

## Physics 4251A — Quantum Physics II

### 1. Course Information

**Prerequisite:** Physics 3200A/B.

**Antirequisite:** The former Applied Mathematics 4251A

**Extra Information:** 3 lecture hours, 0.5 course.

Unless you have either the requisites for this course or written special permission from your Dean's Designate (Department/Program Counsellors and Science Academic Counselling) to enrol in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

### 2. Instructor Information

Instructors	Email	Office	Phone	Office Hours
Prof. Martin Houde	<a href="mailto:mhoude2@uwo.ca">mhoude2@uwo.ca</a>	PAB 207	x86711	

**Office Hours:** I do not hold specific office hours, and I encourage you to contact me whenever you need. It is preferable that you send me e-mail ahead of time to make sure I am available or to make an appointment. The TA's office hours will also be posted on the course web site.

### 3. Course Syllabus, Schedule, Delivery Mode

**Calendar course description:** Potential scattering, spin, addition of angular momenta, stationary and time-dependent perturbation theory, systems of identical particles, applications to atomic, molecular, solid state, nuclear, particle and atmospheric physics.

#### Learning outcomes

- To work with and apply the Dirac formalism of Quantum Mechanics to problems involving particle spin, angular momentum, and their time evolution.

- Solve for the time dependence for single particle systems in multiple dimensions using either wave mechanics or matrix mechanics.
- To solve simple perturbation theory problems and understand the basics of systems of identical particles in quantum mechanics.

**Lectures:** I use chalk and a blackboard in class but my lecture notes will be posted prior to each class on OWL.

First lecture: [\*]

Winter Reading Week: October 30 – November 5, 2023

Last lecture: [\*]

Exam period: December 10 – 22, 2023

**Teaching Assistant:** The TA for this course is Ningyan (Louis) Fang, [nfang6@uwo.ca](mailto:nfang6@uwo.ca).

**Course Outline:** Lecture topics are centred on the key objectives of the course. The topic coverage shown below is approximate and may change depending on lecture progress. We may not get to all topics the list.

1. Review of: Stern-Gerlach Experiments; Rotations and Matrix Mechanics; Angular Momentum; and Time Evolution
2. System of Two Spin-1/2 Particles, EPR paradox, Bell Inequalities, Entanglement
3. Wave Mechanics and Harmonic Oscillator in 1D (Review)
4. Translational and Rotational Symmetry in the Two-Body Problem
5. Bound States of Central Potentials
6. Time-Independent Perturbations
7. Identical Particles
8. Scattering, Time-Dependent Perturbation Theory, & Fermi's Golden Rule

**Contingency plan:** Although the intent is for this course to be delivered in person, should any university-declared emergency require some or all of the course to be delivered online, either synchronously or asynchronously, the course will adapt accordingly. The grading scheme will **not** change. Any assessments affected will be conducted online as determined by the course instructor.

## 4. Course Materials

**Textbook:** The required textbook is *A Modern Approach to Quantum Mechanics, 2<sup>nd</sup> edition*, by John S. Townsend. This is available at the UWO Bookstore; see this [link](#) to the Bookstore for more information. You can also get an electronic copy for **\$85 from the publisher** at: <https://www.redshelf.com/book/522/>.

Students are responsible for checking the course OWL site (<http://owl.uwo.ca>) on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class.

All course material will be posted to OWL: <http://owl.uwo.ca>.

If students need assistance with the course OWL site, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

**Calculator:** You may need a scientific calculator at times in this course. Note however that you may not use a calculator app on a smart phone or other wireless device during an exam – only a standard scientific calculator. Please remember to bring it to exams – we do not supply loaners.

## 5. Methods of Evaluation

**Assignments:** You will receive lists of problems during the semester to turn in as assignments; there will probably be three such assignments during the semester. Students will be allowed to discuss the material among themselves and *electronically* turn in one copy per group of no more than three students. Assignments must be turned in at the requested date. However, a student may miss a single (one) due date once during the semester, and hand in the late assignment on the following lecture day without incurring any penalty. Otherwise, for every 24 hour period or portion thereof for which they are late, assignments will automatically have a third of the maximum number of points subtracted from their total.

