



COURSE OUTLINE

1. **Course:** PHYS 543, Quantum Mechanics II - Fall 2023

Lecture 01 : MWF 10:00 - 10:50 in ST 130

Instructor	Email	Phone	Office	Hours
Dr. Shabir Barzanjeh	shabir.barzanjeh@ucalgary.ca	403 589-6606	SB 507	Thursday 3-4pm

To account for any necessary transition to remote learning for the current semester, courses with in-person lectures, labs, or tutorials may be shifted to remote delivery for a certain period of time. In addition, adjustments may be made to the modality and format of assessments and deadlines, as well as to other course components and/or requirements, so that all coursework tasks are in line with the necessary and evolving health precautions for all involved (students and staff).

In Person Delivery Details:

This course has three scheduled class sessions per week. The classes on Wednesday and Friday will be primarily focused on delivering lectures, whereas the Monday class typically will be dedicated to various activities, including reviewing homework, class activities, discussing the term project, holding office hours, and conducting the midterm exam as per the provided schedule.

Course Site:

D2L: PHYS 543 L01-(Fall 2023)-Quantum Mechanics II

Note: Students must use their U of C account for all course correspondence.

Equity Diversity & Inclusion:

The University of Calgary is committed to creating an equitable, diverse and inclusive campus, and condemns harm and discrimination of any form. We value all persons regardless of their race, gender, ethnicity, age, LGBTQIA2S+ identity and expression, disability, religion, spirituality, and socioeconomic status. The Faculty of Science strives to extend these values in every aspect of our courses, research, and teachings to better promote academic excellence and foster belonging for all.

The Physics and Astronomy EDI Committee acknowledges there are persistent barriers that prevent such accessibility and hinder our progress towards EDI. Our representatives (faculty, postdocs, graduate and undergraduate students) are committed to addressing any concerns and work towards proactive solutions that enact necessary change within the department. To submit anonymous questions, comments or concerns regarding EDI related issues, please reach out to our Associate Head EDI, Claudia Gomes da Rocha (claudia.gomesdarocho@ucalgary.ca)

2. **Requisites:**

See section [3.5.C](#) in the Faculty of Science section of the online Calendar.

Prerequisite(s):

Physics 443.

3. **Grading:**

The University policy on grading and related matters is described in [F.1](#) and [F.2](#) of the online University Calendar.

In determining the overall grade in the course the following weights will be used:

Course Component	Weight	Due Date (duration for exams)	Modality for exams	Location for exams
Assignments and in class activities (4) ¹	30%	Ongoing		
Term project	20%	Ongoing		
Midterm	20%	OCT 30, 2023 at 10:00 am (2 Hours)	in-person	Will be announced
Registrar Scheduled Final Exam	30%	Will be available when the final exam schedule is released by the Registrar	in person	Will be available when the final exam schedule is released by the Registrar

¹ A total of four assignments will be given. On every Monday, we will collaboratively tackle problems, constituting the class activities.

Each piece of work (reports, assignments, quizzes, midterm exam(s) or final examination) submitted by the student will be assigned a grade. The student's grade for each component listed above will be combined with the indicated weights to produce an overall percentage for the course, which will be used to determine the course letter grade.

The conversion between a percentage grade and letter grade is as follows.

	A+	A	A-	B+	B	B-	C+	C	C-	D+	D
Minimum % Required	95 %	90 %	85 %	80%	75%	70 %	65 %	60%	55%	50 %	45 %

This course will have a Registrar Scheduled Final exam that will be delivered in-person and on campus. [The Final Examination Schedule](#) will be published by the Registrar's Office approximately one month after the start of the term. The final exam for this course will be designed to be completed within 2 hours.

Homework:

Homework should be submitted in accordance with the schedule, which typically follows roughly a bi-weekly pattern. The schedule adjustments, if any, will be communicated on the course website at least one week in advance. All homework submissions must be made through the course website's Dropbox feature on D2L. There won't be any homework assignments during the first week of classes, reading week, midterm week, or final exam week. If homework is turned in after the due date without prior arrangement with the instructor, there will be a deduction of 25% from the score if submitted within 24 hours of the due date, and a deduction of 50% if submitted before the graded homework has been returned.

Term Project:

The term project entails simulating a scientific conference in which participants will deliver presentations that cover scientific research articles. These presentations are scheduled for the final week(s) of the term in the form of a semi-conference. This conference will include both poster presentations and a limited number of talks. The decision of whether a participant presents a talk or a poster will be based on their preference, indicated in the conference registration form, and the evaluation of the abstract by the Program and Selection Committee (outlined below). The conference attendees can be either individual students or teams of two or more.

The term project presentations are required. Students are encouraged to propose research papers, subject to approval by the instructor. A compilation of suitable papers will be made available on D2L at the beginning of the term.

