

Modern Physics II (PHYS 3606-3608) Course Outline-Winter 2022

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| Professor | Thomas Koffas (koffas@physics.carleton.ca) Room 2410 Herzberg (613) 520-2600 ext. 8996 |
| Teaching Assistants | Bryce Norman BryceNorman@cmail.carleton.ca Ezekiel Staats ezekielstaats@cmail.carleton.ca Connor McNairn ConnorMcNairn@cmail.carleton.ca Jeremie LePage-Bourbonnais JeremieLePageBourbon@cmail.carleton.ca |
| Office Hours | Tuesday noon - 1:00 pm Thursday noon - 1:00 pm Outside office hours please contact me via email. |
| Lectures | Tuesday-Thursday 10:05 am to 11:25 am, University Centre 231 |
| Labs | <u>Instructor</u> : Penka Matanska (matanska@physics.carleton.ca) Session A1: Thursday 1:05 pm to 14:55 pm Session A2: Friday 1:05 pm to 14:55 pm Session A3: Friday 8:35 am to 11:25 am Session A4: Wednesday 1:05 pm to 2:55pm Labs begin on January 12 for session A4, January 13 for session A1 and January 14 for sessions A2 and 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. 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 |
| Marks | Assignments 15% Laboratory 45% Final Exam 40% In order to pass the course each one of your theory 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

For the creation of these notes I relied heavily on the notes of old professors of mine whose student I had the privilege of being. They have strived to teach me that in the long run physics is nothing else but the application of common sense and analytical thinking. I consider this to be the most important learning objective of this course and it will be emphasized repeatedly during the term.

Assignments: There will be roughly one assignment every three weeks. The assignments will be posted on BrightSpace and they will generally be due two weeks after their distribution (or as 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 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 me 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 yourselves is essential to absorb the material. Your solutions should be thorough, self-contained and logical, with all steps explained. If not typed, the assignments must be deemed legible by the marker.

Exams:

- 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. It is expected that all steps will be explained in detail following a logical outline presented at the beginning of the solution and justified using all knowledge gained during the course. This will account for half (50%) of each problem's final grade.

Missing Exams

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 of the assignments and fulfilling the lab requirements as laid out in the lab policy; in addition, both 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 Policies

Academic Regulations, Accommodations, Plagiarism, Etc.:

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 Accommodations for Students with Disabilities:

The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at **613-520-6608** or **pmc@carleton.ca** for a formal evaluation.

If you are already registered with the PMC, contact your PMC coordinator to send your *Letter of Accommodation* at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (*if applicable*).

Academic Integrity

All work presented by a student must be her or his original work. This includes lab reports and the final exam. I have zero tolerance for cheating and plagiarism. The attention of all students is drawn to the Academic regulations of the University:

<https://carleton.ca/registrar/academic-integrity/>.

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.

Special Information on Pandemic Measures

All members of the Carleton community are required to follow COVID-19 prevention measures and all mandatory public health requirements (e.g. wearing a mask, physical distancing, hand hygiene, respiratory and cough etiquette) and [mandatory self-screening](#) prior to coming to campus daily.

If you feel ill or exhibit COVID-19 symptoms while on campus or in class, please leave campus immediately, self-isolate, and complete the mandatory [symptom reporting tool](#). For purposes of contact tracing, attendance will be taken in all classes and labs. Participants can check in using posted QR codes through the cuScreen platform where provided. Students who do not have a smartphone will be required to complete a paper process as indicated on the [COVID-19 website](#).

All members of the Carleton community are required to follow guidelines regarding safe movement and seating on campus (e.g. directional arrows, designated entrances and exits, designated seats that maintain physical distancing). In order to avoid congestion, allow all previous occupants to fully vacate a classroom before entering. No food or drinks are permitted in any classrooms or labs.

For the most recent information about Carleton's COVID-19 response and required measures, please see the [University's COVID-19 webpage](#) and review the [Frequently Asked Questions \(FAQs\)](#). Should you have additional questions after reviewing, please contact covidinfo@carleton.ca

Please note that failure to comply with University policies and mandatory public health requirements, and endangering the safety of others are considered misconduct under the [Student Rights and Responsibilities Policy](#). Failure to comply with Carleton's COVID-19 procedures may lead to supplementary action involving Campus Safety and/or Student Affairs.

Assistance for Students:

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/>

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).

- Students must always retain a hard copy of all work that is submitted.
- 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.