PHYC50-2022: Quantum Mechanics I

Course Instructor:

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Course Meeting Times

Lectures: 2 hours / week & Tutorial: 1 hour / week

Two-hour lectures on Wednesday (Synchronous 10 to 12 on ZOOM) & the Tutorials are Asynchronous).

Office hours: Tuesday 13.00-14.00 and Thursday 11.00-12.00 or by appointment

Textbook and References

David McIntyre, "Quantum Mechanics: A Paradigms Approach", 1st Edition. Pearson, ISBN-13: 978-0321765796. or/and
D. J. Griffiths, "Introduction to Quantum Mechanics," 3rd Edition, (ISBN 0-13-111892-7)

References:

1. *J. S. Townsend, "A Modern Approach to Quantum Mechanics",*
2. *J. J. Sakurai and J. Napolitano, "Modern Quantum Mechanics",*
3. *R. Shankar, "Principles of Quantum Mechanics",*
4. *Cohen-Tannoudji, Claude. Quantum Mechanics. 2 vols. Wiley,*

In addition, there are many other textbooks on Quantum Physics, and I would advise students to look at as many as possible. They all deal with topics slightly different, and the approach might be different as well. An explanation that resonates with one person may not resonate with another, so the usefulness of reading about the same material presented in a variety of formats cannot be overstated.

Course Objectives

The primary objective of the course is for students to gain a working knowledge of Quantum Mechanics. We provide an introduction to modern quantum mechanics and techniques, which are applied to quantum systems that occur in nature, such as the hydrogen atom, molecules, and photons. Topics to be covered include:

- *General Structure of Quantum Mechanics*
- *Quantum Dynamics*
- *Two-state Systems*
- *Angular Momentum and Spin*
- *The Hydrogen Atom*
- *Addition of Angular Momentum*
- *Introduction to the Quantum Mechanics of Identical Particles*

By the end of the course, the students should be able to:

- Utilize the postulates of quantum mechanics to describe quantum systems and determine their properties, including the results of measurements.
- Use operator techniques to solve relevant problems.
- Analyze the time dependence of quantum systems using the different pictures.
- Use the properties of angular momentum and spin to describe quantum systems such as the hydrogen-like atoms, and an electron in a magnetic field
- How identical particles are treated in Quantum Mechanics.

Academic Expectations: Collaboration

Attendance and Participation is expected to be mandatory where students are encouraged to attend for both tutorials and lectures, which is very important to better understand the material covered.

Adhering to high standards of academic integrity is an important part of your undergraduate experience. The standards are obvious when it comes to exams. Collaboration, such as working with others to conceptualize a problem, define approaches to the solution, or debugging a computer code, is often a gray area, and faculty in different courses may have different approaches to this issue.

In this course, discussion is allowed if it is ***identified***. ***Plagiarism, such as copying someone else's solution or from other sources, such as Internet, is not allowed***. The write-ups must always be ***your own***. Modifying someone else's Assignment to make it your "own" is ***unacceptable***. In case of doubt, consult the course instructor.

If you choose to collaborate with other students on the homework problems, indicate their names and the nature of your joint work. Ensure that your collaborator does the same on his/her assignment. A useful discussion of these issues may be found at http://ctl.utsc.utoronto.ca/home/integrity.

E-Mail: I will only respond to e -mails sent from a recognized University of Toronto address. Please put PHYC56 in the subject line of any course-related e-mails. Will try to respond within 24 hours during Monday to Friday. ***I will not accept solutions to Assignments via e-mail.***

Technical Requirements for Remote and Online Learning:

Please review the Recommended Technology Requirements for Remote/Online Learning located on the following UofT webpage.
https://www.viceprovoststudents.utoronto.ca/covid-19/tech-requirements-online-learning/

Specifically for our course you will need a fast and reliable Internet connection. This is particularly important for all the scheduled synchronous course components, including practicals, tests, and the final exam. Use of a computer (laptop or desktop) instead of a mobile device (smartphone or tablet) will be critical during all electronic forms of assessment. Additionally, you should connect via wire (Ethernet) to your modem or router instead of using a wireless (WiFi) connection to ensure stability and reduce interference. Lastly, you will be required to produce scans of handwritten work in PDF format for your practicals, tests, and the final exam. This can be accomplished using a dedicated scanner or using the camera in your

smartphone after installing a document scanner app. More details and suggestions will be provided in the course website.

