PHYS 5203 Medical Radiation Physics

Instructor: Rowan Thomson

How to address me: Dr/Prof Thomson

Gender Pronouns: she/her/hers (learn more)

Email: rowan.thomson@carleton.ca

Phone: (613) 520-2600 ext. 7540 [Use email instead. Voicemail is NOT reliably checked during the pandemic]

Student Hours: by appointment (send an email).

Office Location: Room 2466 HP

Class Location: 210 TB or virtually (see "Course delivery" below)

Visual directions: https://www.classfind.com/carleton/

Class Times: Monday & Wednesday, 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. This course will be delivered with flexible synchronous classes (see below) in which students are encouraged to ask questions. If you would like to meet separately, feel free to email me to set up a 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 a mixture of synchronous meetings and asynchronous activities. The synchronous meetings will follow the Hybrid-flexible (HyFlex https://carleton.ca/tls/2021/hyflex-a-new-teaching-option-for-the-fall/) model to provide us with flexibility in these uncertain times due to the pandemic. With HyFlex, students choose how they will attend each class, either in person on campus or online via Zoom.

- Asynchronous activities: Material (course notes, slides + audio) will be posted to Birghtspace. You are expected to review and study material; keep up to date. The asynchronous activities are intended to provide flexibility to students.
- Synchronous classes: These will be held during the class times (Monday, Wednesday at starting at 8:35 am Ottawa time) via HyFlex, meaning you can come to class (TB 210) or attend virtually (Zoom). These sessions may not last the full 80 minute nominal class time because there will also be asynchronous activities. These meetings will be used flexibly and will include a combination of discussion of lecture materials, answering questions raised regarding asynchronous activities, discussing

assignments (problem-solving strategies; taking up problems), doing example problems, and students presenting assignment questions. Midterm tests will also take place during these times.

- If I notice that students are not generally attending class in person (only via zoom), I will revert to online course delivery.
- There may also be certain classes that will be only online: e.g., if I cannot access campus; midterm tests.
- You will be notified by email/Brightspace announcements of changes for synchronous meetings.

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}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…
Honesty	• Honestly demonstrate our knowledge and abilities on assignments and exams • Communicate openly without using deception, including citing appropriate sources	• Give you honest feedback on your demonstration of knowledge and abilities on assignments and exams • Communicate openly and honestly about the expectations and standards of the course through the syllabus, and with respect to assignments and exams
Responsibility	• Complete assignments on time and in full preparation for class • Show up to class on time, and be mentally/physically present • Participate fully and contribute to team learning and activities	• Give you timely feedback on your assignments and exams • Show up to class on time, and be mentally & physically present • Create relevant assessments and class activities
Respect	• Speak openly with one another, while respecting diverse viewpoints and perspectives • Provide sufficient space for others to voice their ideas	• Respect your perspectives even while we challenge you to think more deeply and critically • Help facilitate respectful exchange of ideas
Fairness	• Contribute fully and equally to collaborative work, so that we are not freeloading off others • Not seek unfair advantage over fellow students in the course	• Create fair assignments and exams, and grade them in a fair, and timely manner • Treat all students equitably
Trust	• Not engage in personal affairs while on class time • Be open and transparent about what we are doing in class • Not distribute course materials to others without authorization	• Be available to all students when we say we will be • Follow through on our promises • Not modify the expectations or standards without communicating with everyone in the course
Courage	• Say or do something when we see actions that undermine any of the above values • Accept a lower or failing grade or other consequences of upholding and protecting the above values	• Say or do something when we see actions that undermine any of the above values • Accept the consequences (e.g., lower teaching evaluations) of upholding and protecting the above values

[2] 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, 3rd edition, 2016. [Carleton library has 2nd 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, 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.

**Will be referred to most heavily.*

Technology Checklist:

- ☐ An internet-enabled computer (laptop/desktop), preferably with webcam and headset with microphone.
- ☐ Zoom software installed on computer (can also install on phone as backup!)
- ☐ Access to reliable internet

Note: If there are issues with equipment, please email me as soon as possible and I will provide information on Carleton's technology bursary application. Options for purchase include inexpensive options for technology (Best Buy refurbished products, Kijiji); single workspaces for student use on campus (pending pandemic restrictions).

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 also have components that will be presented by each student to classmates during class times; if you have trouble attending the class times, please contact me.

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 tests held during class time, tentative dates Oct 18 and Nov 24. These will be administered virtually (similar to assignments) with 15 minutes provided for scanning and submitting solutions. If you have technical issues with submissions, please email me immediately.

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 and will be administered virtually. (Note: If exam is different, include relevant details here (e.g., is it in-person or online? This could impact whether students can travel).

Oral interview

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

- The tests and exam will be open book and open notes, but you may not use the internet (outside of our Brightspace course pages) or consult with any other person.
- 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.

Special Information Regarding COVID-19

All members of the Carleton community are required to follow COVID-19 prevention measures and all mandatory public health requirements (e.g., wearing a mask, physical distancing, hand hygiene, respiratory and cough etiquette) and mandatory self-screening prior to coming to campus daily.

If you feel ill or exhibit COVID-19 symptoms while on campus or in class, please leave campus immediately, self-isolate, and complete the mandatory symptom reporting tool. For purposes of contact tracing, attendance will be taken in all classes and labs. Participants can check in using posted QR codes through the cuScreen platform where provided. Students who do not have a smartphone will be required to complete a paper process as indicated on the COVID-19 website.

