Quantum Mechanics I

PHY C56 - Winter 2013

Lecture	Wednesday	10:00 am - 12:00 pm	MW 223
Tutorial	Tuesday	10:00 am - 12:00 pm	AC 334

"The more I ponder the physical part of Schrödinger's theory, the more disgusting it appears to me."
– Heisenberg commenting on Schrödinger's *Wave Mechanics*

"If one has to stick to this damned quantum jumping, then I regret ever having been involved in this thing."
– Schrödinger commenting on Heinsenberg's *Matrix Mechanics*

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Course Website: portal.utoronto.ca

Office Hours

Monday, Thursday, Friday	11:30 am - 1:30 pm	3:30 pm - 4:30 pm
Tuesday, Wednesday	3:30 pm - 5:30 pm	
or by Appointment (call or email to schedule)		

Course Description

The course will start with a review of key ideas from linear algebra. Using the mathematical tools learned up to this point we will continue by developing the formalism of quantum mechanics in the form of Hilbert spaces and the Dirac notation; observables and the statistical interpretation; and the uncertainty principle. We will then apply this formalism to solve the problem of the hydrogen atom, to extend the classical angular momentum into quantum mechanics, and to introduce the concept of spin. Time permitting, we will study two-particle systems; fermions and bosons; and atomic structure.

By the end of the course you will be able to:

- Identify and define the formal mathematical structure of Quantum Mechanics.
- Apply the fundamental laws and principles of Quantum Mechanics to describe and solve problems of observables with discrete and continuous spectra.
- Analyze the solutions to quantum mechanical problems within the statistical paradigm.
- Explain and illustrate how Quantum Mechanics describes the structure of the hydrogen atom, the spectra of measurements of angular momentum, and the notion of quantum mechanical spin.

Math Prerequisites: Algebra I (MATA23); Vector Calculus II (MATB42); Diff. Equations I (MATB44)
Physics Prerequisites: Intro. to Quantum Physics (PHYB56); Electricity and Magnetism (PHYB21)

Required Materials

- **Textbook:** ***Introduction to Quantum Mechanics*** by David J. Griffiths (Pearson, 2nd Ed.)

ISBN# 9780131118928; U of T Bookstore SKU# 10878835

Use the textbook and the class schedule at the end of this document to prepare **before** each lecture and to work on the questions and exercises that will be the basis of the problem sets and tutorial quizzes.

- **Calculator:** A scientific non-programmable calculator is required.

Grading Scheme

Component	Points	Due Date
Tutorial Work	15	Ongoing (Weekly Tutorials)
Test #1	20	Week 5
Test #2	20	Week 9
Final Examination	45	Exam Period (April 15 - 30)

Grade Components

Tutorial Work (15%)
During our tutorial sessions we will work on your questions and queries regarding the assigned problem sets posted on the course website. We will also work on any difficult points you may have encountered while reviewing the textbook and lecture materials. The assessment of your work will be a combination of tutorial quizzes, group work, blackboard problems, electronic homework, and take-home questions.

Test #1 (20%)
This test will be scheduled during **Week 5**. Content for the test includes all lecture discussions, textbook readings, and problem sets up to and including the material assigned for Wednesday, January 30.

Test #2 (20%)
This test will be scheduled during **Week 9**. Content for the test includes all lecture discussions, textbook readings, and problem sets up to and including the material assigned for Wednesday, March 06.

Both tests will be **90 minutes** long and the format includes conceptual multiple-choice and short answer questions as well as detailed problems. The only aids allowed are your non-programmable scientific calculator, and **one** hand-written, double-sided, and letter-sized equation sheet. Please note that photocopies or computer printouts are not allowed.

Final Examination (45%)
The final examination will be scheduled during the exam period of **April 15 - 30**. Content for the final examination includes all the topics discussed in the assigned textbook readings, lecture presentations, problem sets, and tutorial quizzes. The final examination will be **3 hours** long and the format includes conceptual multiple-choice and short answer questions as well as detailed problems. The only aids allowed are your non-programmable scientific calculator, and **one** hand-written, double-sided, and letter-sized equation sheet. Please note that photocopies or computer printouts are not allowed.

Class Policies and Course Support

In-class Conduct

- Please turn **off** all cellphones, laptop computers, and tablets when you come into the class.
- Class starts at 1:10 pm and ends at 3:00 pm. Late arrival or early departure is inappropriate and disrespectful to your instructor and your peers.
- Do not bring and consume food in the classroom as this creates unwanted distractions that will negatively affect the learning environment.
- Regarding anything that you might want to use in the classroom: if you are not using it to perform a task specifically related to what we are doing in class at that very moment, please put it away.

