

# Medical Radiation Physics

PHYS 5203 (fall 2024)

**Instructor:** Rowan Thomson

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

**Gender Pronouns:** she/her/hers ([learn more](#))

**Email:** [rowan.thomson@carleton.ca](mailto:rowan.thomson@carleton.ca)

**Phone:** (613) 520-2600 ext. 7540

**Student Hours:** 10:10-11:00 am Tuesday/Thursday.

**Class Location:** see Carleton Central

**Visual directions:** <https://www.classfind.com/carleton/>

**Class Times:** Tuesday & Thursday, 8:35am-9:55am

**Prerequisites:** Permission of the Department.

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

## What are 'Student Hours'?

Student hours are office hours renamed, i.e., dedicated times through the week for the course instructor 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

**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/>

## Welcome to this Course!

This course focuses on fascinating modern physics in the context of radiation medicine. Critically important to people's lives around the world, radiation medicine plays many roles from diagnosis to treatment. For example, 1/4 of Canadians are expected to undergo radiation treatment for cancer in their lifetime. We will be learning about the physics that plays a central role in all of this! You will need to remember your background in Modern Physics, particularly Special Relativity and Quantum Mechanics, plus Electricity and Magnetism.

**Calendar entry:** Interaction of electromagnetic radiation with matter. Sources: X-ray, accelerators, radionuclide. Charged particle interaction mechanisms, stopping powers, kerma, dose. Introduction to dosimetry. Units, measurements, dosimetry devices.

**Learning objectives:**

1. Master the details of and be able to explain, be familiar with typical values concerning, and be able to perform calculations for and connecting:
  - transfer of energy from radioactive decay to decay particles, photons, excited nuclear states, excited atomic states, and ultimately their relaxation via photon and electron emission
  - kinetics of isotope decay chains, radioisotope generators
  - interaction cross section concept and types - total, energy transferred, energy absorbed, expressed in linear terms, mass terms, atomic, electronic
  - photon interactions with matter: photoelectric effect, incoherent scattering, coherent scattering, pair production, photonuclear absorption
  - charged particle interactions with matter, description by collisional (ionizational) and radiative stopping powers
  - production of radiation by an x-ray tube, basic HV circuit, control circuitry
  - production of radiation by linear accelerators, including overall machine design features including head and accelerating waveguide
  - production of radiation by isotope machines such as  $^{60}\text{Co}$
  - penetration of photon and particulate radiation into matter, including the concepts of buildup, S/P, backscatter, HVL
  - kerma and dose, collision kerma, air kerma and exposure, and their units
  - basic cavity theory, the concept of absolute dosimetry
  - essentials of radiation protection, including dose equivalent and whole-body effective dose, medical exposures compared to annual background
2. Enhance and extend problem-solving skills in radiation physics by working through advanced multi-step problems using the tools of physics, calculus, algebra, and numerical analysis.
3. Become familiar with the general outline of the field of medical physics, its history, subfields, the Canadian context, Canadian and international scientific and professional organizations.

**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/>

## 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.

## Learning Materials

**Texts:** Many of these are available (virtually – ebooks; physically) at Carleton’s MacOdrum Library [no need to buy!]

- \*P. Andreo, D.T. Burns, A.E. Nahum, J. Seuntjens, & F.H. Attix, *Fundamentals of Ionizing Radiation Dosimetry (“FIORD”)*, 2017. [Carleton library has as ebook with ability to download chapters]
- \*E.B. Podgorsak, *Radiation Physics for Medical Physicists*, 3<sup>rd</sup> edition, 2016. [Carleton library has 2<sup>nd</sup> edition as ebook which has most of the same content, but not chapters 16 and 17 on dosimetry]
- P. Mayles, A. Nahum, J.C. Rosenwald (eds.), *Handbook of Radiotherapy Physics: Theory and Practice*, 2007.
- H.E. Johns & J.R. Cunningham, *The Physics of Radiology*, 4<sup>th</sup> edition, 1983.  
C.J. Karzmark and R.J. Morton, *A Primer on Theory and Operations of Linear Accelerators in Radiation Therapy*, 2nd ed., Medical Physics Publishing, Madison Wisconsin, 1998.

\*Will be referred to most heavily.

### Technology Checklist:

- An internet-enabled computer (laptop/desktop) with appropriate software for assignments
- Access to reliable internet for using course website

## Assessment in this Course

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.

