Introduction to Quantum Physics

PHY B56 - Fall 2013

Lecture	Tuesday	10:00 am - 12:00 pm	MW 262
Tutorial	Thursday	10:00 am - 12:00 pm	MW 262

"I think I can safely say that nobody understands quantum mechanics"

– Richard Feynman

"If you are not confused by quantum physics then you haven't really understood it"

– Niehls Bohr

"There is no general consensus as to what its fundamental principles are, how it should be taught, or what it really "means". Every competent physicist can "do" quantum mechanics, but the stories we tell ourselves about what we are doing are as various as the tales of Scheherazade, and almost as implausible."

– David Griffiths

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Course Website: portal.utoronto.ca

Office Hours

Monday (Virtual)	9:30 am - 11:30 am	2:30 pm - 4:30 pm
Tuesday and Thursday	12:30 pm - 2:30 pm	5:30 pm - 6:30 pm
Wednesday	11:30 am - 1:30 pm	2:30 pm - 4:30 pm
Friday (Virtual)	9:30 am - 11:30 am	

Course Description

We will start the course with an introduction to the experimental basis of Quantum Mechanics and the properties of the wave function. Schrödinger's equation will be introduced with some applications in one dimension. Topics will include square potential wells, the quantum harmonic oscillator, uncertainty principles, delta potential, scattering, and tunnelling.

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

- Identify and define the basic vocabulary used in Quantum Physics.
- Recognize the experimental evidence that led to the revision of Classical Physics.
- Illustrate conceptually and with experimental examples, the main differences between the quantum paradigm and the classical paradigm.
- Apply the fundamental ideas of Quantum Mechanics to simple one-dimensional models.
- Continue the development and application of the mathematical tools useful in the study of Physics.

Corequisite: Techniques of the Calculus of Several Variables I (MATB41)
Pre-Requisites: Introduction to Physics IIA (PHYA21); Calculus II (MATA36/MATA37)

Required Materials

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

ISBN# 0131118927; U of T Bookstore SKU# 10878835

The schedule provided at the end of this document indicates the chapters and sections you must read **before** each lecture. The textbook also provides the conceptual questions and detailed problems that will be the subject of the weekly problem sets, reading quizzes, and tutorial quizzes.

- **Textbook:** ***Quantum Mechanics*** by Robert Scherrer (Pearson, 1st Ed.)

Handouts on the **Origins of Quantum Mechanics** and **Complex Numbers** will be provided.

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

Grading Scheme

Component	Points	Due Date
Reading Quizzes	5	Ongoing (Pre-Lecture)
Tutorial Work	10	Ongoing (Weekly Tutorials)
Reading Project	20	Weeks 3, 6, 10, 11-12
Test #1	15	Week 5
Test #2	15	Week 9
Final Examination	35	Exam Period (December 06 - 20)

Grade Components

Reading Quizzes (5%)
Each week on the course website you will be asked a set of questions from the assigned readings for the upcoming week. You will have until **11:55 pm** on Monday to submit your answers. Each quiz is worth **5 points**, and your final grade is the total sum of all quizzes up to a maximum of **50 points**. Use the **Class Schedule** found at the end of this document to prepare for the lectures and reading quizzes.

Tutorial Work (10%)
During the tutorials we will discuss the most important points in the problem sets as well as difficult points you may have encountered in your readings. Please note that the problem sets will not be collected or graded and it is your responsibility to make sure you understand the discussions presented in these problems. The assessment of your work will be a combination of tutorial quizzes, group work, blackboard problems, electronic homework, and take-home questions.

Reading Project (20%)
Students will work in pairs on a topic that is an extension or application of one of the course subjects. The topic will be stated in the form of a **pre-proposal** submitted no later than the start of **Week 3**. Failing to submit an adequate pre-proposal by the deadline will result in a deduction of **2 points** to the grade of the project. By the start of **Week 6** each pair will submit a **proposal** worth **5 points**. The proposal will include title, abstract, and annotated bibliography with a minimum of one peer-reviewed primary source. The **report** paper on the selected topic is due at the start of **Week 10** and will be worth **10 points**. The report should be 10-12 double-spaced pages in length, not counting cover page, major illustrations, or references. A **presentation** worth **5 points** summarizing the material in the report will be prepared by each pair and delivered during **Weeks 11** and **12**. Each pair will have **35 minutes** to report on their topic and take up questions from the rest of the class.

