Landau and E.M. Lifshitz, "Quantum Mechanics", 1977.
7. Stephen Gasiorowicz, "Quantum Physics", 1974.
8. David J. Griffiths, "Quantum Mechanics", 2005.

- **HuskyCT web site:** Online access to lecture notes and scanned solutions to homework problems, individual student grade records, and various other useful reference materials related to the course are available on the course web site at `http://huskyct.uconn.edu`. Students should log in using their netid and password, and click on the link to PHYS 5402 under their list of classes.
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IV. ASSIGNMENTS

- **In-class assignments:** There will periodically be assignments carried out in class to probe your understanding of concepts and methods presented in the lectures. These will typically be graded in class, and then turned in afterward for credit.
- **Weekly homework:** Homework will be assigned each week, and will be due each Monday at 9:00 am, to be handed in at the beginning of the lecture. Not every problem from every homework set will be graded; the instructor will choose which ones to grade, and will make it clear to the students which ones they were. The same problem(s) will be graded from any given homework set for all students in the class.
- **Exams:** There will be one midterm exam and one final exam for this course. All exams will take place during regularly scheduled hours for the course. The exact dates will be determined and announced ahead of time in class and online. All exams are closed-book.

V. GRADING POLICIES

The weight that will be used to compute a student's final numerical score for the course are as follows.

breakdown of final grade	
In-class work	10%
Weekly homework	20%
Midterm exam	30%
Final exam	40%

The conversion from numerical score to letter grade will be determined at the end of the course. The traditional major decade divisions (90-100=A, 80-90=B, ...) are useful as an approximate guide.

VI. HOMEWORK

Weekly homework assignments are due at the beginning of class on Mondays. Solutions will be posted on-line on HuskyCT after the submission deadline. You may discuss the problems with each other, but you are expected to do your own work. Devoting serious effort to doing the homework assignments well is crucial for understanding Quantum Mechanics since is sometimes foreign to common physics intuition. Disorganized, illegible, incoherent, or otherwise substandard home work will receive correspondingly low marks. To be specific, you should:

– *NOT* turn in images of solutions taken with a camera;

- *NOT* turn in solutions written on paper torn from a notebook;
- *NOT* turn in solutions written on both sides of the paper;
- *NOT* turn in copies of work done by others;
- *DO* sign the front page of your solution, marking it as your own.

You may turn in your solutions either in paper form at the beginning of class, or in electronic form (eg. pdf sent as an email attachment) provided that the time stamp shows it was submitted prior to the deadline. In some cases you may be able to find solutions to homework problems on-line. *Do not use them.* Any solution submitted with the signature of a student, that is obviously taken verbatim from someone or somewhere else, will get zero points for the whole assignment. More importantly, your grade in this course comes mostly from the exams, not the homework. Doing the homework yourself is the primary way that you will be able to prepare for the exams.

VII. LATE HOMEWORK POLICY

Late homework will not be accepted since solutions will be posted online. If you will be absent on the day it is due, you may scan your work to pdf and email a copy to the instructor in advance of the beginning of Monday's class.

VIII. MISSED EXAMS POLICY

Exams must be taken at the scheduled time. Exceptions must be approved in advance, or be genuine emergencies. Make up exams for unexcused absences will not be given.

IX. CLASS ETIQUETTE

Use of laptops or cell-phones for non-class-related business is not permitted during lectures. Cell phones should be muted, and must be put away at all times during exams.

X. ACADEMIC INTEGRITY

Students are permitted, even encouraged, to work together on the homework problems. Any work submitted for credit, however, must be the student's own work and be signed by the student. Assistance from others on exams is not permitted. Even one occasion of academic dishonesty will result in failure for the entire course and referral to Student Judicial Affairs. For University policies on academic honesty please see UConn's Responsibilities of Community Life: `http://community.uconn.edu/the-student-code-preamble/`.

XI. STUDENTS WITH DISABILITIES

Students who think that they may need accommodations because of a disability are encouraged to contact the Center for Students with Disabilities as soon as possible to verify their eligibility for reasonable accommodations. You may also meet with the instructor privately to discuss any barriers to learning that you encounter in this course. Any matters that are discussed in this context will be confidential, in keeping with university policy in this area. For more information, please go to `http://www.csd.uconn.edu/`.

XII. CONTACT INFORMATION

Prof. Richard Jones, richard.t.jones@uconn.edu, office P-411. Regular weekly office hours will be posted online, but instructor will be available to meet at other times by appointment. Please email in advance.