Absences
In the case of a problem that supports an absence to a tutorial session your grade will be calculated on the basis of all other tutorial work. In the case of a problem that supports an absence to the first test your second test will have its weight increased to **40%**. In the case of a problem that supports an absence to the second test your final exam will have its weight increased to **65%**. Valid and official supporting documentation must be submitted within **five (5)** business days of the missed tutorial or test.

Name and Student Number
Any work you hand in for credit must clearly indicate your name and student number. Any work you submit that fails to meet this requirement will be penalized with a 10% deduction provided we are able to identify the work as yours. If we are unable to identify the work as yours, no grade will be awarded.

e-mail
If you want to ask a question via e-mail, please first check the electronic forums in the **Discussion Board** of the course website. Quite likely, you are not the only person with that same question, and if that question has already been asked, you will find the answer there. If the question has not been asked, go ahead and post it yourself instead of sending it by e-mail. This way you will also help other students facing the same issue. The forums in the discussion board are monitored regularly by the course instructor and your peers, making it the best way of communicating for various queries of diverse nature.

However, if the electronic forums are not the best place for your query, make sure you send your e-mail from an official **utoronto.ca** address (e.g., your UTmail+ account), as all other addresses will be filtered out automatically. Furthermore, include the code **PHYC56** somewhere in the subject line of your message, to ensure a quicker response time. I reply to e-mails within a period of 24 hours and I rarely reply to e-mails during weekends.

Academic Integrity and Respect for the Academic Endeavor
Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's *Code of Behaviour on Academic Matters:*

http://www.governingcouncil.utoronto.ca/policies/behaveac.htm

outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

- In papers and assignments: Using someone else's ideas or words without appropriate acknowledgment; submitting your own work in more than one course without the permission of the instructor; making up sources or facts; obtaining or providing unauthorized assistance on any assignment.
- On tests and exams: Using or possessing unauthorized aids; looking at someone else's answers during an exam or test; misrepresenting your identity.
- In academic work: Falsifying institutional documents or grades; falsifying or altering any documentation required by the University, including (but not limited to) doctor's notes.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the *Code of Behaviour on Academic Matters.* If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see http://www.utoronto.ca/academicintegrity/resourcesforstudents.html).

Access*Ability*

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or the Access*Ability* Services Office as soon as possible. I will work with you and Access*Ability* Services to ensure you can achieve your learning goals in this course. Enquiries are confidential. The UTSC Access*Ability* Services staff (located in SW302) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations (416) 287-7560 or ability@utsc.utoronto.ca

Class Schedule

This schedule is ***tentative*** and might change during the term in order to accommodate for variations in the lectures in response to performance and feedback from the students. Some topics might be removed and others added to adjust for variations in the background of the class. Announcements will be made whenever needed.

Please note that it is your responsibility to read the assigned sections and chapters **before** each lecture.

During the lectures we will concentrate on the most important and difficult aspects of the theories and concepts from your textbook readings. Therefore, failing to complete the textbook readings before each lecture will negatively affect your ability to understand and participate in the class discussions.

Dates	**Tuesday Tutorial** 10am - 12pm	**Wednesday Lecture** 10am - 12pm
Jan. 08 Jan. 09	**Vectors and Matrices** Appendix: 1 - 3	**Eigenvectors and Eigenvalues** Appendix: 4 - 6
Jan. 15 Jan. 16	**Problem Set # 01** Tutorial #01	**Hilbert Space and Observables** Chapter 3: 1 - 2
Jan. 22 Jan. 23	**Problem Set # 02** Tutorial #02	**Eigenfunctions and Operators** Chapter 3: 3 - 4
Jan. 29 Jan. 30	**Problem Set # 03** Tutorial #03	**The Uncertainty Principle** Chapter 3: 5
Feb. 05 Feb. 06	**Problem Set # 04** Tutorial #04	**Dirac Notation / Quantum Oscillator** Chapter 3: 6 / Chapter 2: 3
Feb. 12 Feb. 13	**Problem Set # 05** Tutorial #05	**Spherical Schrödinger Equation** Chapter 4: 1
Feb. 19 Feb. 20	**Problem Set # 06** Tutorial #06 (Electronic Homework)	**Reading Week** **Reading Week**
Feb. 26 Feb. 27	**Problem Set # 07** Tutorial #07	**The Hydrogen Atom** Chapter 4: 2
Mar. 05 Mar. 06	**Problem Set # 08** Tutorial #08	**Angular Momentum** Chapter 4: 3
Mar. 12 Mar. 13	**Problem Set # 09** Tutorial #09	**Spin - Part I** Chapter 4: 4
Mar. 19 Mar. 20	**Problem Set # 10** Tutorial #10	**Spin - Part II** Chapter 4: 4
Mar. 26 Mar. 27	**Problem Set # 11** Tutorial #11	**Two-Particle Systems** Chapter 5: 1
Apr. 02 Apr. 03	**Problem Set # 12** Tutorial #12	**Atoms** Chapter 5: 2