

Modern Physics II (PHYS 3606-3608) Course Outline-Winter 2025

Instructor	Professor Thomas Koffas (koffas@physics.carleton.ca) Room 2410 Herzberg (613) 520-2600 ext. 8996
Teaching Assistant	Ezekiel Staats (EzekielStaats@email.carleton.ca)
Office Hours	Professor Koffas Tuesday 3:00 pm – 4:00 pm Thursday 3:00 pm – 4:00 pm Outside office hours please contact me via email.
Lectures	Tuesday-Thursday 16:05 (4:05 pm) to 17:25 (5:25 pm)
Labs	<u>Instructor:</u> Penka Matanska (matanska@physics.carleton.ca) Session A1: Thursday 1:05 pm to 3:55 pm Session A3: Friday 8:35 am to 11:25 am Labs begin on January 9 for session A1 and January 10 for session A3. You will be asked to keep an electronic log to demonstrate your work to set up the experiment, make the measurement and analyze the collected data. The lab policy will be reviewed in the first lab period.
Text	There is no assigned textbook for the course. Students are not required to purchase textbooks or other learning materials for this course. Lecture notes will be posted on BrightSpace in advance of the lecture. Students are expected to attend the lectures and take notes. For further study a list of recommended books is given later in the course outline.
WebSite	BrightSpace PHYS 3606 and PHYS 3608 sites
Prerequisites	PHYS 2604 and PHYS 3701 or permission by the department
Grades	Assignments 15% Midterm Exam 15% Final Exam 30% Laboratory 40% In order to pass the course each one of your Theory (Assignments, Midterm exam, and Final Exam) and Laboratory grades must be above 50%.

Course Description

In this course, we will examine a variety of physics phenomena and we will interpret them through the application of the fundamental laws of non-relativistic quantum mechanics. Most of the topics that will be covered in this course form the basis of a number of sciences such as chemistry, biology and geology and of every aspect of modern engineering as a discipline. For each topic two lectures on average will be dedicated which will correspond to about one week for each. The following topics will be covered:

Atomic Physics

1. The Hydrogen Atom (with a brief introduction to the Polynomial Method)
2. The Periodic Table of Elements
3. Atoms in Magnetic Fields-Nuclear Magnetic Resonance (NMR)
4. The Hydrogen Atom in a Magnetic Field-The Zeeman Effect

Molecular Physics

1. The Chemical Bond I-The Amazing Properties of the Water Molecule
2. The Chemical Bond II-The Cycle of Light

Solid State Physics

1. Theory of the Energy Bands: Conductors, Semiconductors, Insulators

Cosmology

1. Fermi Energy: Gravitational Collapse-The Life of a Star

Light & Matter

1. Interaction of Light with Matter: Stimulated Transitions-Lasers
2. Interaction of Light and Matter: Scattering-The Color of the Sky

Nuclear Physics

1. Hyperfine Structure-The Most Important Line in the Universe
2. From Discrete to Continuous: The Alpha Decay and the Age of the Earth
3. α, β, γ : Nuclear Transmutations, the Sun and the Best Energy Source we have

Course communication: All course-related announcements such as assignment due dates, midterm and final exam formats and preparation will be made exclusively in class. No other form of communication is envisioned for this course. Any other interactions with the course instructor should be facilitated during the dedicated office hours.

Course Schedule: A preliminary weekly schedule of the course lectures and assignments is provided in the document "Lectures-ProblemSets_Winter-2025" posted on BrightSpace. As the term evolves, any modifications to this schedule will be promptly announced in class.

Assignments: There will be roughly one assignment every two weeks. The assignments will be posted on BrightSpace and they will generally be due two weeks after their

handing out. Exact assignment due dates will be only announced in class. Assignments will be collected at the beginning of the lecture. Late assignments will not be accepted without a valid reason such as documented severe illness. You may discuss the assignment problems with other students in this course however, the work you turn in must be your own. Feel free to consult the instructors and/or teaching assistants when you have questions (either during office hours or by setting up an appointment). The assignments are a critical part of the course and working through the problems by yourselves is essential to absorb the material. Your solutions should be thorough, self-contained and logical, with all steps properly motivated and explained. If not typed, the assignments must be deemed legible by the marker.

Exams:

- There will be one closed-book midterm exam, 1.5 hours long, during the lecture period.
- The final exam will be 3 hours long, to be held during the final examination period in April.
- The final exam will be closed book. Exam formats will be discussed in advance in class. It is expected that all steps will be explained in detail following a logical outline and justified using all knowledge gained during the course. In particular, no use of formulas/equations without sufficient justification of their applicability to the given problem will be accepted. Adequate justification of all solution steps will account for half (50%) of each problem's final grade.

