Introduction to Quantum Physics

PHY B56 - Fall 2018

Lecture	Tuesday	09:00 am - 11:00 am	BV 264
Tutorial	Wednesday	03:00 pm - 05:00 pm	HW 215

"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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Phone Number: 416-287-7327 **Course Website:** q.utoronto.ca

Office Hours

Tuesday	5:15 pm - 6:15 pm	
Wednesday	9:30 am - 11:30 am	5:15 pm - 6:15 pm
Thursday	9:30 am - 11:30 am	12:30 pm - 2:30 pm

Course Description and Requirements

We will start the course with a brief introduction to the experimental basis of Quantum Mechanics and the properties of the wave function. Schrödinger's equation will then be studied with some applications in one dimension. Further topics will include square potential wells, the quantum harmonic oscillator, uncertainty principles, delta potential, scattering, and tunneling.

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 and classical paradigms.
- Apply the basic ideas of Quantum Mechanics to the study and analysis of one-dimensional models.
- Develop individual and group problem solving strategies, and implement these strategies to the study and solution of examples and questions involving the one-dimensional Schrödinger equation.
- Continue building a mathematical toolbox connected to quantitative and analytical skills that are useful to the scientist in general, and to the physicist in particular.

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 (Cambridge, 2nd Ed.)

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 work. Note that the 2nd Edition by Cambridge, 2016 is identical to the 2nd Edition by Pearson, 2005.

- **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	%	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 (Tentative)
Test #2	15	Week 9 (Tentative)
Final Examination	35	Exam Period (December 07 - 22)

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 any difficulties you may have encountered in your readings. Please note that the problem sets will not be collected or graded; it is your responsibility to make sure you understand the discussions presented in these problems. The assessment of your tutorial work will be a combination of tutorial quizzes, group work, blackboard problems, electronic homework, and take-home questions.

Test #1 (15%)
This **90-minute** long test will be scheduled during **Week 5**. Content includes all lecture discussions, textbook readings, and problem sets up to and including the material assigned and discussed in Week 4.

Test #2 (15%)
This **2-hour** long test will be scheduled during **Week 9**. Content includes all lecture discussions, textbook readings, and problem sets up to and including the material assigned and discussed in Week 8.

Both tests will include 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 that may not include explicit problem solutions. Photocopies or computer printouts are not allowed.

Reading Project (20%)
Throughout the term students will work in groups on a topic that is an extension or application of one of the course subjects. There are four stages in the work your group will complete in this reading project:

- **Pre-Proposal:** Your group must select and inform the course instructor of the idea for the topic of your reading project. Should the idea be appropriate for the course the topic will be approved, otherwise you will receive feedback on how to adjust it. You must have your topic selected and approved no later than the end of the office hours on **Wednesday, September 19**. Failure to meet this deadline will result in a deduction of **2 points** to the final grade of the project.
- **Proposal (5%):** Each group must submit a proposal for the project no later than **11:55 pm** on **Wednesday, October 17**. The proposal must include the title of the paper, a brief abstract or an outline describing the topic, and an annotated bibliography with a minimum of one peer-reviewed primary source. The penalty for late submission of the proposal is 10% per day of lateness.
- **Report (10%):** The final report must be 10-12 letter-sized pages in length, double-spaced with standard 12 point fonts and 2.5 cm margins on all sides. The report must be submitted electronically to **turnitin.com** no later than **11:55 pm** on **Tuesday, November 13**. A hard-copy version of the report must be handed in during the tutorial session of **Wednesday, November 14**. The penalty for late submission of the report is 10% per day of lateness.
- **Presentation (5%):** A **20-minute** long presentation that summarizes the material in the report will be prepared by each group and will be delivered to the whole class during **Weeks 11** and **12**.

More information on the reading project can be found on the course website.

Normally, students will be required to submit their course essays to Turnitin.com for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the Turnitin.com reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com web site.

Final Examination (35%)
The final examination will be scheduled during the exam period of **December 07 - 22**. Content for the final examination includes all the topics discussed in the assigned textbook readings, problem sets, and tutorial work. 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 a hand-written, double-sided, and letter-sized aid sheet that may not include explicit problem solutions. Photocopies or computer printouts are not allowed.

Class Policies

In-class Conduct

- Lectures and tutorials start 10 min past the hour and end on the hour. Late arrival or early departure from class is inappropriate and disruptive so please be considerate.
- Regarding anything that you 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, you must put it away. This includes but is not limited to cell phones, laptop computers, tablets, and other electronic devices.
- Do not bring or consume food in the classroom as this creates unwanted distractions that will negatively affect the learning environment. Be considerate to your peers.

Absences
In order to ensure fairness in the assessment of all students, 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. If the problem is health-related use the official form: http://www.utsc.utoronto.ca/∼registrar/resources/pdf_general/UTSCmedicalcertificate.pdf

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.

Email Communications
If you want to ask a question via email, please first check the various threads in the Discussions section 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 email. This way you will also help other students facing the same issue. These discussions 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 these electronic forums are not the best place for your query, make sure you send your email from an official **utoronto.ca** address (e.g., your UTmail+ account), as all other addresses will be filtered out automatically. For a quicker response time include the code **PHYB56** in the subject line of your message. I reply to emails within a period of 24 hours and I rarely reply to emails 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 https://www.utsc.utoronto.ca/vpdean/academic-integrity).

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

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** 9am - 11am	**Wednesday Tutorial** 3pm - 5pm
Sep. 04	**Light and Matter Waves**	**Bohr's Atom and Blackbody Radiation**
Sep. 05	**Scherrer** Ch.1: 1, 3, 4	**Scherrer** Ch.1: 5, 2, 6
Sep. 11	**Schrödinger's Equation**	**Problem Set #01**
Sep. 12	**Griffiths** Ch.1: 1 - 4	Tutorial #01
Sep. 18	**Wave Functions and Uncertainty**	**Problem Set #02**
Sep. 19	**Griffiths** Ch.1: 5 - 6	Tutorial #02
Sep. 25	**Stationary States**	**Problem Set #03**
Sep. 26	**Griffiths** Ch.2: 1	Tutorial #03
Oct. 02	**The Particle in a Box**	**Problem Set #04**
Oct. 03	**Griffiths** Ch.2: 2	Tutorial #04
Oct. 09	**Reading Week**	**Problem Set #05**
Oct. 10	**Reading Week**	Reading Week eHomework
Oct. 16	**The Free Particle and Momentum**	**Problem Set #06**
Oct. 17	**Griffiths** Ch.2: 4	Tutorial #06
Oct. 23	**Delta Potential and Scattering**	**Problem Set #07**
Oct. 24	**Griffiths** Ch.2: 5	Tutorial #07
Oct. 30	**The Finite Square Well**	**Problem Set #08**
Oct. 31	**Griffiths** Ch.2: 6	Tutorial #08
Nov. 06	**Quantum Harmonic Oscillator I**	**Problem Set #09**
Nov. 07	**Griffiths** Ch.2: 3	Tutorial #09
Nov. 13	**Quantum Harmonic Oscillator II**	**Problem Set #10**
Nov. 14	**Griffiths** Ch.2: 3	Tutorial #10
Nov. 20	**Student Presentations**	**Problem Set #11**
Nov. 21	**Groups:** 1 - 5	Tutorial #11
Nov. 27	**Student Presentations**	**Student Presentations**
Nov. 28	**Groups:** 6 - 10	**Groups:** 11 - 15