# Course Outline: **PHYS 2604** Modern Physics I – Fall 2020

*This course for Fall 2020 is a real-time, online course where the professor and students meet via the web conferencing tool **BigBlueButton**, at scheduled days and times. The Professor share information, key ideas, theories, problems and concepts in a virtual course environment. Participation in **synchronous** courses requires students 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.*

*Web 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*** Monday 10:00 am to 11:00 am; Wednesday 10:00 am to 11:00 am.
Outside of office hours, contact me via e-mail to arrange a time to meet.

***Class time*** Monday and Wednesday 8:30 am to 10:00 am (on-line)
Classes start September 9, 2020.
Friday December 11, 2020 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$^{th}$ 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.

***Labs*** **Instructors:**
Igor D. Ivanovic (igor@physics.carleton.ca)
Maria Rozo Martinez (prmartin@physics.carleton.ca)

Format: Lab kits, web and on-line
Labs begin the week of September 14, 2020. 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*** cuLearn

***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% |
| Essay | 5% |
| Midterm exam | 10% |
| Laboratory | 30% |
| Final Exam | 30% |
| PollEverywhere | +2% (bonus for participation in ¾ of in-class activity) |

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 2020.
https://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 1 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)

***Assignments:*** There will be roughly weekly assignments throughout the term and they will generally be due one week after their distribution. Assignment will be posted on cuLearn. Students will be asked to upload their solutions (PDF format preferred) onto cuLearn. 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.

***Essay:*** The essay need to be handed by November 6, 2020. Student will be asked to write an essay on an application or a topic related to modern physics. The subject will need to be set with the professor of the course before October 16, 2020. The essay will have to be written with a Word Processor (hand written essay will not be accepted). The essay should contains one page of text for a maximum total of two pages including mathematical formula, physics equations and figures. The general guideline is one page of text with 500-600 words (single spaced), plus supporting equations or figures.

***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 November 2, 2020 at 8:30am. The students will have 45 minutes to answer the multiple choice questions and 45 minutes to provide a full detailed solution of the problem.
- The final exam (on-line) will be held during the final examination period in December 2020. It will contains two components: (1) ten multiple choice questions and (2) three problems. The student will have 90 minutes to answer the multiple choices question and 90 minutes to provide full solutions of the problems on a given date to be defined.
- All exams will be open book since examination will be on-line. It is suggested to keep an 8.5" x 11" crib sheet. Exam formats will be discussed in advance.
- 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.

***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 2020). Modern Optics & Wave PHYS2202 is during Winter 2021. Thus only basic aspects of optics will be covered in this course.

***This is the experiment schedule for PHYS2604 this Fall 2020 term.***

| Week of | Experiment | Format |
|---|---|---|
| Sept. 14th, 2020 | *Introductory Session* | In-Class Activity |
| Sept. 21st, 2020 | Thomson's Experiment | Data Analysis |
| Sept 28th, 2020 | | |
| Oct. 5th, 2020 | Photoelectric Effect | Data Analysis |
| Oct. 12th, 2020* | Planck's Constant | At-Home Lab Kit |
| Oct. 19th, 2020 | | |
| Oct. 26th, 2020 | Fall Break | |
| Nov 2nd, 2020 | Millikan's Experiment | Remote Controlled Lab |
| Nov 9th, 2020 | | |
| Nov 16th, 2020 | Radioactive Decay | Data Analysis |
| Nov 23rd, 2020 | Franck-Hertz Experiment | Data Analysis |
| Nov 30th, 2020 | Atomic Spectra | At-Home Lab Kit |
| Dec 7th, 2020** | | |

*Due to the civic holiday on Oct 12th, 2020, the lab session for students registered in section A2 will be rescheduled at a different time during the same week.

**Due to the Monday schedule on Dec 11th, 2020 (last day of Fall term classes), the lab session for students registered in section A5 will be rescheduled at a different time during the same week.

***The lab sections will be distributed as follows:***

| Lab Section | Time | Lab Supervisor |
|---|---|---|
| A1 | Tuesday, 2:30 pm – 5:30 pm | Maria Rozo Martinez |
| A2 | Monday, 2:30 pm – 5:30 pm | Maria Rozo Martinez |
| A5 | Friday, 8:30 am – 11:30 am | Maria Rozo Martinez |
| A6 | Tuesday, 8:30 am – 11:30 am | Maria Rozo Martinez |

***Poll Everywhere:***
**pollev.com/alainbcarleton**
**Student FAQ:** https://carleton.ca/edc/pollev/#sect6

### *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 | | | |

**Academic Regulations and Request for Academic Accommodations**

https://students.carleton.ca/course-outline/#academic-accommodations-for-students-with-disabilities

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

**Important dates and deadlines**

https://carleton.ca/registrar/registration/dates-and-deadlines

### *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, and requires the use of webcams, microphones, and/or smart phones.