Aside from giving presentations, all students will participate in one of two committees, each comprising half of the class. The "Program & Selection Committee" will assess and rate the submitted abstracts, using these evaluations to designate presentations as talks or poster presentations. The "Awards Committee" will appraise and score both talks and poster presentations, ultimately determining the most outstanding talk and poster presentation, both of which will receive awards.

Furthermore, there is a possibility of hosting a guest speaker from the quantum industry who will discuss the quantum landscape in Canada. If we are able to confirm the speaker, the date for this event will be communicated prior to the term break.

The University of Calgary offers a [flexible grade option](#), Credit Granted (CG) to support student's breadth of learning and student wellness. Faculty units may have additional requirements or restrictions for the use of the CG grade at the faculty, degree or program level. To see the full list of Faculty of Science courses where CG is not eligible, please visit the following website: <https://science.ucalgary.ca/current-students/undergraduate/program-advising/flexible-grading-option-cg-grade>

4. Missed Components Of Term Work:

In the event that a student legitimately fails to submit any online or in-person assessment on time (e.g. due to illness, domestic affliction, etc...), please contact the course coordinator, or the course instructor if this course does not have a coordinator to arrange for a re-adjustment of a submission date, or possible exemption and reweighing of components. Absences not reported within 48 hours will not be accommodated. Students may be asked to provide supporting documentation ([Section M.1](#)) for an excused absence, See [FAQ](#).

If an excused absence is approved, options for how the missed assessment is dealt with is at the discretion of the coordinator or course instructor. Some options such as an exemption and pro-rating among the components of the course may not be a viable option based on the design of this course.

5. **Scheduled Out-of-Class Activities:**

There are no scheduled out of class activities for this course.

6. **Course Materials:**

Required Textbook(s):

David J. Griffiths and Darrell F. Schroeter, *Introduction to Quantum Mechanics*: 3rd Edition: Cambridge University Press.

In order to successfully engage in their learning experiences at the University of Calgary, students taking online, remote and blended courses are required to have reliable access to the following technology:

- A computer with a supported operating system, as well as the latest security, and malware updates;
- A current and updated web browser;
- Webcam/Camera (built-in or external);
- Microphone and speaker (built-in or external), or headset with microphone;
- Current antivirus and/or firewall software enabled;
- Stable internet connection.

For more information please refer to the UofC [ELearning](#) online website.

7. **Examination Policy:**

No aids are allowed on tests or examinations.

Students should also read the Calendar, [Section G](#), on Examinations.

8. **Approved Mandatory And Optional Course Supplemental Fees:**

There are no mandatory or optional course supplemental fees for this course.

9. **Writing Across The Curriculum Statement:**

For all components of the course, in any written work, the quality of the student's writing (language, spelling, grammar, presentation etc.) can be a factor in the evaluation of the work. See also Section [E.2](#) of the University Calendar.

10. **Human Studies Statement:**

Students will not participate as subjects or researchers in human studies.

See also [Section E.5](#) of the University Calendar.

11. **Reappraisal Of Grades:**

A student wishing a reappraisal, should first attempt to review the graded work with the Course coordinator/instructor or department offering the course. Students with sufficient academic grounds may request a reappraisal. Non-academic grounds are not relevant for grade reappraisals. Students should be aware that the grade being reappraised may be raised, lowered or remain the same. See [Section I.3](#) of the University Calendar.

- a. **Term Work:** The student should present their rationale as effectively and as fully as possible to the Course coordinator/instructor within **ten business days** of either being notified about the mark, or of the item's return to the class. If the student is not satisfied with the outcome, the student shall submit the Reappraisal of Graded Term work [form](#) to the department in which the course is offered within 2 business days of receiving the decision from the instructor. The Department will arrange for a reappraisal of the work within the next ten business days. The reappraisal will only be considered if the student provides a detailed rationale that outlines where and for what reason an error is suspected. See sections [I.1](#) and [I.2](#) of the University Calendar

- b. **Final Exam:**The student shall submit the request to Enrolment Services. See [Section I.3](#) of the University Calendar.

12. Other Important Information For Students:

- a. **Mental Health** The University of Calgary recognizes the pivotal role that student mental health plays in physical health, social connectedness and academic success, and aspires to create a caring and supportive campus community where individuals can freely talk about mental health and receive supports when needed. We encourage you to explore the mental health resources available throughout the university community, such as counselling, self-help resources, peer support or skills-building available through the SU Wellness Centre (Room 370, MacEwan Student Centre, [Mental Health Services Website](#)) and the Campus Mental Health Strategy website ([Mental Health](#)).
- b. **SU Wellness Services:** For more information, see their [website](#) or call [403-210-9355](#).
- c. **Sexual Violence:** The Sexual Violence Support Advocate, Carla Bertsch, can provide confidential support and information regarding sexual violence to all members of the university community. Carla can be reached by email (svsa@ucalgary.ca) or phone at [403-220-2208](#). The complete University of Calgary policy on sexual violence can be viewed [here](#).
- d. **Student Ombuds Office:** A safe place for all students of the University of Calgary to discuss student related issues, interpersonal conflict, academic and non-academic concerns, and many other problems.
- e. **Student Union Information:** [SU contact](#), Email your SU Science Reps: science1@su.ucalgary.ca, science2@su.ucalgary.ca, science3@su.ucalgary.ca,
- f. **Academic Accommodation Policy:**

It is the student's responsibility to request academic accommodations according to the University policies and procedures listed below. The student accommodation policy can be found at: <https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Student-Accommodation-Policy.pdf>

Students needing an accommodation because of a disability or medical condition should communicate this need to Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities: <https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Accommodation-for-Students-with-Disabilities-Procedure.pdf>.