**Term Tests:** There will be two in-class term tests. These are expected to happen on the following dates: [\*]; and [\*] but are subject to change: any changes will be announced in class. The first test will last 50 minutes and the second 110 minutes. These are cumulative and could test material on topics covered at any earlier point in the course. Bring a calculator but no notes or books will be allowed, with the exception of a formula sheet (to be turned with your exam booklet(s)). The tests will include problems to be worked out. At the end you may or may not be required to obtain numerical answers; if you are, you will be required to maintain control of numerical accuracy to three significant digits and to include units.

**Final Exam:** Three hours long, covers material of the entire course. Bring a calculator and a formula sheet (to be turned with your exam booklet(s)). Date, time, and location are to be announced.

### Grading:

Assignments: 25%

Term Tests: (15+20) 35%

Final Exam: 40%

Please note: The Department of Physics and Astronomy may, in rare cases, adjust the final course marks in order to conform to Departmental policy.

## 6. Student Absences

If you are unable to meet a course requirement due to illness or other serious circumstances, please follow the procedures below.

### Absences from Midterm Examinations

You must provide valid medical or supporting documentation to the Academic Counselling Office of your Faculty of Registration as soon as possible. For further information, please consult the University's medical illness policy at

[https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_medical.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf).

The Student Medical Certificate is available at

[https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/medicalform.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf).

### Absences from Final Examinations

If you miss the Final Exam, please contact the Academic Counselling office of your Faculty of Registration as soon as you are able to do so. They will assess your eligibility to write the Special Examination (the name given by the University to a makeup Final Exam).

You may also be eligible to write the Special Exam if you are in a "Multiple Exam Situation" (e.g., more than 2 exams in 23-hour period, more than 3 exams in a 47-hour period).

## 7. Accommodation and Accessibility

### Religious Accommodation

When a course requirement conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request accommodation for their absence in writing at least two weeks prior to the holiday to the course instructor and/or the Academic Counselling office of their Faculty of Registration. Please consult University's list of recognized religious holidays (updated annually) at

<https://multiculturalcalendar.com/ecal/index.php?s=c-univwo>.

### Accommodation Policies

Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

[https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/Academic\\_Accommodation\\_disabilities.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Accommodation_disabilities.pdf).

## 8. Academic Policies

The website for Registrarial Services is <http://www.registrar.uwo.ca>.

In accordance with policy,

[https://www.uwo.ca/univsec/pdf/policies\\_procedures/section1/mapp113.pdf](https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf),

the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at their official university address is attended to in a timely manner.

**Electronic Devices:** No electronic devices except standard scientific calculators will be allowed during tests and examinations. Calculators may be of any standard scientific type but may not be wireless-capable.

**Scholastic offences** are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

[http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/scholastic\\_discipline\\_undergrad.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf).

## 9. Support Services

Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: <https://www.uwo.ca/sci/counselling/>.

Students who are in emotional/mental distress should refer to Mental Health@Western (<https://uwo.ca/health/>) for a complete list of options about how to obtain help.

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at

[https://www.uwo.ca/health/student\\_support/survivor\\_support/get-help.html](https://www.uwo.ca/health/student_support/survivor_support/get-help.html).

To connect with a case manager or set up an appointment, please contact [support@uwo.ca](mailto:support@uwo.ca).

Learning-skills counsellors at the Student Development Centre (<https://learning.uwo.ca>) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Western University is committed to a thriving campus as we deliver our courses in the mixed model of both virtual and face-to-face formats. We encourage you to check out the Digital Student Experience website to manage your academics and well-being: <https://www.uwo.ca/se/digital/>.

Additional student-run support services are offered by the USC, <https://westernusc.ca/services/>.