

# PHYS 5601

## EXPERIMENTAL TECHNIQUES OF NUCLEAR AND ELEMENTARY PARTICLE PHYSICS

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**How to address me:** Dr/Prof Heilman

**Gender Pronouns:** (he/him/his) ([learn more](#))

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**Phone:** (613) 520-2600 ext. 8215 [E-mail is the best way to contact me]

**Office Location:** Room 3314 HP

**Class Times:** Monday & Wednesday, 10:05pm-11:25pm

**Prerequisites:** PHYS 4307 or equivalent, and PHYS 4707; or permission of the Department.

**Website:** <https://brightspace.carleton.ca>

**Student Hours:** TBD

### What are 'Student Hours'?

Student hours are dedicated times through the week for the course instructor and TAs to meet with YOU. Pop in to introduce yourself, ask questions about the course, or discuss content from the course.

Note: If these times don't work for you, email me and we can arrange an alternate time to meet.

**Algonquin territory acknowledgement:** We acknowledge that the land on which we gather and learn is the traditional and unceded territory of the Algonquin nation. You are invited [to learn more](#), reflect on how you can support anti-racism and decolonization, and take action. <https://carleton.ca/indigenous/>

**Course delivery:** The course will consist of asynchronous activities to be completed in advance of synchronous meetings. These meetings will follow an **in-person** model where we will gather in our classroom. I will lead a discussion of the course material covered in the out of class activities where we will digest and synthesize the course material into a cohesive and usable form. Student participation is an essential part of this instruction model, so come to class prepared and ready to engage in discussion and analysis of the pre-class activities. The synergies between the out-of-class and in-class activities are essential to how this class is taught and students are highly encouraged to attend all in-class sessions except in the case of emergency.

**Important Dates:** Please see <https://calendar.carleton.ca/academicyear/> for a full list of important dates for the term. An especially important date November 15<sup>th</sup> which is the last day for withdrawal from the course without receiving a 'WDN' on your transcript.

## Welcome to PHYS 5601!

This course focuses on building understanding of how to measure subatomic particles. We will explore some of the history of particle detector development as well as important information for designing and operating particle physics experiments. The world of particle detectors is complex and amazing and hopefully you will gain an appreciation of the

science and engineering that has gone into some of the most immense scientific endeavors that our species has ever undertaken.

**Calendar entry:** The interaction of radiation and high energy particles with matter; experimental methods of detection and acceleration of particles; use of relativistic kinematics; counting statistics.

**Inclusive teaching statement:** Science is for everyone. I am committed to fostering an environment for learning that is inclusive for everyone regardless of gender identity, gender expression, sex, sexual orientation, race, ethnicity, ability, age, class, etc. All students in the class, the instructor, and any guests should be treated with respect during all interactions. It is my hope that our class will support diversity of experience, thought, and perspective. I will continually strive to create inclusive learning environments and would therefore appreciate your support and feedback. I welcome emails or in-person communications to let me know your preferred name or pronoun. Please see the Faculty of Science Equity, Diversity, and Inclusion (EDI) statement: <https://science.carleton.ca/about/edi/>

## Learning Materials

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### Text

*This course does not follow a specific text as there is no one text that covers the material completely and appropriately. However, there is one short book that all students should read either before the beginning of term or during the first week:*

- *“Particle Physics: A Very Short Introduction”*
  - o *Frank Close*

*Beyond that, we will follow sections from several texts. Most are freely available through the Carleton Library or are otherwise Open Source. Texts that I have the rights to share will be uploaded to Brightspace. If you would like to purchase a physical book to study from and use as reference, I would suggest one of the following:*

- *Introduction to Experimental Particle Physics [Reprint Edition]*
  - o *R. Fernow*
  - o *Cambridge University Press – 2010*
- *Techniques for Nuclear and Particle Physics Experiments (ebook available through the Carleton Library)*
  - o *W.R. Leo*
  - o *Springer*
- *Principles of Radiation Interaction in Matter and Detection*
  - o *C. Leroy and P.G. Rancoita*
  - o *World Scientific Publishing*

## Assessment in this Course

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Research about learning strongly suggests that the most important factor in learning is doing the work of reading, writing, recalling, practicing, synthesizing, and analyzing. Learning happens best when people actively engage material on a consistent basis, and that is why we have high standards in this course. We are confident that, with appropriate effort, you **all** can meet those standards.

We also make an effort to reduce unintentional bias in grading by, for example and when possible, grading assignments one question at a time (grading all of question 1 before grading any of question 2), grading anonymously, and using rubrics.

All marks will be posted on Brightspace. If you think there is an error in the Brightspace gradebook, contact me immediately as it will be used as the official record for your marks.

## Grade Breakdown

COMPONENT	GRADE VALUE
ASSIGNMENTS	40%
CLASS DISCUSSION LEAD	10%
MID-TERM ORAL EXAMS	20% (10% each)
TAKE HOME EXAM	30%

## Assignments

Assignments will be distributed every few weeks during the term and will generally be due 2 weeks after they are distributed. Late assignments will not be accepted without an acceptable reason such as illness.