Students needing an accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, by filling out the [Request for Academic Accommodation Form](#) and sending it to Dr. David Feder by email phas.ahugrd@ucalgary.ca preferably 10 business days before the due date of an assessment or scheduled absence.

- g. **Misconduct:** Academic integrity is the foundation of the development and acquisition of knowledge and is based on values of honesty, trust, responsibility, and respect. We expect members of our community to act with integrity. Research integrity, ethics, and principles of conduct are key to academic integrity. Members of our campus community are required to abide by our institutional [Code of Conduct](#) and promote academic integrity in upholding the University of Calgary's reputation of excellence. Some examples of academic misconduct include but are not limited to: posting course material to online platforms or file sharing without the course instructor's consent; submitting or presenting work as if it were the student's own work; submitting or presenting work in one course which has also been submitted in another course without the instructor's permission; borrowing experimental values from others without the instructor's approval; falsification/fabrication of experimental values in a report. Please read the following to inform yourself more on academic integrity:

[Student Handbook on Academic Integrity](#)
[Student Academic Misconduct Policy and Procedure](#)
[Faculty of Science Academic Misconduct Process](#)
[Research Integrity Policy](#)

Additional information is available on the [Student Success Centre Academic Integrity page](#)

- h. **Copyright of Course Materials:** All course materials (including those posted on the course D2L site, a course website, or used in any teaching activity such as (but not limited to) examinations, quizzes, assignments, laboratory manuals, lecture slides or lecture materials and other course notes) are protected by law. These materials are for the sole use of students registered in this course and must not be redistributed. Sharing these materials with anyone else would be a breach of the terms and conditions governing student access to D2L, as well as a violation of the copyright in these materials, and may be pursued as a case of

student academic or [non-academic misconduct](#), in addition to any other remedies available at law.

- i. **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). Students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information, see [Legal Services](#) website.
- j. **Surveys:** At the University of Calgary, feedback through the Universal Student Ratings of Instruction ([USRI](#)) survey and the Faculty of Science Teaching Feedback form provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses. Your responses make a difference - please participate in these surveys.

Course Materials:

The schedule is an approximation and might be subject to adjustments based on the pace of progress and received feedback.

Lecture components:

Week 1:

Review of the basic materials and mathematical background

Week 2:

Perturbation theory (non-degenerate and degenerate) – Chapter 7.1-2

Week 3:

Fine structure and hyperfine splitting – Chapter 7.3- 5

Week 4:

Variational principle and application to molecules – Chapter 8.1-3

Week 5:

The Hydrogen Molecule – Chapter 8.4

Week 6:

WKB approximation – Chapter 9.1-2

Week 7:

Scattering – Chapter 10.1-4 and notes

Week 8:

Time-dependent perturbation theory – Chapter 11.1

Interaction with E.M. waves – Chapter 11.2

Week 9:

incoherent EM interaction and Einstein A and B coefficients – Chapter 11.3

Fermi's golden rule and adiabatic approximation – Chapter 11.4

Week 10: Term-break

Week 11:

Quantum Theory of Quantization I – Lecture notes

Week 12:

Quantum Theory of Quantization II – Lecture notes

Week 13:

Nonclassical Radiation (if time allows)- Lecture notes

Nov27, Nov29, Dec1, Dec 4: Project presentation/Conference, lab tours.

Course Incomes: Proficiency in solving differential equations and conducting fundamental matrix/vector operations is required. A grasp of eigenvectors and eigenvalues is essential. You should be at ease manipulating complex numbers, including complex exponentials. Familiarity with the foundational principles of modern physics is expected, encompassing topics such as atoms, photons, electrons, Coulomb's Law, electric potential, and other electromagnetism concepts. An understanding of wavefunctions, the Schrödinger equation, Dirac notation, and Hilbert space is also necessary.

Course Outcomes:

- Use various perturbation and approximation approaches in quantum mechanics to explain and derive a number of phenomena, e.g. fine and hyperfine structure of atoms and Zeeman splitting.
- Apply scattering theory and understand its consequences under a range of experimental conditions
- Have a broad understanding of the interaction between electromagnetic radiation and atomic quantum systems and be able to address a number of practical applications.
- Address qualitatively and quantitatively how quantum mechanics relates to a number of common technologies and phenomena.

Electronically Approved - Aug 28 2023 17:02

Department Approval