

## Modern Physics II (PHYS 3606-3608) Course Outline-Winter 2023

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<b>Teaching Assistants</b>	Liz Fletcher <a href="mailto:LizFletcher@cmail.carleton.ca">LizFletcher@cmail.carleton.ca</a> Ezekiel Staats <a href="mailto:ezekielstaats@cmail.carleton.ca">ezekielstaats@cmail.carleton.ca</a> Taylon Clark <a href="mailto:TaylonClark@cmail.carleton.ca">TaylonClark@cmail.carleton.ca</a> Ian Ramirez-Berend <a href="mailto:IanRamirezBerend@cmail.carleton.ca">IanRamirezBerend@cmail.carleton.ca</a>
<b>Office Hours</b>	Tuesday 1:00pm – 2:00pm Thursday 1:00pm – 2:00pm Outside office hours please contact me via email.
<b>Lectures</b>	Tuesday-Thursday 11:35 am to 12:55 pm, University Centre 282
<b>Labs</b>	<b>Instructor:</b> Penka Matanska ( <a href="mailto:matanska@physics.carleton.ca">matanska@physics.carleton.ca</a> ) 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  Labs begin on January 12 for session A1 and January 13 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.
<b>Text</b>	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.
<b>WebSite</b>	BrightSpace PHYS 3606 and PHYS 3608 sites
<b>Prerequisites</b>	PHYS 2604 and PHYS 3701 or permission by the department
<b>Marks</b>	Assignments 15% Midterm Exam 15% Final Exam 35% Laboratory 35% 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.  $\alpha, \beta, \gamma$ : 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 two 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 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 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 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 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. 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**

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 will usually be permitted under two conditions: illness or bereavement. Documentation is required to schedule an alternative time for the midterm. If no documentation is provided you will receive a grade of zero for the midterm. If you do provide appropriate documentation within 24 hours after the date of the exam, the professor 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 of the assignments, writing 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.

#### **Exam Accommodations for PMC Students via Ventus**

Carleton University has launched a new academic accommodation management system, [Ventus](#). With Ventus, course instructors can view up-to-date information on their student's academic accommodation requirements, and submit and manage exam booking requests with the McIntyre Exam Centre. Ventus provides students with more control over their accommodations on a per-course and per-test basis, and creates an improved user experience for students and faculty with real-time data in one shared web location. Students can request and manage their academic accommodations via the [Ventus Student Portal](#). More information on using Ventus, with overviews of the student and faculty portals, can be found on [VentusHelp](#).

## **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](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](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**

It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are [a number of actions you can take](#) to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.

**Feeling sick?** Remaining vigilant and not attending work or school when sick or with symptoms is critically important. If you feel ill or exhibit COVID-19 symptoms do not come to class or campus. If you feel ill or exhibit symptoms while on campus or in class, please leave campus immediately. In all situations, you must follow Carleton's [symptom reporting protocols](#).

**Masks:** Carleton has paused the [COVID-19 Mask Policy](#), but continues to strongly recommend masking when indoors, particularly if physical distancing cannot be maintained. It may become necessary to quickly reinstate the mask requirement if pandemic circumstances were to change.

**Vaccines:** Further, while proof of vaccination is no longer required as of May 1 to attend campus or in-person activity, it may become necessary for the University to bring back proof of vaccination requirements on short notice if the situation and public health advice changes. Students are strongly encouraged to get a full course of vaccination, including booster doses as soon as they are eligible, and submit their booster dose information in [cuScreen](#) as soon as possible. Please note that Carleton cannot guarantee that it will be

able to offer virtual or hybrid learning options for those who are unable to attend the campus.

All members of the Carleton community are required to follow requirements and guidelines regarding health and safety which may change from time to time. For the most recent information about Carleton's COVID-19 response and health and safety requirements please see the [University's COVID-19 website](#) and review the [Frequently Asked Questions \(FAQs\)](#). Should you have additional questions after reviewing, please contact [covidinfo@carleton.ca](mailto:covidinfo@carleton.ca).

### **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.

### **Important Dates and Deadlines:**

See the academic calendar for other important deadlines:

<https://calendar.carleton.ca/academicyear/>