

## Course Outline: **PHYS 2604** Modern Physics I – Fall 2022

---

*Modern Physics for physicists and engineering physicists. **This course for Fall 2022 is an IN-PERSON WITH ON-CAMPUS ATTENDANCE.** It is a real-time synchronous course where the professor and students meet simultaneously in room University Centre Room: 282, at scheduled days and times. The*

*Professor share information, key ideas, theories, problems and concepts in an in-person course environment. Participation in **synchronous** courses requires students to be on campus. **PollEverywhere** will be used to break up lecture time with a quick riddle, quiz, or brain teaser to engage the participants. All the lecture material will be posted on Brightspace to engage the participants.*

*Lecture sessions in of PHYS 2604 will be recorded and made available only to those within the class. Sessions will be recorded to enable access to students who may have conflicting commitments or cannot attend the in-person lecture. If students wish not to be recorded, they need to leave their camera and microphone turned off.*

*Please note that the lecture notes and the recordings are protected by copyright. Students are not permitted to reproduce or distribute lecture notes publicly for commercial or non-commercial purposes. The recordings are for your own educational use, but you are not permitted to publish to third party sites, such as social media sites and course materials sites. You may be expected to use the video and/or audio and/or chat during web conferencing sessions for participation and collaboration. If you have concerns about being recorded, please email me directly so we can discuss these.*

*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 of the Faculty of Science.*

**Professor** A. Bellerive ([alainb@physics.carleton.ca](mailto:alainb@physics.carleton.ca))  
Room 3316 Herzberg

**Office Hours** Wednesday 14:30 to 15:30; Friday 14:30 to 15:30.  
Outside of office hours, contact me via e-mail to arrange a time to meet.

**Lecture time** Wednesday and Friday 16:00 to 17:30  
**Room: University Centre Room: 282**  
Classes start September 7, 2022; and end December 7, 2022  
Note that Friday December 9, 2022 follows a Monday schedule.

**The Course** The word ‘modern’ is a very relative word. Essentially this course covers the exciting period of physics at the start of the 20<sup>th</sup> century, where new phenomena were found that could not be explained with the older, classical physics of Maxwell, Rayleigh, and Newton. Classical Physics was not ‘overthrown’, but became the macroscopic limit with which the new quantum theory had to agree, upon extrapolation. The course core is constituted of topics such as photoelectric effect, special theory of relativity, wavelike properties of particles, Schrödinger equation, Rutherford-Born model of the atom and atomic structure. Necessary prerequisites for understanding the content of this course include standard vector and calculus-based algebra used to described concepts of mechanics, electrostatics, magnetism, E&M waves, thermal physics and probability & statistics.

## Labs

### Lab superintendents:

Igor D. Ivanovic ([igor@physics.carleton.ca](mailto:igor@physics.carleton.ca))

Maria Roza Martinez ([prmartin@physics.carleton.ca](mailto:prmartin@physics.carleton.ca))

Julie Sutton ([juliesutton3@cunet.carleton.ca](mailto:juliesutton3@cunet.carleton.ca))

Format: Labs are in-person

Room: 3125/3145 Herzberg

Labs begin the week of September 12, 2022. Schedule, lab policy and other details of the lab will be provided by the lab superintendents.

## Texts

**Required:** Kenneth S. Krane, "Modern Physics", 4<sup>th</sup> edition, Wiley, 2019. The book is available as a print copy ISBN 9781119495550 or eText ISBN 9781119495468. It can be found at the Carleton University Bookstore.

**Complementary Reading:** Physics for Scientists and Engineers with Modern Physics , 10th Edition Raymond A. Serway and John W. Jewett ISBN-10: 1-337-55329-8 or ISBN-13: 978-1-337-55329-2, book used in PHYS1001 and PHYS1002.

## Website

Brightspace (<https://carleton.ca/brightspace/>)

**Prerequisites** PHYS1001 & PHYS1002, or PHYS1003 & PHYS1004 (PHYS1007 & PHYS1008 are acceptable provided a grade of B- or better); plus MATH1004 & MATH1104, or MATH1007 & MATH1107, or MATH1002 & MATH1102. Or, by permission of the department. Students who do not have these prerequisites **must** check with the course instructor and obtain permission of the Physics Department to remain in the course.