All members of the Carleton community are required to follow guidelines regarding safe movement and seating on campus (e.g., directional arrows, designated entrances and exits, designated seats that maintain physical distancing). In order to avoid congestion, allow all previous occupants to fully vacate a classroom before entering. No food or drinks are permitted in any classrooms or labs.

For the most recent information about Carleton's COVID-19 response and required measures, please see the University's COVID-19 webpage and review the Frequently Asked Questions (FAQs). Should you have additional questions after reviewing, please contact covidinfo@carleton.ca.

Please note that failure to comply with University policies and mandatory public health requirements, and endangering the safety of others are considered misconduct under the Student Rights and Responsibilities Policy. Failure to comply with Carleton's COVID-19 procedures may lead to supplementary action involving Campus Safety and/or Student Affairs.

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 can direct you to resources that might help. Remember that Carleton also offers an array of mental health and well-being resources, which can be found here.

Children & zoom class sessions: You are welcome to have children with you during video sessions as I fully understand that childcare situations may be complicated for many of us at this time. Do your best to participate and engage, but also please get in touch with me if you have any questions or concerns.

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

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 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.

Religious Obligations

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).

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 these are unprecedented times during the COVID-19 pandemic, and 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

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 misconduct undermines the values of honesty, trust, respect, fairness, and responsibility that we expect in this class. 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

Sanctions for not abiding by Carleton's Academic Integrity Policy

A student who has not adhered to Carleton's Academic Integrity Policy may be subject to one of several sanctions:

1. If you take full responsibility for your actions, and it is the first time you have violated the policy, you will receive zero on the assessment. If you are found to have violated the policy but do not take responsibility, an additional grade deduction will be applied (e.g. an A- will become a B+)
2. Subsequent violations of the policy may result in more severe sanctions such as failing the course, suspension from all studies and/or expulsion.

Process of an Academic Misconduct Investigation

Step 1: The instructor believes misconduct has occurred and submits documentation to the Dean of the Faculty of Science.

Step 2: The Dean reviews documentation and can proceed with or dismiss the allegation.

Step 3: If sufficient evidence, the student receives an allegation statement by email. Ombuds services is copied on the email.

Step 4: The student provides a written response to the evidence provided.

Step 5: Either party may request a meeting between student, dean, and the ombudsperson.

Step 6: Dean informs the student of the decision.

Appeal: Student has the right to appeal the decision.

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.

Plagiarism

Plagiarism is the passing off of someone else's work as your own and is a serious academic offence. For the details of what constitutes plagiarism, refer the Faculty of Science Academic Integrity website. To further understand Academic Integrity, consider attending the Learning and Support Academic Integrity Workshop.

What are the Penalties for Plagiarism?

A student found to have plagiarized an assignment may be subject to one of several penalties including: expulsion; suspension from all studies at Carleton; suspension from full-time studies; and/or a reprimand; a refusal of permission to continue or to register in a specific degree program; academic probation; award of an FNS, Fail, or an ABS.

What are the Procedures?

1. All allegations of plagiarism are reported to the Dean of Faculty of Science. Documentation is prepared by instructors and/or departmental chairs.
2. The Dean writes to the student and the University Ombudsperson about the alleged plagiarism.

3. The Dean reviews the allegation. If it is not resolved at this level then it is referred to a tribunal appointed by the Senate.

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.

Course Copyright

Classroom teaching and learning activities, including lectures, discussions, presentations, etc., by both instructors and students, are copyright protected and remain the intellectual property of their respective author(s). All course materials, including PowerPoint presentations, outlines, and other materials, are also protected by copyright and remain the intellectual property of their respective author(s).

Students registered in the course may take notes and make copies of course materials for their own educational use only. Students are not permitted to reproduce or distribute lecture notes and course materials publicly for commercial or non-commercial purposes without express written consent from the copyright holder(s).

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/

CALENDAR (Tentative! Dates may be subject to change)

Week	Monday	Tuesday	Wednesday	Thursday	Friday
September					
1	6	7	***L1. Class 1.*** 8 ***A1 out***	9	10
2	***L2. Class 3.*** 13	14	***L3. Class 3.*** 15 ***A2 out***	***A1 in.*** 16	17
3	***L4. Class 4.*** 20	21	***L5. Class 5.*** 22 ***A3 out***	***A2 in.*** 23	24
4	***L6. Class 6.*** 27	28	***L7. Class 7.*** 29 ***A4 out***	***A3 in.*** 30	1
October					
5	***L8. Class 8.*** 4	5	***L9. Class 9.*** 6 ***A5 out***	***A4 in.*** 7	8
6	Thanksgiving holiday – no class 11	12	***L10. Class 10.*** 13	14	15
7	***Class11:*** Midterm #1 (no L11) 18	19	***L12. Class 12.*** 20 ***A6 out***	21	***A5 in.*** 22
No Classes	25	26	27	28	29
	----------*Fall Break*----------				
November					
8	***L13.Class13*** 1	2	***L14. Class 14.*** 3 ***A7 out***	***A6 in.*** 4	5
9	***L15.Class15*** 8	9	***L16. Class 16.*** 10 ***A8 out***	***A7 in.*** 11	12
10	***L17.Class17*** 15	16	***L18. Class 18.*** 17 ***A8 out***	***A8 in.*** 18	19
11	***L19.Class19*** 22	23	***Class20:*** Midterm #2 (no L20). ***A9 out.*** 24	25	26
12	***L21.Class21*** 29	30	***L22. Class 22.*** 1	***A9 in.*** 2	3
December					
13	***L23.Class23*** 6	7	***L24.Class24*** 8	9	Last day of classes: ***L25.Class25.*** 10
December 11-23: Final examination period (final exam, oral interview).					