

# PHYS 5203: Medical Radiation Physics

**Course Instructor:** Emily Heath

**How to address me:** Dr Heath

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

**Email:** Emily.Heath@Carleton.ca

Note: If you have a 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) 520-2600 ext. 4053

**Student Hours:** by appointment (send an email)

## What are 'Student Hours'?

*Student hours are 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.*

**Office Location:** Room 2424, Herzberg Laboratories

**Class Location:** 217 Tory Building (TB 217)

[Click here for visual directions.](#)

**Class Times:** Monday & Wednesday, 4:05pm-5:25pm

**Prerequisites:** Permission of the Department.

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

**Land Acknowledgement:** Here at Carleton University, it is important that we acknowledge that the land on which we gather is the traditional and unceded territory of the Algonquin nation.

## Welcome to this Course!

This course applies concepts from modern physics (special relativity, quantum mechanics) and electricity and magnetism in the context of radiation medicine. Radiation medicine uses ionizing radiation in the diagnosis and treatment of cancer as well as other diseases. In this course we will be learning about the sources of ionizing radiation used in radiation medicine, how the radiation interacts in the human body and the key concepts for quantifying the amount of radiation delivered.

**Course level 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\*. 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 of 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

**Textbooks:** *All of these are available (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, 2017.
- E.B. Podgorsak, Radiation Physics for Medical Physicists, 3rd edition, 2016.
- 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, 4th 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.

## 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
ASSIGNMENTS	50%
MIDTERM TESTS	25%
FINAL EXAM	15%
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 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 Tests

There will be two 70-minute (in-person) tests held during class time, tentative dates Oct 12 and Nov 16.

Looking for help preparing for midterms? [Student Academic Success Services \(SASS\)](#) at Carleton offers course-targeted study groups and 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 10-22.

## Oral interview

In addition to the final exam, a 15 minute oral interview with each student will take place (to be scheduled after the final 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. This experiment is also optional and does not count towards your grade in this course.

## Special Information Regarding COVID-19

It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are [a number of actions you can take](#) to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.

**Feeling sick?** Remaining vigilant and not attending work or school when sick or with symptoms is critically important. If you feel ill or exhibit COVID-19 symptoms do not come to class or campus. If you feel ill or exhibit symptoms while on campus or in class, please leave campus immediately. In all situations, you must follow Carleton's [symptom reporting protocols](#).

**Masks:** Carleton has paused the [COVID-19 Mask Policy](#), but continues to strongly recommend masking when indoors, particularly if physical distancing cannot be maintained. It may become necessary to quickly reinstate the mask requirement if pandemic circumstances were to change.

**Vaccines:** While proof of vaccination is no longer required to attend campus or in-person activity, it may become necessary for the University to bring back proof of vaccination requirements on short notice if the situation and public health advice changes. Students are strongly encouraged to get a full course of vaccination, including booster doses as soon as they are eligible, and submit their booster dose information in [cuScreen](#) as soon as possible. Please note that Carleton cannot guarantee that it will be able to offer virtual or hybrid learning options for those who are unable to attend the campus.

All members of the Carleton community are required to follow requirements and guidelines regarding health and safety which may change from time to time. For the most recent information about Carleton's COVID-19 response and health and safety requirements please see the [University's COVID-19 website](#) and review the [Frequently Asked Questions \(FAQs\)](#). If you have additional questions after reviewing, please contact [covidinfo@carleton.ca](mailto:covidinfo@carleton.ca).

## Note About COVID-19 & Mental Health

The global pandemic has led to extra stress and uncertainty for everyone, and while we may all be experiencing the same storm, this does not mean that we are all in the same boat! 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

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

## Important dates and deadlines

A list of important academic deadlines can be found here:

<https://calendar.carleton.ca/academicyear/>

Please note that November 11 is the last day to withdraw from late fall term courses with a full fee adjustment. Withdrawals after this date will result in a permanent notation of WDN on the official transcript. November 15<sup>th</sup> is the last day for academic withdrawal.

## 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 be experiencing greater stress and other life factors that are not in their 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

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	5	6	7 <i>Lecture 1</i> <i>Assignment 1 posted</i>	8	9
2	<i>Lecture 2</i> 12	13	14 <i>Lecture 3</i> <i>Assignment 2 posted</i>	<i>Assignment 1 due</i> 15	16
3	<i>Lecture 4</i> 19	20	21 <i>Lecture 5</i> <i>Assignment 3 posted</i>	<i>Assignment 2 due</i> 22	23
4	<i>Lecture 6</i> 26	27	28 <i>Lecture 7</i> <i>Assignment 4 posted</i>	<i>Assignment 3 due</i> 29	30
<b>October</b>					
5	<i>Lecture 8</i> 3	4	5 <i>Lecture 9</i> <i>Assignment 5 posted</i>	<i>Assignment 4 due</i> 6	7
6	<i>Stat Holiday</i> <i>– no class</i> 10	11	12 <b>Midterm #1</b> <b>(in class)</b>	13	14
7	<i>Lecture 10</i> 17	18	19 <i>Lecture 11</i> <i>Assignment 6 posted</i>	<i>Assignment 5 due</i> 20	21
<b>No</b> <b>Classes</b>	<i>Fall Break</i> 24	<i>Fall Break</i> 25	<i>Fall Break</i> 26	<i>Fall Break</i> 27	<i>Fall Break</i> 28
<b>November</b>					
8	<i>Lecture 12</i> 31	1	2 <i>Lecture 13</i> <i>Assignment 7 posted</i>	<i>Assignment 6 due</i> 3	4
9	<i>Lecture 14</i> 7	8	9 <i>Lecture 15</i> <i>Assignment 8 posted</i>	<i>Assignment 7 due</i> 10	11
10	<i>Lecture 16</i> 14	15	16 <b>Midterm #2</b> <b>(in class)</b>	17	18
11	<i>Lecture 17</i> 21	22	23 <i>Lecture 18</i> <i>Assignment 9 posted</i>	<i>Assignment 8 due</i> 24	25
<b>December</b>					
12	<i>Lecture 19</i> 28	29	30 <i>Lecture 20</i>	<i>Assignment 9 due</i> 1	2
13	<i>Lecture 21</i> 5	6	7 <i>Lecture 22</i>	8	9 <i>Lecture 23</i> <i>Last Day of Fall term</i>