

# PHYS 4707: Introduction to Quantum Mechanics I – Fall 2022

Mondays and Wednesdays, 10.05-11.25, UC280, in person

<p style="text-align: center;"><b>Professor</b></p> <p>Dr. Seyda Ipek (pronounced Shae-duh E-peck) 3348 HP, <a href="mailto:Seyda.Ipek@carleton.ca">Seyda.Ipek@carleton.ca</a> <b>Pronouns:</b> she/her <b>Student hours:</b> Tue and Fri 10.00-11.00am or by appointment</p>	<p style="text-align: center;"><b>Teaching Assistants</b></p> <p>Cem Murat Ayber (he/him) <a href="mailto:cemayber@email.carleton.ca">cemayber@email.carleton.ca</a></p> <p>Carlos Henrique de Lima (he/him) <a href="mailto:carloshenriquedelima@email.carleton.ca">carloshenriquedelima@email.carleton.ca</a></p>
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**First and Last day of class:** Sep 7 - Dec 9, 2022

**Class website:** Brightspace

**Book (recommended):** *A Modern Approach to Quantum Mechanics*, 1st or 2nd Edition, John S. Townsend, University Science Books

**Topics:** Spin; angular momentum; Dirac bra-ket notation; matrix representation of operators; 1D and 3D quantum systems; time evolution of quantum systems; symmetries; bound states of central potentials; entanglement

## Prerequisite knowledge and skills:

Linear algebra: Finding the eigensystem of a matrix; diagonalizing matrices; matrix multiplication; writing and manipulating rotation matrices in 3D

Differential equations: Solving 1st and 2nd order linear differential equations with boundary conditions

Quantum Mechanics (PHYS 3701): Schrödinger equation; wave function formalism; setting up, solving and understanding canonical 1D potentials in QM, e.g. particle in a box, potential barrier, potential well; calculating probabilities given a wave function

Electromagnetism: Charged particles in an electromagnetic field; magnetic dipole moment interactions

Classical Mechanics: Hamiltonian mechanics; orbital angular momentum; 3D motion in a gravitational potential; changing coordinate systems

## Course Assessment

- **Homework (30%)** There will be weekly problem sets, about 9 in total.
- **Midterm (30%)** There will be one midterm, *tentatively* scheduled for Oct 19 during class time.
- **Final (40%)** The final exam will be given during the finals week.

## Learning Objectives

- Connect mathematical construction of quantum mechanics to physical concepts and observables
- Given the description of a QM system, set up the appropriate mathematical problem to be solved
- Given the description of a quantum system, set up the Hamiltonian and find the time evolution of a given quantum state
- Given a physical observable, find the corresponding operator and its eigenvalues and eigenstates
- Given the spin/orbital angular momentum of a particle, use the Dirac notation to construct the matrix representation of various angular momentum operators in an appropriate basis
- Given the matrix representation of an operator in one basis, find its representation in a different basis and diagonalize the matrix if necessary
- Given a quantum state in some basis, decompose it using another basis, calculate the probabilities for measuring various basis states
- Given a physical system, identify its symmetries and their physical meaning and consequences
- Given an abstract or physical situation, use the uncertainty relation to draw meaningful conclusions
- For a particle in a given potential, compare and contrast the classical and quantum behavior

## Tentative Schedule – PHYS 4707 – Fall 2022

Week 1	Sep 7, Wed	<b>Welcome!</b> Introductions, syllabus Chapter 1
Week 2	Sep 12, Mon Sep 14, Wed	Chapters 1&2
Week 3	Sep 19, Mon Sep 21, Wed: HW1 due <i>Sep 20: Last day to change courses or sections (including auditing) for fall term.</i>	Chapter 2&3
Week 4	Sep 26, Mon Sep 28, Wed: HW2 due <i>Sep 30, Thu: Last day to withdraw from fall term and fall/winter courses with a full fee adjustment.</i>	Chapter 3
Week 5	Oct 3, Mon Oct 5, Wed: HW3 due <i>Oct 7, Fri: Dec examination schedule available online.</i>	Chapter 4
Week 6	<b>Oct 10, Mon: Statutory holiday, no class</b> Oct 12, Wed: HW4 due	Chapter 4
Week 7	Oct 17, Mon Oct 19, Wed: Midterm	<b>Review</b> Midterm
<b>Week X</b>	<b>Oct 24, Mon: Reading week, no class</b> <b>Oct 26, Wed: Reading week, no class</b>	<i>Have a nice break!</i>
Week 8	Oct 31, Mon Nov 2, Wed	Chapter 5
Week 9	Nov 7, Mon Nov 9, Wed: HW5 due <i>Nov 11, Fri: Last day to request Formal Examination Accommodation Forms for December examinations to the PMC</i>	Chapter 5&6
Week 10	Nov 14, Mon Nov 16, Wed: HW6 due <i>Nov 15, Tue: Last day for academic withdrawal</i>	Chapter 7
Week 11	Nov 21, Mon Nov 23, Wed: HW7 due	Chapter 9
Week 12	Nov 28, Mon Nov 30, Wed: HW8 due	Chapter 10
Week 13	Dec 5, Mon Dec 7, Wed: HW9 due <b>Dec 9, Fri: Monday schedule, Last day of class</b>	Chapter 8 <b>Review</b>
Week 14	<b>Dec XX: Final exam</b>	<i>Good luck!</i>