Missing Exams

Midterm Exam: If you miss the midterm exam, you must notify the Professor within 24 hours after the date of the exam. A make-up midterm might be permitted under only two conditions: severe illness leading to hospitalization or bereavement. Documentation within 24 hours after the scheduled midterm exam is required to schedule an alternative time for the midterm. If no documentation is provided or if the provided documentation is deemed insufficient by the course instructor, you will receive a grade of zero for the midterm exam. If you do provide adequate documentation within 24 hours after the date of the exam, the instructor or teaching assistant will contact you to inform you of the location, time, and date of the make-up midterm exam.

Final Exam: If you miss the final exam, you must contact the Registrar's Office within the time period specified in the university calendar. You will need to fully document your application. Students are encouraged to review the policies of deferred exams in the university calendar. A request to write a deferred exam will be granted only if adequate term work has been demonstrated. In this context, adequate term work means completing and submitting all the assignments, taking the midterm exam, and fulfilling the lab requirements as laid out in the lab policy; in addition, each of the student's assignment and lab term grades should be above 50%. The grade FND (Failure with no deferred final exam) will be assigned when the student has failed the course on the basis of inadequate term work. The grade FND is assigned 0.0 grade points.

Suggested Reading

1. Harris, Randy, 2008, Modern Physics, 2nd edition, University of California, Davis.
Publisher: Pearson/Addison-Wesley and taken over from Prentice Hall.
2. Taylor & Zafiratos, 2004, Modern Physics for Scientists & Engineers
Publisher: Pearson/Prentice Hall.
3. Krane, Kenneth, 2012, Modern Physics, 3rd edition.
Publisher: Wiley.
4. Tipler, Paul, et al. 2008, Modern Physics, 5th edition.
Publisher: W.H. Freeman.
5. Serway, Raymond A., et al. 2004, Modern Physics, 3rd edition.
Publisher: Thomson Education
https://ocul-crl.primo.exlibrisgroup.com/permalink/01OCUL_CRL/1gorbd6/alma991014075679705153
6. Thornton & Rex 2013, Modern Physics for Scientists & Engineers, 4th edition.
Publisher: Cengage Learning
7. D. J. Griffiths, 2004, Introduction to Quantum Mechanics, 2nd edition
Publisher: Pearson/Prentice Hall
8. E. H. Wichmann, Quantum Physics (Berkeley Physics Course, Vol.4)
Publisher: McGraw-Hill, multiple editions
9. B. L. Van Der Waerden, Editor, 1967, Sources of Quantum Mechanics, Classics of Science Vol.5
Publisher: Dover
https://ocul-crl.primo.exlibrisgroup.com/permalink/01OCUL_CRL/1gorbd6/alma991008826689705153
10. A. C. Melissinos, 2003, Experiments in Modern Physics, 2nd edition
Publisher: Academic Press

Academic Accommodations

Carleton is committed to providing academic accessibility for all individuals. You may need special arrangements to meet your academic obligations during the term. The accommodation request processes are outlined on the Academic Accommodations website (<https://students.carleton.ca/course-outline/>).

Academic Regulations

University rules regarding registration, withdrawal, appealing marks, and most anything else you might need to know can be found on the university's website, here: <http://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/>

Academic Integrity

Misconduct in scholarly activity will not be tolerated and will result in consequences as outlined in [Carleton University's Academic Integrity Policy](#). A list of standard sanctions in the Faculty of Science can be found [here](#). Additional details about this process can be found on [the Faculty of Science Academic Integrity website](#). Students are expected to familiarize themselves with and abide by [Carleton University's Academic Integrity Policy](#).

Examples of actions that do not adhere to Carleton's Academic Integrity Policy include:

- Plagiarism
- Accessing unauthorized sites for assignments or tests
- Unauthorized collaboration on assignment and exams

In PHYS 3606/3608 such offences will normally result in a mark of zero for the lab report or exam in question. In addition, a report will automatically be sent to the Dean of the student's Faculty, for possible further disciplinary action. I have no tolerance for cheating, and there are no second chances.

Student Rights and Responsibilities

Students are expected to act responsibly and engage respectfully with other students and members of the Carleton and the broader community. See [7 Rights and Responsibilities Policy](#) for details regarding the expectations of non-academic behaviour of students. Those who participate with another student in the commission of an infraction of this Policy will also be held liable for their actions.

Assistance for Students:

Learning and Writing Support: <https://carleton.ca/csas/support/>

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/>

Important Information:

- Student or professor materials created for this course (including presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the author(s). They are intended for personal use and may not be reproduced or redistributed without prior written consent of the author(s).
- Standing in a course is determined by the course instructor subject to the approval of the Faculty Dean. This means that grades submitted by the instructor may be subject to revision. No grades are final until they have been approved by the Dean.

- Carleton University is committed to protecting the privacy of those who study or work here (currently and formerly). To that end, Carleton's Privacy Office seeks to encourage the implementation of the privacy provisions of Ontario's *Freedom of Information and Protection of Privacy Act* (FIPPA) within the university.
- In accordance with FIPPA, please ensure all communication with staff/faculty is via your Carleton email account. To get your Carleton Email you will need to activate your MyCarletonOne account through Carleton Central. Once you have activated your MyCarletonOne account, log into the MyCarleton Portal.