### Grade Breakdown

COMPONENT	GRADE VALUE
IN-CLASS PARTICIPATION	15%
ASSIGNMENTS	35%
MIDTERM TEST AND ORAL INTERVIEW	20%
FINAL EXAM	20%
ORAL INTERVIEW	10%

### Assignments

Assignments will be distributed roughly each week throughout the term and will generally be due in class 1 week after distribution. Late assignments will not generally be accepted.

Students are permitted 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 also have components that will be presented by each student to classmates during class times.

Assignments will be posted and submitted on Brightspace. Hand-written solutions may be scanned or photographed for upload. A computer will be needed for graphing and some word processing. The complete assignment must be uploaded as a single PDF file.

The lowest 2 assignment grades will be dropped.

### **Midterm test and Oral interview**

There will be one 70-minute test held in class, tentative date Oct 10.

There will be one 15-minute midterm oral interview scheduled 1-on-1, tentative date Nov 14.

Looking for help preparing for midterms? Student Academic Success Services (SASS) at Carleton offers supports and the Science Student Success Centre (SSSC) provides help with study skills.

### **Final exam**

The final exam will take place during the final exam period (Dec 9-21).

### **Oral interview**

In addition to the final exam, a 15 minute oral interview with each student will take place during the final exam period.

- In the case of an exam deferral for legitimate reasons, please inform me within 24 hours of the regularly scheduled midterm to arrange a time to write the deferred exam.

## **Hospital tours and optional hands-on activities**

Depending on COVID restrictions, there may be an opportunity to tour facilities at the Ottawa Civic Hospital and Ottawa General Hospital Cancer Centre which are related to the material being taught in the course. Participation in these tours is entirely optional. There may also be an opportunity to carry out a hands-on x-ray half-value layer (HVL) experiment.

## **Feeling Sick?**

If you feel very sick (e.g., fever, chills, stomach upset) do not come to class or campus.

## Mental Health

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 class, don't stress - email me and we will set a time to meet. Remember that Carleton also offers an array of mental health and well-being resources, which can be found [here](#).

## Online Community Expectations for Social Platforms

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 or assignment

## University Policies

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			
DEF = Deferred			

## Academic Accommodations, Regulations, Plagiarism, Etc.

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 ([students.carleton.ca/course-outline](https://students.carleton.ca/course-outline))

- **Deferred/missed term work for short-term accommodation (5 days or less):**  
[stipulate the process by which the student may gain informal accommodation for short term incapacitation (i.e., via submitting a [self-declaration form](#), a written email to the professor, TA, etc.), and the appropriate accommodation (e.g., extension, alternate assignment, etc.).]
- **Deferred/missed term work for longer term incapacitation (5 days or longer);**  
[It would be helpful to include a statement to indicate to the student to email you (the instructor) for guidance. The student will need to go to the Registrar's Office for support, but it is important that the instructor is apprised of the long-term accommodation needs.] If you require accommodations for this course that are longer than the 5-day (short-term) period, please email me to discuss how/whether accommodation needs could be met for this course.

## 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/>

Week	Monday	Tuesday	Wednesday	Thursday	Friday
<b>September</b>					
1	2	3	<i>Fall term begins</i> 4	L1. A1 out 5	6
2	9	L2 10	11	L3. A2 out 12	A1 in 13
3	16	L4 17	18	L5. A3 out 19	A2 in 20
4	23	L6 24	25	L7. A4 out 26	A3 in 27
<b>October</b>					
5	30	L8 1	2	L9. A5 out 3	A4 in 4
6	7	L10 8	9	L11. Midterm #1 10	11
7	14	L12 15	16	L13. A6 out 17	A5 in 18
No Classes	<i>Fall Break</i> 21	<i>Fall Break</i> 22	<i>Fall Break</i> 23	<i>Fall Break</i> 24	<i>Fall Break</i> 25
8	28	29	30	31	1
<b>November</b>					
9	28	L14 29	30	L15. A7 out 31	A6 in 1
10	4	L16 5	6	L17. A8 out 7	A7 in 8
11	11	L18 12	13	L19. Midterm Oral Interview 14	15
12	18	L20 19	20	L21. A9 out 21	A8 in 22
13	25	L22 26	27	L23 28	A9 in 29
<b>December</b>					
14	2	L24 3	4	L25 5	<i>Last Day of Classes</i> 6