See the academic calendar for other important deadlines: <https://calendar.carleton.ca/academicyear/>

## Class Code Of Conduct

My goal is to make each and everyone of you feel welcome, not only in my classroom but also in the field of physics. I expect you to behave respectfully and collegiately towards your peers, your TA and me. You should expect the same from me. If you think you are not being welcome or respected in the class, please contact me. If you have problems that are interfering with your learning, please contact me. I might not have all the answers, but I can point you in the right direction. If there is an issue about which you don't feel comfortable contacting me directly, please seek out department and/or campus resources.

Some of the behavior I expect in this class are:

- Academic honesty. The work you turn in must be yours. You are encouraged to work in groups but you cannot copy someone else's work, including answers found on the internet and solution manuals. You cannot give your work to someone else to be copied.
- Be on time with assignments. You should turn in your homework by the due date. Late homework will not be accepted. Exams will start and end on the allotted time. Graded assignments and exams, together with comments on your work, will be returned within a week.
- Respecting the class time. You should be on time to class and refrain from behavior that distracts you or others from learning. This includes, for example, talking to others and using social media during the class.
- Engagement with the class material. You are encouraged to interject during class to ask questions. At the same time, please be mindful of the class time and your classmates' needs. Remember that you can use the office hours to ask more questions.
- Respecting your classmates and the professor. You should be respectful of your classmates and your instructor, during and outside of the class. For example, if you know their preferred pronouns and/or chosen names, you should use them. You should respect their privacy and personal space. Harassment, bullying and demeaning behavior of any degree will not be tolerated. You are not allowed to record my class partially or in full in any form.
- Addressing me and each other. My name is pronounced Shae-duh E-peck. Please correct me if I pronounce your name wrong. You can address me as Dr. Ipek or Professor Ipek. You can also call me "Seyda Hocam", if you feel comfortable using this Turkish honorific. My preferred pronouns are she/her. You can put your preferred name/pronouns in your Brightspace profile, or talk to me if I am getting them wrong. If you know a classmate's chosen name/pronoun, be thoughtful about using them consistently.
- Be understanding. Show empathy towards others and be kind to yourself as well as those around you. Give positive feedback when you can, be constructive in your criticism.
- Communications. Questions about course material will be answered during the office hours. If you have other questions about the class, first make sure they are not answered through the syllabus, this webpage or by asking a classmate. If you *have to* email me, use your Carleton email address and make sure your email 1- has an informative subject line including the course code, 2- articulates your question or problem well, 3- has a closing statement such as *Sincerely, Kind Regards* etc. and 4- has your name at the end.

## Academic Integrity

As scholars, you are expected to adhere to academic integrity. Academic misconduct is considered a very serious offense at Carleton University. Academic misconduct offenses include, but are not limited to, copying of others' work (plagiarism) and not abiding by exam rules.

Make yourselves familiar with the Carleton University Academic Integrity Policy. You can also refer to the [Faculty of Science Academic Integrity](#) webpage for information. Remember:

"Students are expected to familiarize themselves with this policy and to uphold the principles set out herein. It should further be noted that claiming ignorance of or confusion about the academic integrity standards as described in the Policy does not excuse a student from responsibility for violations of those standards."

All violations of the Academic Integrity Policy will be reported to the Dean of Faculty of Science with supporting documentation. After reporting by the faculty, the following steps are followed, as summarized by the [Registrar's Office](#):

1. Faculty Dean reviews documentation
2. Student is contacted by email and letter
3. Meeting with student, Dean and Advisor
4. Dean informs student of decision
5. Student has the right to appeal the decision

## Academic Accommodations

**Pregnancy and Religious Obligations:** Write to me with any requests for academic accommodation due to pregnancy or religious obligations during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: <https://carleton.ca/equity/>

**Students with Disabilities:** The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities, psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder, Autism Spectrum Disorders, chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations, please contact PMC at 613-520-6608 or [pmc@carleton.ca](mailto:pmc@carleton.ca) for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made.

**Addressing Human Rights Concerns:** The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the [Department of Equity and Inclusive Communities](#) at [equity@carleton.ca](mailto:equity@carleton.ca).

**Survivors of Sexual Violence:** As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: <https://carleton.ca/sexual-violence-support/>

**Accommodation for Student Activities:** Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the [Senate Policy on Accommodation for Student Activities](#).

## **Campus Assistance For Students**

Mental Health Resources: <https://carleton.ca/wellness/living-well/resources/>

Academic and Career Development Services: <http://carleton.ca/sacds/>

Writing Services: <http://www.carleton.ca/csas/writing-services/>

Peer Assisted Study Sessions (PASS): <https://carleton.ca/csas/group-support/pass/>

Math Tutorial Centre: <https://carleton.ca/math/math-tutorial-centre/>

Science Student Success Centre: <https://sssc.carleton.ca/>