Course Outline: **PHYS 2604** Modern Physics I – Fall 2021

*Modern Physics for physicists and engineering physicists. This course for Fall 2021 is an IN-PERSON WITH FLEXIBLE ONLINE/ON-CAMPUS ATTENDANCE. The format is called **HYFLEX**. It is a real-time synchronous course where the professor and students meet simultaneously in room HSB 1301 and online via the web conferencing tool **BigBlueButton**, at scheduled days and times. The Professor share information, key ideas, theories, problems and concepts in an in-person and virtual course environment simultaneously. Participation in **synchronous** courses requires students to be on campus, or to have reliable, high-speed internet access, a computer (ideally with a large screen), and a headset with a microphone. **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. It is encouraged to participate in-person with campus attendance.*

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 with internet connectivity problems, who are based in different time zone, and/or who have conflicting commitments. 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)
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 (HYFLEX)
Room: Health Science Building 1301
Classes start September 8, 2021.
Friday December 10, 2021 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 20th 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, electromagnetism, optics, thermal physics and probability & statistics.

Labs **Lab superintendents:**
Igor D. Ivanovic (igor@physics.carleton.ca)
Maria Rozo Martinez (prmartin@physics.carleton.ca)
Jesse Lock (jesselock@cmail.carleton.ca)

Format: Labs are in-person (and some on-line sessions dedicated for data analysis)
Room: 3125/3145 Herzberg

Labs begin the week of September 12, 2021. Schedule, lab policy and other details of the lab will be provided by the lab superintendents.

Texts **Required:** Kenneth S. Krane, "Modern Physics", 4th 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 minimum grade of B-); 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 2021.
https://research.physics.carleton.ca/current-undergraduate-students/physics-drop-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). 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 2021). Modern Optics & Wave PHYS2202 is during Winter 2022. 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 Wednesday November 3, 2021 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 open book. Students will be given the possibility to write the exam in the classroom.
- The final exam (on-line) will be held during the final examination period in December 2021. 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. Exam formats will be discussed in advance. The final exam will be e-proctored 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 2021 term.

Week of	Experiment	Format
Sept. 12th, 2021	*Introductory Session*	Online
Sept. 19st, 2021	*Oscilloscope*	In-person
Sept. 26st, 2021	Thomson's Experiment	In-person Data Analysis (online)
Oct. 3th, 2021		
Oct. 10th, 2021	Photoelectric Effect	In-person
Oct. 17th, 2021	Millikan's Experiment	In-person
Oct. 24th, 2021	Fall Break	
Oct. 31st, 2021	Millikan's Experiment	In-person
Nov 7th, 2021	Radioactive Decay	In-person Data Analysis (online)
Nov 14th, 2021		
Nov 21st, 2021	One of: Rydberg Constant, Franck-Hertz, X-rays, Two slit	In-person Data Analysis (online)
Nov 28th, 2020		

Poll Everywhere:

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/

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 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) 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 will be used in your assessments, and requires the use of webcams, microphones, and/or smart phones.