## Marks

Assignments	25%
Midterm exam	15%
Laboratory	30%
Final Exam	30%

In order to pass the course, your laboratory and theory grades must both be over 50%.

**Drop-In-Center** Hour to be define for Fall 2022.

<https://physics.carleton.ca/drop-in-centre>

## Course description

This course covers a variety of topics in modern physics, with particular emphasis on topics related to special relativity and quantum mechanics. Taking a historical and practical approach, we will look at how classical physics came into conflict with experiment, thus prompting the development of the modern theories of physics. First, we will secure some concepts of chapters 15, 16, 17, 33, 34, 36 and 37 of Serway (Physics for Scientists and Engineers with Modern Physics used in PHYS1001 & PHYS1002). **Then, we will roughly cover the material in chapters 2 through 7 of the textbook by Krane.** However, the course content is defined by the lectures and some material not contained in the textbooks will be included in the lecture notes. The material of chapters 8, 10, 12 and 14 will be surveyed to give the student a prospective on the structure of matter and more insight about relativistic kinematics.

We will cover most of the material presented in the book by Krane:

1. Ch 1: Some Deficiencies of Classical Physics
2. Ch 2: The Special Theory of Relativity (plus extra lecture notes)
3. Ch 3: The Particle-Like Properties of Electromagnetic Radiation
4. Ch 4: The Wavelike Properties of Particles
5. Ch 5: The Schrödinger Equation
6. Ch 6: The Rutherford-Bohr Model of the Atom
7. Ch 7: The Hydrogen Atom in Wave Mechanics
8. Ch 8: Many Electron Atoms and Ch. 10: Statistical Physics (in brief)
9. Ch. 12: Nuclear Structure and Radioactivity and Ch. 14: Elementary Particles (in brief)

**Reading in text books (in order):**

- Survey of sections 15.1, 15.2, 15.3; sections 16.1, 16.2, 16.5; sections 17.1, 17.7 (Serway)
- Survey of sections 34.1, 34.2; sections 36.1, 36.2, 36.3; sections 37.1, 37.2 (Serway)
- Review of sections 33.3, 33.6 and 33.7 (Serway)
- Chapter 1 of Krane (all sections - read only)
- Chapter 3 of Krane (Sections 3.1 and 3.2 – plus selected problems)
- Chapter 2 of Krane (all sections - plus selected problems)
- Chapter 3 of Krane (all sections - plus selected problems)
- Chapter 4 of Krane (all sections - plus selected problems)
- Chapter 5 of Krane (all sections - plus selected problems)
- Chapter 6 of Krane (all sections - plus selected problems)
- Chapter 7 of Krane (sections 7.1 to 7.7 - plus selected problems)
- Chapter 8 of Krane (periodic table and lasers)
- Chapter 10 of Krane (survey of concepts)
- Chapter 12 of Krane (briefly with applications)
- Chapter 14 of Krane (briefly with applications and selected problems)

Extra reading will be provided to complement Chapter 2 of Krane (*e.g.* book “Special Relativity” by A.P. French). Note that concepts of thermodynamics (thermal physics) and statistical physics are covered in PHYS2401 (Fall term 2022). Modern Optics & Wave PHYS2202 is during Winter 2023. Thus, only basic aspects of optics will be covered in this course.

THE MIDTERM EXAMS WILL BE ON REVIEW CONCEPTS and PART OF CHAPTERS 2 and 3.  
THE FINAL EXAMS WILL BE MAINLY CONCERNED WITH CHAPTERS 2, 3, 4, 5, 6, and 7.

**Assignments:** There will be roughly weekly assignments throughout the term, and they will generally be due one week after their distribution. Assignments will be posted on Brightspace. Students will be asked to upload their solutions (PDF format preferred) onto Brightspace. Late assignments will not be accepted without an acceptable reason such as illness. The work you turn in must be your own. The assignments are a critical part of the course and working through the problems yourself is essential to learn the material. Your homework solutions should be thorough, self-contained, and logical, with all steps explained. Assignments must be deemed legible by the marker.

