

PHYS 4010: Quantum Mechanics (Fall 2022)

Course Instructor: Tom Kirchner, Department of Physics and Astronomy, York University, Petrie 228, (416) 736-2100 x33695, tomk@yorku.ca

WWW: [eClass](#)

Class Times: MWF 13:30 – 14:30 (CB 120)

Student Hours: M 14:30 – 15:30 in PSE 228 or by appointment

Recommended Text: R. Shankar, *Principles of Quantum Mechanics* (2nd edition), Plenum Press 1994

Other Books: D. J. Griffiths and D. F. Schroeter, *Introduction to Quantum Mechanics* (3rd edition), Cambridge University Press 2018
C. Cohen-Tannoudji *et al.*, *Quantum Mechanics I, II* (2nd edition), (Wiley-VCH, 2019)
R. Liboff, *Introductory Quantum Mechanics* (4th edition), (Pearson, 2002)
[A. Messiah, *Quantum Mechanics I, II*, (Dover Paperback, 1999)]
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Class Notes: will be posted on eClass (and classes will be recorded)

Content

Physical concepts and mathematical foundations of quantum mechanics

Approximate List of Topics:

- 0 Postulates of QM
A very brief review
- 1 Quantum Dynamics
Evolution operator, Heisenberg picture, Ehrenfest's theorem and energy-time uncertainty relation, propagators and path integrals, time-dependent perturbation theory
- 2 Many-Particle Systems
Product states, identical particles, permutations, indistinguishability, fermions and bosons, Pauli principle, applications
- 3 Scattering Theory
Time-dependent description, S- and T-matrix operators, Born approximation, applications
- 4 Relativistic Quantum Mechanics
Klein-Gordon equation, Dirac equation, relativistic hydrogen problem

Learning Outcomes

- Demonstrate a systematic understanding of the framework and the principles of (nonrelativistic) quantum mechanics and their mathematical representation.
- Apply the principles of quantum mechanics to analyze and solve problems in the field and describe applications in new settings.
- Appreciate the complexity, broader implications, and limitations of quantum mechanics in the description of physical phenomena.
- Gather, organize, synthesize, and critically evaluate information from quantum mechanics textbooks and other sources.

Prerequisites

PHYS 3040, PHYS 3020 (prerequisite or corequisite)

Marking scheme

- assignments (4–5 problem sets, pro-rated): 20 % of final grade
- midterm tests (two in total): 2×20 % of final grade
test dates: tbd
- comprehensive final exam: 40 % of final grade

Other Considerations and Relevant Policies

- **Class attendance is highly recommended.** This is an in-person course without remote attendance options. However, I plan to record lectures and save the class notes and recordings and post them on eClass (within 24 hours).
- I might take advantage of the fact that I pre-recorded a number of lectures during the COVID-19 pandemic, and augment the material to be discussed in class with some of those recordings (made available via eClass). **The material covered, in the pre-recorded and the live lectures, is the material that will be relevant for the midterm tests and the final exam.**
- All class materials will be available on the course eClass site. It is imperative that you consult it regularly.
- There are many excellent QM textbooks on the market (and in our library), a few of which are listed on p. 1. Check them out and find the one that suits you! I will not follow any of them very closely, but will teach from my own notes.
- I will be available to meet with you (in-person in my office) on Mondays, 2:30 – 3:30 pm. Please swing by if you have questions, concerns etc. If this time slot doesn't work for you and/or you prefer to meet via Zoom, email me and we will work something out.

- It is VERY important that you do the assignments, which will be posted on eClass and will have (firm) due dates. You can submit your homework either in person or via eClass. In addition to the graded homework problems you will be provided with a few ungraded practice problems during the term. My advice: Do them all. There are many more problems available in the recommended text and in the numerous other quantum mechanics textbooks, and you are encouraged to try at least a few of those as well. It is a good idea to work together with your peers, but it is a bad idea to copy solutions from others or from the internet. This is dishonest and you won't learn anything by doing this. **I expect everybody to hand in their own, original solutions.**
- Minimal formula sheets will be provided for the midterm tests and the final exam and will be posted on eClass a few days before the exam dates. The exams will be in-person and closed-book, i.e., they will happen in a classroom and the formula sheets will be the only permitted aids. The midterm tests will last one hour each and the final exam three hours.
- If you miss a test/exam, email me as soon as possible. A make-up test/exam may be scheduled. A missed make-up exam cannot be made up.
- Given that I plan to record classes I have to remind you that lecture recordings may pick up sounds in the classroom and thus your voice may be recorded. Students who participate orally are consenting to have their voices, personal views and opinions recorded.
- Cheating and plagiarism—the attempt to gain unfair academic advantage—will not be tolerated. Note that this includes allowing another student to submit original work—whole or in part—that you yourself have done. Note also that exams, tests, and other assignments are the copyrighted works of the professor assigning them, whether copyright is overtly claimed or not. Scanning or sharing these documents constitutes copying, which is a breach of Canadian copyright law, and the breach is aggravated when scans are shared or uploaded to third party repository sites¹.
- Any offence against the standards of academic honesty is a serious matter. It is expected that you are familiar with the York [Senat Policy on Academic Honesty](#) and the academic integrity module in the Student Papers & Academic Research Kit (SPARK) that can be accessed via eClass.
- Other relevant York University policy statements deal with the student code of rights and responsibilities, with academic accommodation, and accessibility for persons

¹Important note from the FSc Committee on Examinations & Academic Standards (CEAS): Numerous students in Faculty of Science courses have been charged with academic misconduct when materials they uploaded to third party repository sites (e.g., Course Hero, One Class, etc.) were taken and used by unknown students in later offerings of the course. Whenever a student submits work obtained through an external site (e.g., Course Hero, Chegg), the submitting student will be charged with plagiarism and the uploading student will be charged with aiding and abetting. Students are urged not to upload their work on these sites.

with disabilities. They can be found at <https://secretariat-policies.info.yorku.ca/> or via eClass.

- Please be aware of University-wide important dates to be found at <https://registrar.yorku.ca/enrol/dates/2022-2023/fall-winter>
- Please consult the Physics and Astronomy Undergraduate Handbook 2022-2023 for further information (such as the grading scheme and degree requirements) and links to student support services and other useful resources.
- We all have to follow York's guidance on COVID-19, which may change during the term, e.g., we may have to change plans and dates of tests and exams or oscillate between in-person and online delivery. Any such changes will be communicated promptly (via eClass). Meanwhile, visiting <https://www.yorku.ca/bettertogether/> regularly will help everybody to stay updated on the latest York COVID-19 information and guidance.
- If you are in doubt about any of the above or require access to other resources, please ask. I am committed to fostering an environment for learning that is inclusive for everyone and I welcome emails or in-person communications on this or any other issue so long as they pertain to this course. Just use one of the communication channels mentioned on the first page and get in touch. It is understood that we will all adhere to “common sense” guidelines to communicate courteously and effectively.