Test #1 (15%)
Our first test will be tentatively scheduled during **Week 5**. This test includes all materials discussed up to and including the tutorial session of Thursday, September 26.

Test #2 (15%)
Our second test will be tentatively scheduled during **Week 9**. This test includes all materials discussed up to and including the tutorial session of Thursday, October 31.

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

Final Examination (35%)
The final examination will be scheduled during the exam period of **December 06 - 20**. Material for the final examination will include all the topics discussed in the assigned textbook readings, lecture presentations, problem sets, tutorial quizzes, and student presentations. The final examination will be **3 hours** long and the format includes conceptual questions in multiple-choice or short-answer format and detailed problems. The only aids allowed are your non-programmable scientific calculator, and a hand-written, double-sided, and letter-sized aid sheet. Please note that photocopies or computer printouts are not allowed.

Class Policies

Absences
There will be no makeup options for tutorial work or the tests. In the case of a **valid** and **documented** problem that supports an absence to a tutorial, the grade will be calculated on the basis of all other work. In the case of a **valid** and **documented** problem that supports an absence to the first test, the second test will have its weight increased accordingly. In the case of a **valid** and **documented** problem that supports an absence to the second test, the final examination will have its weight increased accordingly.

Name and Student Number
Any work you hand in must clearly indicate your name and student number, this includes tutorial quizzes, materials for the reading project, tests, and the final exam. 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, a grade of zero 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 a 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 **PHYB56** 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.

In-class Conduct

- Please turn **off** all cellphones, laptop computers, and tablets when you come into the class.
- Lectures and tutorials start at 10:10 am and end at 12:00 pm. Late arrival or early departure from class is inappropriate and disruptive so please be considerate.
- Do not bring or 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.

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).

Course Support

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

Discussion Board

The course website supports electronic forums useful for questions and discussions on course content, conceptual problems, textbook readings, as well as any issues relating to administrative details of the course such as deadlines, future topics, and scheduling.

Class Schedule

This schedule is ***tentative*** and might change during the term in order to accommodate for variations in the lectures in response to student performance and understanding of the various topics.

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

The lecture discussions will **not** be a direct repetition of the basic material found in the textbook.

During the lectures we will concentrate on important and difficult aspects of the theories and concepts from your textbook readings.

Failing to complete the textbook readings before each lecture will significantly affect your ability to understand the class discussions.

Dates	**Tuesday Lecture** 10am - 12pm	**Thursday Tutorial** 10am - 12pm
Sep. 03	**Blackbody Radiation and Light**	**Matter Waves and Bohr's Atom**
Sep. 05	**Scherrer** Ch.1: 1 - 3	**Scherrer** Ch.1: 4 - 6
Sep. 10	**Schrödinger's Equation**	**Problem Set #01**
Sep. 12	**Griffiths** Ch.1: 1 - 4	Tutorial #01
Sep. 17	**Wave Functions and Uncertainty**	**Problem Set #02**
Sep. 19	**Griffiths** Ch.1: 5 - 6	Tutorial #02
Sep. 24	**Stationary States**	**Problem Set #03**
Sep. 26	**Griffiths** Ch.2: 1	Tutorial #03
Oct. 01	**The Particle in a Box**	**Problem Set #04**
Oct. 03	**Griffiths** Ch.2: 2	Tutorial #04
Oct. 08	**The Free Particle and Momentum**	**Problem Set #05**
Oct. 10	**Griffiths** Ch.2: 4	Tutorial #05
Oct. 15	**Reading Week**	**Problem Set #06**
Oct. 17	**Reading Week**	Tutorial #06 (Electronic Homework)
Oct. 22	**Delta Potential and Scattering**	**Problem Set #07**
Oct. 24	**Griffiths** Ch.2: 5	Tutorial #07
Oct. 29	**The Finite Square Well**	**Problem Set #08**
Oct. 31	**Griffiths** Ch.2: 6	Tutorial #08
Nov. 05	**Quantum Harmonic Oscillator I**	**Problem Set #09**
Nov. 07	**Griffiths** Ch.2: 3	Tutorial #09
Nov. 12	**Quantum Harmonic Oscillator II**	**Problem Set #10**
Nov. 14	**Griffiths** Ch.2: 3	Tutorial #10
Nov. 19	**Student Presentations**	**Problem Set #11**
Nov. 21	**Groups:** 1, 2, 3	Tutorial #11
Nov. 26	**Student Presentations**	**Student Presentations**
Nov. 28	**Groups:** 4, 5, 6	**Groups:** 7, 8, 9