Students are encouraged to discuss concepts and strategies related to solving the assignments; however, 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 will be posted and submitted on Brightspace. Hand-written solutions may be scanned or photographed for upload. The complete assignment must be uploaded as a single PDF file.

## Class Discussion Lead

Once during the term, each student will lead a discussion on a particular particle physics experiment that utilizes the techniques discussed in the course. The student will provide a representative paper to the class in advance of their assigned date and then will give a short introduction to the experiment before leading a discussion with the rest of the class. The discussion should focus on the principles the detector operates on, its relevant specifications and any challenges the research team had to overcome when designing/calibrating/operating the detector. More description of the process of these discussions will be given in class.

## Oral Examination

We will have two short oral examinations during the course term. These will take place during class periods which will be scheduled once the term begins. A grading rubric for the examinations will be provided later in the term.

## Take Home Exam

In lieu of a traditional final exam, a take home final will be given during the final exam period. The exam will be distributed at 9 AM on the day of the exam and will be due 8 hours later. Any reference material will be allowed during the exam but collaboration with anyone else will not be permitted. The date for the take home final will be set once the university has set the final exam schedule for other courses to ensure that the take home final does not conflict with other exams.

# Community Guidelines

The following values are fundamental to academic integrity and are adapted from the International Center for Academic Integrity<sup>2</sup>. In our course, we will seek to behave with these values in mind:

	As students, we will...	As a teaching team, we will...
<b>Honesty</b>	<ul style="list-style-type: none"> <li>Honestly demonstrate our knowledge and abilities on assignments and exams</li> <li>Communicate openly without using deception, including citing appropriate sources</li> </ul>	<ul style="list-style-type: none"> <li>Give you honest feedback on your demonstration of knowledge and abilities on assignments and exams</li> <li>Communicate openly and honestly about the expectations and standards of the course through the syllabus, and with respect to assignments and exams</li> </ul>
<b>Responsibility</b>	<ul style="list-style-type: none"> <li>Complete assignments on time and in full preparation for class</li> <li>Show up to class on time, and be mentally/physically present</li> <li>Participate fully and contribute to team learning and activities</li> </ul>	<ul style="list-style-type: none"> <li>Give you timely feedback on your assignments and exams</li> <li>Show up to class on time, and be mentally &amp; physically present</li> <li>Create relevant assessments and class activities</li> </ul>
<b>Respect</b>	<ul style="list-style-type: none"> <li>Speak openly with one another, while respecting diverse viewpoints and perspectives</li> <li>Provide sufficient space for others to voice their ideas</li> </ul>	<ul style="list-style-type: none"> <li>Respect your perspectives even while we challenge you to think more deeply and critically</li> <li>Help facilitate respectful exchange of ideas</li> </ul>
<b>Fairness</b>	<ul style="list-style-type: none"> <li>Contribute fully and equally to collaborative work, so that we are not freeloading off others</li> <li>Not seek unfair advantage over fellow students in the course</li> </ul>	<ul style="list-style-type: none"> <li>Create fair assignments and exams, and grade them in a fair, and timely manner</li> <li>Treat all students equitably</li> </ul>
<b>Trust</b>	<ul style="list-style-type: none"> <li>Not engage in personal affairs while on class time</li> <li>Be open and transparent about what we are doing in class</li> <li>Not distribute course materials to others without authorization</li> </ul>	<ul style="list-style-type: none"> <li>Be available to all students when we say we will be</li> <li>Follow through on our promises</li> <li>Not modify the expectations or standards without communicating with everyone in the course</li> </ul>
<b>Courage</b>	<ul style="list-style-type: none"> <li>Say or do something when we see actions that undermine any of the above values</li> <li>Accept a lower or failing grade or other consequences of upholding and protecting the above values</li> </ul>	<ul style="list-style-type: none"> <li>Say or do something when we see actions that undermine any of the above values</li> <li>Accept the consequences (e.g., lower teaching evaluations) of upholding and protecting the above values</li> </ul>

<sup>2</sup> This class statement of values is adapted from Tricia Bertram Gallant, Ph.D.

# Online Community Expectations for Social Platforms

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With the growing use of social platforms (e.g., Discord) on campuses, it is important to keep in mind that university codes of conduct still apply to the behaviours of students online. Please be considerate and respectful while engaging with peers and remember that we are all humans, and that your words matter. If any student witnesses or experiences harassment, I encourage you to reach out to me. Alternatively, you can contact [Ombuds Services](#) or [Carleton Equity and Inclusive Communities](#).

Online communities can be highly beneficial to students and can help to facilitate learning within the course. I encourage people to ask questions, learn from one another, and have open discussions about class material. That said, any acts of academic misconduct (i.e., cheating) will not be tolerated and will result in serious consequences ranging from a grade reduction to expulsion (see [academic integrity violations](#)).