Submitting PDF files

Submitting your Assignments, or during tests & Exam you will need to submit your file in PDF format, and you need to follow the following format in naming the file. The completed file should be digitized using a scanner, a mobile phone or other photographic devices. **Make sure it is properly focused and readable.** Name the file in the format **lastname_initial_test-1.pdf**. For example, my full name is Tawfiq Salam, so the filename for test-1 should be ***Tawfiq_S_test-1.pdf***. Please submit your scripts as a **single file** in pdf format. To submit your answers, you could navigate to **Grades >> Test-1 >> Attach File >> Browse >> Save >> Submit Assignment**. Make sure that you can preview your submission afterwards, and whether the words are legible. Be sure to submit your work **before the deadline**, otherwise the work will be considered late and will not be accepted. Your TAs will be strict on this and will not accept any late or other non pdf format, i.e. you could get a ZERO. Please be diligent and prepare your weekly practical, Tests and Exam **single files in time, in pdf format and named properly.**

Assignments, Tests & Exam. (online)

- There will be two midterm Tests to be held according to the Registrar's schedule.
- There will be 5 to 6 problem sets during the semester with 5 to 6 problems in each Assignment and three chosen problems will be graded.
- We will work on problems during the tutorials every week.
- During the last two weeks (exam period, as set by Registrar's office) there will be a comprehensive final exam, which covers all the material.

Assignments, Tests & Exam Policy & Submission Checklist

1. Problem set Assignments (and tests) will be submitted by student online on Quercus within the due date posted. There will be a penalty of 50% after the first 10 minutes and a zero will be assigned after that. Please do not wait for last minute & submit your Assignments (Tests) before due date as technical submission problems might arise.
2. Name the submitted file (for Assignments, Tests & Exam) in the format described above, i.e.lastname_initial_HW-1.pdf (for example).
3. The instructor reserves the right to send the assignment paper(s) to **plagiarism detection tool (PDT).** in case there is significant overlap with publisher notes, books, or solutions posted on the Internet, it will be a violation of the University of Toronto academic code.
4. Homeworks are assigned about a week before due date. Therefore, to be fair with other students no excuses (including doctor notes) will be accepted for extension or not submitting the homework. So lutions will be posted right after the due date.
5. Each homework problem must be on a separate sheet of paper. If you need more than one sheet you should indicate this. The first page should be dedicated to the U of T honor pledge signed by the student, which is posted on Quercus.

6. You need to ***attempt*** all questions on the assignment though only 3 questions will be graded from each problem set. Missing any problem mean 20% deduction will be applied. Show the marker that you genuinely attempted to solve the problem; it is fine if it was not correct.
7. When collaborating, please be sure to write the name(s) of those you discuss with on the top of your homework, missing this could be considered an academic offence.

   Note that collaboration is not copying someone's answers after changing letters or sharing code files if you write a program. It is discussing concepts and asking questions to help clarify your own difficulties with the problem.

For all graded problems, in addition to any mathematical work, we expect clear written statements at each stage in the solution. Full marks will not be awarded without this. Another problem that sometimes arises is that of legibility. It takes a lot of time to grade problems for the marker. You will likely be more successful on your problem sets if you do what you can to not frustrate the marker. Please put some effort into ensuring that your work is clearly written.

In case some problem sets require the use of computers for visualizing a solution, which is very informative sometimes. Programming with Python, Mathematica (or MATLAB) is not an end but a means to investigate more complex phenomena using visual, analytic, and numerical methods. The code itself is not an adequate solution to the problem; you must interpret your results and answer the questions posed. You should approach the problem with the goal to understand and explain the physical phenomena investigated and the behavior of the system for variations of the parameters.

Grading: ***(Tentative and will be discussed with students)***

ACTIVITIES	PERCENTAGES
Problem sets	24%
Two Midterm tests	24% (12% each test)
Final exam	44%
End of term paper	8%
Note: There is ***No makeup tests in this course***, if you miss test-1, for acceptable documented reasons, then test-2 will worth 24%, however, if you miss test-2 your final exam worth 56%	

The tentative calendar below provides information about the Topics covered in this course. This schedule follows the textbook by ***David McIntyre***. However, you may use other books that cover the same topics.

CHAPTER #	TOPICS	
Chapter-1 & 2	Review of Quantum mechanics postulates & different types of formalism.	Week-1
Chapter-3	Bound & unbound states systems	Week-2
Chapter-9	Harmonic Oscillator	Week-3
Chapter-7	Angular Momentum	Week-4
Chapter-8	Hydrogen Atom	Week-5 & 6
Chapter-11	Hyperfine Structure & Addition of Angular momentum	Week-7 & 8
Chapters 1 & 2 + Chapter-5 Griffith's book	Spin & Identical Particles	Week-9 & 10
Chapter-12	Perturbation of Hydrogen Atom	Week-11

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and the Access*ibility* Services at UTSC as early as possible in the term. The Access*ibility* Services will determine reasonable accommodations for this course.

GOOD LUCK