

## **PHYB56F-2019: Introduction to Quantum Mechanics**

### **Course Instructor:**

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### **Course Meeting Times**

Lectures: 2 sessions / week with 1 hour / session

Tutorial: 1 sessions / week with 1 hour / session

Office hours: Monday 13.00-14.00 and Wednesday 13.00-14.00 or by appointment

### **Textbook and References**

**David McIntyre, “Quantum Mechanics: A Paradigms Approach”, 1st Edition.  
Pearson, ISBN-13: 978-0321765796.**

#### *References:*

1. J. S. Townsend, “A Modern Approach to Quantum Mechanics”, 2<sup>nd</sup> ed. ISBN 978-1-891389-78-8.
2. J. J. Sakurai and J. Napolitano, “Modern Quantum Mechanics”, 2<sup>nd</sup> ed. ISBN 10: 0-8053-8291-7
3. D. J. Griffiths, “Introduction to Quantum Mechanics,” 2nd Edition, (ISBN 0-13-111892-7)

The following two books will be useful to cover the first part about failure of Classical Physics.

4. Serway, et. Al., Modern Physics, 3<sup>rd</sup> ed., (Chapter-3).
5. Stephen T. Thornton and Andrew Rex, Modern Physics for Scientists and Engineers, 4th edition. (Chapter-1 & Section 3.5 and 3.6).

In addition, there are many other textbooks on Quantum Physics and I would advise students to take a look at as many as possible as they all deal with topics slightly differently. 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 course introduces the basic concepts of Quantum Physics and Quantum Mechanics starting with the experimental basis and the properties of the wave function. Schrödinger's equation will be introduced with some applications in one dimension. Topics include Stern-Gerlach effect; uncertainty principle; interference packets; scattering; tunnelling in one-dimension and harmonic oscillator.

#### **Overview of the course:**

- *Introduction: The failures of classical physics lead to the Quantum Mechanical way of thinking about nature at the microscopic level. We shall condense the essence of key empirical evidence stemming from the Stern-Gerlach experiment and from a gedanken electron-diffraction experiment which provide the simplest quantum mechanical system to study.*

- *The language of Quantum Mechanics (QM): Wave function, Dirac notation — bras, kets, operators, matrix elements, etc.*
- *The postulates of Quantum Mechanics: Probability amplitudes, probabilities, mean values, the measurement process, the “uncertainty principle, and time evolution of quantum systems.*
- *Spin 1/2 and other two-level systems are essential to understand the foundation of QM. The systems to be considered display the beauty and practical implications of Quantum Mechanics. This is achieved with a minimum of mathematical complications (Linear Algebra), which is a great advantage of the two-level systems).*
- *The harmonic oscillator in Quantum Mechanics, solved by operator techniques, represents an excellent application. Other applications will also be considered if time permits.*

*Elementary aspects of wave mechanics are assumed to be part of your background.*

### **Academic Expectations: Collaboration**

*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 debug code, is often a gray area, and faculty in different courses may have different approaches to this issue.*

*In this course, discussion is allowed as long as it is identified. Plagiarism, such as copying someone else's solution or COMPUTER code (if required) is not allowed. The write-ups must always be your own. Modifying someone else's Assignment or code 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://www.utoronto.ca/~vpdean/academic\\_integrity.html](http://www.utoronto.ca/~vpdean/academic_integrity.html).*

***E-Mail:*** *I will only respond to e-mails sent from a recognized University of Toronto address. Please put PHYB56 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.*

### **Assignments, Tests & Exam**

- There will be about 6 sets of problems with 5 to 6 problems on each set.
- There will be two midterm Tests. Date and time will be decided by the Registrar.
- There will be a comprehensive final exam during final Exams week.
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### **Problem Set Policy & Submission Checklist**

1. **Staple all pages of each set before coming to class after writing your name & student number.** Penalties may be assigned to assignments with pages that are not stapled together.
2. The Instructor reserve the right to send the assignment paper(s) to TURNITIN service in case there is significant overlap with publisher notes or solutions.

3. Each homework problem must be on a separate sheet of paper. If you need more than one sheet you should staple them together.
4. You need to attempt all questions on the assignment though only 3 questions only will be graded from each problem set. Missing any problem mean 20% deduction will be applied.
5. Turn paper copies in before class starts on the due date. No late work will be graded. If it is submitted the same day after the lecture, a penalty of 50% will be applied. No paper will be accepted after 5.00 PM on the due date.
6. When collaborating, be sure to write the name(s) of those you discuss with on the top of your homework.
  - a. Collaboration is not sharing code files or copying someone's answers.
  - b. Collaboration is asking questions to help clarify your own difficulties with the problem set.

For all graded problems, in addition to any mathematical work, I 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.

**Note: (In case computer programs are used like Mathematica, Python or MATLAB)**

In case some problem sets require the use of computers. Programming with Python, Mathematica (or MATLAB) is not an end in itself 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	25%
Midterm tests	30% (10% and 20%)
Final exam	45%
Note: There is <b>No makeup tests in this course</b> , if you miss test-1, for acceptable documented reasons, then test-2 will worth 30%, however, if you miss test-2 your final exam worth 60%	

Attendance and participation are highly encouraged for both tutorials and lectures since we believe it will assist you to better understand the material covered.

The tentative calendar below provides information about the Topics covered in this course. This schedule follows the textbook “Quantum Mechanics: A Paradigms Approach”, by David McIntyre. However, you may use other books that cover the same topics.

CHAPTER #	TOPICS	
Chapter-1	Introduction: Failures of Classical Physics & Stern-Gerlach Experiments	Week-1 & 2
Chapter-2	Operators and Measurement	Week- 3 & 4
Chapter-3	Schrödinger Time Evolution	Week-5 & 6
Chapter-5	Quantized Energies: Particle in a Box	Week-7 & 8
Chapter-6	Unbound States	Week-9 & 10
Chapter-9	Harmonic Oscillator	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 *Accessibility Services* at UTSC as early as possible in the term. The *Accessibility Services* <http://www.utsc.utoronto.ca/~ability/> will determine reasonable accommodations for this course.

GOOD LUCK