- Examples of appropriate peer-to-peer sharing/learning vary from course to course. In this course appropriate peer-to-peer sharing includes: identifying the proper formula to use, identifying an incorrect or missing step in a person's work, brainstorming potential reasons behind a concept, suggesting helpful sites and videos for learning a concept, posting your own work showing only a specific step or process for illustrative purposes (note: this is very different from posting your work and solution for others to simply copy)
- Examples of unacceptable peer-to-peer sharing: Posting or sharing the answers, indicating which answers are correct on assignments, sharing links to solutions, posting your own complete work for a question/solution

I ask that you read and follow the list of guidelines below (moderators may re-post, if helpful):

## Feeling Sick?

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If you feel very sick (e.g., fever, chills, stomach upset) do not come to class or campus. Send an email to either myself or your laboratory instructor to make arrangements for any important elements of the course you may have missed. It is also a good idea to contact your classmates to help you to catch up with anything you may have missed.

## Mental Health

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If you are struggling, please do not hesitate to reach out. I am happy to listen, and/or direct you to resources that might help. In terms of class, if you need extra help or missed a lesson, don't stress! Email me and we will set a time to meet. I'll work with you, I promise. Remember that Carleton also offers an array of mental health and well-being resources, which can be found [here](#).

## University Policies

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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			

WDN = Withdrawn from the course

ABS = Student absent from final exam

DEF = Deferred

FND = (Failed, no Deferred) = student could not pass even with 100% on final exam

## Academic Accommodations, Regulations, Plagiarism, Etc.

Carleton University is committed to providing access to the educational experience in order to promote academic accessibility for all individuals.

Academic accommodation refers to educational practices, systems and support mechanisms designed to accommodate diversity and difference. The purpose of accommodation is to enable students to perform the essential requirements of their academic programs. At no time does academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the University. More information can be found at:

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

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:

<https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/>

## Academic Accommodations for Students with Disabilities

If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or [pmc@carleton.ca](mailto:pmc@carleton.ca) for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. For more details, visit the [Paul Menton Centre website](#).

## Addressing Human Rights Concerns

The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the [Department of Equity and Inclusive Communities](#) at [equity@carleton.ca](mailto:equity@carleton.ca).

## Religious Obligations

Please contact me with requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the [Student Guide to Academic Accommodation \(PDF, 2.1 MB\)](#).

## Survivors of Sexual Violence

As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: <https://carleton.ca/sexual-violence-support/>

## Accommodations for Missed Work

Carleton recognizes that students may experience unexpected, temporary incapacitation (i.e., illness, injury, or extraordinary circumstances outside of a student's control). As a result, Carleton has put into place a protocol for students to apply for accommodations using a self-declaration form in the event of missed work. The form can be found at:

<https://carleton.ca/registrar/wp-content/uploads/self-declaration.pdf> Note that these forms should be used for short-term concerns related to missed work; if you are experiencing chronic, ongoing challenges which necessitate a broader solution, I recommend reaching out to the Paul Menton Centre and/or the Care Support team.

## For Pregnancy

Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the [Student Guide to Academic Accommodation \(PDF, 2.1 MB\)](#).

## Accommodation for Student Activities

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the [Senate Policy on Accommodation for Student Activities \(PDF, 25KB\)](#).

## Academic Integrity

Academic Integrity is upholding the values of honesty, trust, respect, fairness, responsibility, and courage that are fundamental to the educational experience. Carleton University provides supports such as academic integrity workshops to ensure, as far as possible, that all students understand the norms and standards of academic integrity that we expect you to uphold. Your teaching team has a responsibility to ensure that their application of the Academic Integrity Policy upholds the university's collective commitments to fairness, equity, and integrity. (Adapted from [Carleton University's Academic Integrity Policy](#), 2021).

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
- Using artificial intelligence tools such as ChatGPT when your assessment instructions say that it is not permitted

Please review the checklist [linked here](#) to ensure you understand your responsibilities as a student with respect to academic integrity and this course.

## Sanctions for Not Abiding by Carleton's Academic Integrity Policy

A student who has not upheld their responsibilities under Carleton's Academic Integrity Policy may be subject to one of several sanctions. A list of standard sanctions in science can be found [here](#).

Additional details about this process can be found on [the Faculty of Science Academic Integrity website](#). Students are expected to familiarize themselves with and follow the Carleton University [Student Academic Integrity Policy](#). The Policy is strictly enforced and is binding on all students.

## Student Rights & Responsibilities

Students are expected to act responsibly and engage respectfully with other students and members of the Carleton and the broader community. See the [7 Rights and Responsibilities Policy](#) for details regarding the expectations of non-academic behaviour of students. Those who participate with another student in the commission of an infraction of this Policy will also be held liable for their actions.

## Student Concerns

If a concern arises regarding this course, **your first point of contact is me**: Email or drop in during student hours and I will do my best to address your concern. If I am unable to address your concern, the next points of contact are (in this order):



**Note:** You can also bring your concerns to [Ombuds services](#).

## Assistance for Students

Academic and Career Development Services: <http://carleton.ca/sacds/>

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/>