

Univ. of Winnipeg Dept. of Physics  
Fall/Winter 2018-19

## PHYS-4601 Quantum Mechanics II

Lecture Times: TTh 2:30-3:45PM

Room: 3M56

Instructor: Dr. Andrew Frey

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Office: 2L26

Office Phone: 786-9215

WWW: <http://ion.uwinnipeg.ca/~afrey/FW1819/qm2/>

Office Hours: M 2:30-3:30PM or by appointment

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### Course Description

This advanced course covers the basic theory and applications of quantum mechanics at a more detailed level than PHYS-3301.

### Textbooks

There is one required text, but several others may be helpful.

- **Required:** *Introduction to Quantum Mechanics* by Griffiths, 2nd ed  
OR *Introduction to Quantum Mechanics* by Griffiths and Schroeter, 3rd ed
- **Supplementary:** *Principles of Quantum Mechanics* by Ohanian
- **Supplementary:** *Principles of Quantum Mechanics* by Shankar, 2nd ed
- **Supplementary:** *Quantum Mechanics* by Merzbacher, 3rd ed

In addition, some extra reading (from other texts, journal articles, etc) may be assigned.

### Topics

We will discuss

- Formalism and Postulates of Quantum Mechanics: — Linear Algebra, Dirac Notation, & States — Operators, Observables, & Uncertainty — Schrödinger Equation & Stationary States
- 1D Quantum Mechanics: — Free Particle — Delta Function — Square Well — Harmonic Oscillator
- 3D Quantum Mechanics: — Angular Momentum — Spin — Hydrogen Atom
- Particle Statistics & Statistical Mechanics
- Interpretation of Quantum Mechanics & Quantum Computing
- Solid State Physics: — Fermi Energy — Band Structure
- Perturbative Approximations: — Formalism — Applications to Hydrogen — Time-Dependent Perturbation Theory
- Nonperturbative Approximations: — Variational Principle & Atomic/Molecular Physics — Semi-classical Approximation & Tunneling
- Possible Advanced Topics: — Path Integrals — Dirac Equation — Quantum Electrodynamics — Scattering & the Born Approximation — Adiabatic Approximation — Symmetries — Student-requested Topics

Not all topics above will be covered equally. Also, some topics may be skipped due to time constraints or taught in different orders. Typically only a selection of the Advanced Topics will be taught.

**Teaching Outcomes:** By the end of the course, you should have a conceptual and quantitative understanding of the above topics. You should also be able to carry out multi-step calculations and apply quantum mechanics to real-world problems.

## Assignment Policies

**Reading:** Reading assignments will be posted on the course web page each week (usually 1-3 sections per week). You are responsible for keeping up with the reading; material covered in the reading will not necessarily be discussed in the class lectures but may be included in tests.

**Homework:** Assignments will be posted on the course web page (see above) in PDF format each Thursday. They will **NOT** be handed out in class, so you must tell me if you cannot access the assignments! One student will be assigned to discuss each problem the following Tuesday for a few minutes. The assignment will then be due at 10:59PM on the listed due date in the labeled dropbox outside room 2L26; make sure to mark your paper with your name and “QMIL.” Alternately, homework can be emailed to the instructor as black-and-white scanned (*not photographed*) PDF or a PDF prepared with L<sup>A</sup>T<sub>E</sub>X software. Homework solutions will be posted on the course web page as soon as possible after assignments have been collected. Collaboration on the problems is allowed, but each student must write up the solutions independently. Late assignments will **not** be accepted without prior permission from the instructor. Some assignments will require the use of Maple software, which is available on the computers in room 2L14.

**Exams:** No electronic equipment is allowed during either in-class tests or the final exam, except at the discretion of the instructor. Students should be prepared to present identification at tests and exams.

**Religious Holidays:** You may choose not to attend class or write tests/examinations on holy days of your religion, but you must notify me at least two weeks in advance. If so, I will provide the opportunity to make up work without penalty.

**Organization:** Your homework and exam solutions should be written (or typed) neatly with steps explained *as if you were writing a research paper or lab report*. Not all algebra need be shown if the steps are explained in words; however, showing your work may improve your credit if you make a mistake. Homework that is not neatly organized and written will not be graded and will be given **zero credit** (one warning will be allowed). In addition, multiple pages must be stapled together.

**Regrading:** If you feel that there is a mistake in grading, I will regrade each problem in question completely. It is possible that newly discovered mistakes will reduce your credit. Please also see the section on appeals.

## Evaluation

**Grades:** Course grades will be comprised of the following components:

- Homework Assignments: 47%
- Class Participation (see below): 5%
- 2 In-Class Tests: 13% each
- Final Exam: 22%

Guidelines for the assignment of numerical percentage grades to letter grades are as follows:

- A+ = 95-100%
- A = 87-94%
- A- = 80-86%
- B+ = 74-79%
- B = 67-73%
- C+ = 61-66%
- C = 53-60%
- D = 50-52%
- F = 0-49%

Note that these are guidelines. Final grades shall be approved by the Department Review Committee and may be subject to change.

**Participation:** The participation grade will be based solely on presentations of homework problems during the Tuesday class meeting following the assignment of homework. If a student is prepared to discuss the assigned problem (that is, demonstrates that he/she has thought about the problem), then the student will receive full credit for that presentation. Otherwise, the student will receive no credit for that presentation. Presenting students are encouraged to take advantage of office hours for advice on the problems.

**Appeals and Misconduct:** See the **Regulations and Policies** section of the **Academic Calendar** (<https://uwinnipeg.ca/academics/calendar/docs/regulationsandpolicies.pdf>) regarding appeals and academic misconduct. Note that use of solutions from other courses, previous years, or from the textbook publisher will be considered cheating.

**Exam & Other Important Dates:** Dates to note include

- First Lecture: Sept 4, 2018
- Fall Reading Week: Oct 7-13, 2018
- First In-Class Test: early Nov, 2018
- Last Fall Lecture: Nov 29, 2018
- First Winter Lecture: Jan 8, 2019
- Second In-Class Test: late Jan/early Feb, 2019
- Voluntary Withdrawal Date: Feb 15, 2019 (without academic penalty)
- Winter Reading Week: Feb 17-23, 2019
- Final Course Lecture: April 4, 2019
- Final Exam: April 9, 2019, 1:30-4:30PM (subject to university scheduling)

## Miscellaneous

**Emails:** I may at times need to communicate with the class as a whole via email, which may be through your official university email address. Please check that account as well as your preferred account.

**Accessibility Services:** Students with documented disabilities, temporary or chronic medical conditions, requiring academic accommodations for tests/exams (e.g., private space) or during lectures/laboratories (e.g., note-takers) are encouraged to contact Accessibility Services (AS) at 204-786-9771 or [accessibilityservices@uwinnipeg.ca](mailto:accessibilityservices@uwinnipeg.ca) to discuss appropriate options. All information about a student's disability or medical condition remains confidential. <http://www.uwinnipeg.ca/accessibility>.

**Data Collection:** Students who plan to conduct research interviews, focus groups, surveys, or any other method of collecting data from any person, even a family member, must obtain the approval of the appropriate ethics committee before commencing data collection. Exceptions are research activities in class as a learning exercise. See <http://www.uwinnipeg.ca/research/human-ethics.html> for submission requirements and deadlines.

**Respectful Working and Learning Environment Policy:** All students, faculty, and staff have the right to participate, learn and work in an environment that is free of harassment and discrimination. The UW Respectful Working and Learning Environment Policy may be found online at <http://www.uwinnipeg.ca/respect>.