## Exams

- There will be one midterm exam (**on-line**). The midterm will contain two components: (1) five multiple choice questions and (2) one problem. The midterm exam will be on Friday October 21, 2022 at 16:00. The students will have 90 minutes to answer the multiple-choice questions and to provide a full detailed solution of the problem. **The midterm exam will be on-line and open book.** The exam is online and students will not write the exam in the classroom. It is the responsibility of the student to connect to Brightspace at 16:00 on October 21<sup>st</sup>.
- The final exam (**in-person**) will be held during the final examination period in December 2022. It will contain two components: (1) ten multiple choice questions and (2) three problems. The student will have 180 minutes to answer the multiple choices question and to provide full solutions of the problems on a given date to be defined.
- The final exam will be with a detailed formula sheet provided by the instructor. **The final exam will be in-person and closed book.**
- No deferred exam will be set for the midterm exam. A deferred exam will be scheduled only for the final exam. If a deferred final exam is necessary for a student, that exam will replace only the final exam component of the course mark and will only be granted if adequate term work has been completed. In this context, adequate term work means completing and submitting 75% of the assignments and fulfilling the lab requirements; the term mark must exceed 20 out of 70.

*This is the experiment schedule for PHYS2604 this Fall 2022 term.*

Week of	Experiment	Format
Sept. 12 <sup>th</sup> , 2022	<i>Introductory Session</i>	In-class activity
Sept. 18 <sup>th</sup> , 2022	e/m Thomson's Method	Lab Report
Sept. 25 <sup>th</sup> , 2022		
Oct. 2 <sup>nd</sup> , 2022	Photoelectric Effect	Write-up sheet
Oct. 9 <sup>th</sup> , 2022	Millikan's Experiment	Lab Report
Oct 16 <sup>th</sup> , 2022		
Oct. 23 <sup>th</sup> , 2022	Fall Break	
Oct 30 <sup>th</sup> , 2022	Radioactive Decay	Lab Report
Nov 6 <sup>th</sup> , 2022		
Nov 13 <sup>th</sup> , 2021	One of: Rydberg Constant, Franck-Hertz, X-rays, Two slit	Lab Report
Nov 20 <sup>th</sup> , 2020		
Nov 27 <sup>th</sup> , 2022	Oral Presentations	In-class activity

*Online: \* special days \* midterm October 21 and lecture November 2, 2022*

Day	Mark your agenda	Format
Friday Oct. 21 <sup>th</sup> , 2022	Open book exam 4pm	Online (Brightspace)
Wednesday Nov. 2 <sup>nd</sup> , 2022	Virtual lecture 4pm	Online (Zoom)

*Poll Everywhere:*

[pollev.com/alainbcarleton](http://pollev.com/alainbcarleton)

### *University Policies*

**Grade Definition:** In accordance with the Carleton University Undergraduate Calendar Regulations, the letter grades assigned in this course will have the following percentage equivalents:

A+ = 90-100	B+ = 77-79	C+ = 67-69	D+ = 57-59
A = 85-89	B = 73-76	C = 63-66	D = 53-56
A- = 80-84	B- = 70-72	C- = 60-62	D- = 50-52
F = <50			

### **Important dates and deadlines**

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

September 30, 2022 is the last day to withdraw from this courses with a full fee adjustment. The last day for academic withdraw is November 15, 2022.

### **Self-declaration form**

<https://carleton.ca/registrar/wp-content/uploads/self-declaration.pdf>

To request any academic accommodation for missed course work including exams, quizzes and assignments, please fill the self-declaration form. Hence, if you miss a test or do not submit an assignment or miss a lab quiz: immediately contact your instructor, or lab instructor, and explain why. If the reason is illness, in place of a doctor's note or medical certificate, students are asked to complete the self-declaration form available on the Registrar's Office website.

### *Paul Menton Centre for Students with Disabilities (PMC)*

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](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 test or exam requiring accommodation (if applicable). Requests made within two weeks will be reviewed on a case-by-case basis. After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website ([www.carleton.ca/pmc](http://www.carleton.ca/pmc)) for the deadline to request accommodations for the formally-scheduled exam (if applicable).

### **Academic Regulations and Request for Academic Accommodations**

<https://students.carleton.ca/course-outline/>

<https://carleton.ca/edc/teachingresources/administrative-pedagogy/academic-accommodations/>

*Use of official university e-Proctoring*

This course has timed written assessments, which may consist of midterms and final examinations. The Carleton University e-Proctoring system may be used in your assessments in case the course needs to proceed online. The Carleton University e-Proctoring system requires the use of webcams, microphones, and/or smart phones.