Nuclear Physics

PHYS 4608 (Fall 2025)

Course Instructor: Emily Heath

How to address me: Professor/Dr Heath

Gender Pronouns: she/her/hers

Email: Emily.Heath@Carleton.ca

Note: If you have or question or would like to talk with me, you can send an email, visit me during student hours (see below), or approach me after lecture.

Phone: (613) 555-2829 ext. 4053

Student Hours: will be posted on Brightspace

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

Office Location: Room 2424, Herzberg Laboratories

Class Location: posted on Brightspace

Class Times: Wednesdays & Fridays, 8:35am-10:55am

Prerequisites: PHYS 3606 or PHYS 3608 or permission of the Department.

Department/Unit: Physics

Teaching Assistant: Ishan Vyas

Email: ishanvyas@cmail.carleton.ca

Note: for any questions about your assignment mark, please email the TA first before contacting the instructor.

Welcome to this Course!

In this course we will apply the concepts learned in your electricity & magnetism, modern physics and quantum mechanics courses towards understanding the properties of nuclei and how these properties transform through nuclear reactions or radioactive decay. The second part of the course will cover how radiation emitted by these processes interacts with matter and the different types of detectors used to measure radiation. We will finish up with a discussion of how nuclear fission and fusion can be used in power generation.

Topics to be covered

Week	Lecture	Date	Topics	Textbook Chapter(s)	
1	1	Sept 3	Basic facts and definitions	1	
	2	Sept 5	Liquid Drop model	2.2	Post HW1
2	3	Sept 10	Shell model	2.3, 2.4	
	4	Sept 12	Collective States	2.5	
3	5	Sept 17	Radioactivity and radioactive decay	1.5	
	6	Sept 19	Decay chains, radioactive dating	1.5	HW1 due Post HW2
4	7	Sept 24	Alpha decay	3.4	
	8	Sept 26	Beta decay	3.3	
5	9	Oct 1	Gamma decay	3.2	
	10	Oct 3	Catch-up		HW2 due Post HW3
6	11	Oct 8	Nuclear collisions	1.6, 4	
	12	Oct 10	Coulomb scattering	1.6	
7	13	Oct 15	QM scattering	4.2	
	14	Oct 17	Resonance and compound nucleus	1.6, 4.5	HW3 due
8		Oct 20-24	Fall Reading Week (no classes)		
9		Oct 29	Midterm exam		Post HW4
	15	Oct 31	Interactions of Radiation with Matter – charged particles	5	
10	16	Nov 5	Interactions of Radiation with Matter – photons and neutrons	5	
	17	Nov 7	Radiation detectors – gas detectors	6.2	
11	18	Nov 12	Solid-state detectors	6.3, 6.4	HW4 due Post HW5
	19	Nov 14	Requirements for power generation from fission	10	
12	20	Nov 19	Requirements for power generation from fusion	11.1 – 11.4	
	21	Nov 21	Stellar nucleosynthesis	11.5 – 11.7	
13-15	22	Nov 26 – Dec 3	In-class presentations		HW5 due

Important dates and deadlines can be found here: https://carleton.ca/registrar/registration/dates/academic-dates/, including class suspension for fall, winter breaks, and statutory holidays.

Assessments

Grade Breakdown

COMPONENT	GRADE VALUE
IN-CLASS PARTICIPATION	10%
ASSIGNMENTS	25%
MIDTERM	15%
FINAL EXAM	35%
PRESENTATION	15%

IN-CLASS PARTICIPATION

We will be using an in-class response system, Wooclap, to administer short in-class quizzes to review concepts from previous lectures. Grades will be based on a combination of participation and correctness.

ASSIGNMENTS

There are 5 assignments in this course. Assignments will be posted and submitted on Brightspace approximately every 2 weeks. Hand-written solutions may be scanned or photographed for upload. The complete assignment must be uploaded as a single PDF file. The lowest assignment mark will not count towards the final grade.

Late and Missed Assignment Policies:

Late assignments will lose 10% per day. An assignment can no longer be submitted 5 days following its initial deadline. If you are unable to meet an assignment deadline due to extenuating circumstances then you must complete an academic considerations form. Students may submit this form up to two times throughout the semester. Longer term accommodations must be discussed with the course instructor.

MIDTERM EXAM

The midterm exam will be held in class on Wednesday October 29th. More details about the exam (eg. formula sheet) will be provided closer to that date.

PRESENTATION

During the last week of classes, students will give in-class presentations on an application of nuclear physics. Students can select from a list of topics that will be provided by the instructor, or they can propose their own (subject to instructor approval).

Learning Materials

TEXTBOOK:

Lilley, John (2021). Nuclear Physics: Principles and Applications. Wiley & Sons, 2001.

This book is available as an e-text at Carleton's MacOdrum library (no need to buy).

Academic Accommodations and Regulations

Carleton is committed to providing academic accessibility for all individuals. You may need special arrangements to meet your academic obligations during the term. The accommodation request processes are outlined on the Academic Accommodations website (https://students.carleton.ca/course-outline/).

Statement on Chat GPT/Generative AI usage

As our understanding of the uses of AI and its relationship to student work and academic integrity continue to evolve, students are required to discuss their use of AI in any circumstance not described here with the course instructor to ensure it supports the learning goals for the course.

AI use in this course: Students may use AI tools for sharing ideas, clarifying challenging concepts, or getting started on projects. Some acceptable uses include:

- Brainstorming ideas (e.g., generating essay topics with ChatGPT, using Microsoft Word's Smart Lookup to find inspiration and related topics).
- Creating outlines (e.g., using AI to structure an essay or presentation flow, using Microsoft Word's Outline View with AI suggestions).
- Providing definitions or explanations of complex concepts (e.g., using AI to explain a difficult theory, e.g., using Microsoft Word's Researcher tool to find relevant information).

Documenting use of AI: It is necessary to document your use of AI in this course, using the following guidelines:

- Clearly identify and cite AI-generated text (e.g., 'The following paragraph was generated by ChatGPT/Microsoft Word's Researcher tool'). Please consult resources on the Library website.
- Review, edit, and ensure the accuracy and originality of final submissions.
- AI-generated content should not exceed 30% of the total assignment length.

Why have I adopted this policy? This policy supports the use of AI as a supplementary tool, helping students develop ideas and structure their work while emphasizing the importance of transparency and personal engagement with the content. AI can be used for inspiration and foundational support, and can encourage students to critically assess and refine AI-generated material.

Statement on Academic Integrity

Students are expected to uphold the values of academic integrity, which include fairness, honesty, trust, and responsibility. Examples of actions that that compromise these values include but are not limited to plagiarism, accessing unauthorized sites for assignments or tests, unauthorized collaboration on assignments or exams, and using artificial intelligence tools such as ChatGPT when your assessment instructions say it is not permitted.

Misconduct in scholarly activity will not be tolerated and will result in consequences as outlined in Carleton University's Academic Integrity Policy. A list of standard sanctions in the Faculty of 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 abide by Carleton University's Academic Integrity Policy.

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.