PHYS 5206 Medical Radiotherapy Physics

Course Instructor: Emily Heath
How to address me: Dr/Prof Heath
Gender Pronouns: she/her/hers
Email: Emily.Heath@Carleton.ca
Student Hours: will be posted on Brightspace
Office Location: Room 2424, Herzberg Laboratories
Class Location: posted on Brightspace
Class Times: Monday & Wednesday, 11:35am-12:55pm
Prerequisites: PHYS 5203
Website: https://carleton.brightspace.com/

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 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.

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!

The goal of this course is to provide an overview of modern radiotherapy, its purposes, its techniques, and the importance of physics in its practice. The first part of this course builds upon the concepts taught in PHYS 5203 and applies them to the measurement of radiation dose distributions. The second part of the course focusses on clinical treatment planning with emphasis on calculation of clinical radiation dose distributions in both external beam radiation therapy and brachytherapy.

Calendar entry: Radiation therapy process and physics. Ion chamber dosimetry, Monte Carlo techniques of radiation transport, cavity theories, external beam therapy, brachytherapy, dosimetry protocols, detectors used in radiation therapy. Treatment planning, monitor unit calculations, intensity-modulated radiation therapy. Novel and alternate techniques**.**

Course level learning objectives:

After completion of this course, students will be able to:

1. develop a deep understanding of the fundamentals or radiation dosimetry, with special emphasis on ion chamber dosimetry under reference conditions (TG-51, TG-61) and under non-standard conditions in small and/or composite fields;
2. become familiar with the general characteristics of many types of radiation detectors and their relative strengths and weaknesses;
3. understand the physics behind the structure of dose distributions for photon beams, electron beams and brachytherapy sources;
4. understand the physics behind TARs, TPRs, TMRs, PDDs and the relationships between them;
5. perform a simple hand calc monitor unit calculation;
6. understand the basic physics behind dose calculation algorithms for treatment planning and to understand the limitations of each;
7. become familiar with the elements of Monte Carlo simulation as applied in radiotherapy applications
8. understand the TG-43 formalism for brachytherapy dosimetry and its limitations.

Schedule of lecture topics and assessments

Week	Lecture	Date	Topics	Assignments
1	1	January 5	Course intro, Review: Kerma, Dose, Exposure, CPE	
	2	January 7		Post HW1
2	3	January 12	Cavity theory	
	4	January 14		HW1 due, Post HW2
3	5	January 19	Radiation dosimeters	
	6	January 21		HW2 due Post HW3
4	7	January 26	Absorbed dose formalisms for megavoltage photon and electron beams (TG-21, TG-51 and TRS-398)	
	8	January 28		HW3 due Post HW4
5	9	February 2	Absorbed dose formalism for kV x-ray beam dosimetry	
	10	February 4	Small field dosimetry	HW4 due
6	11	February 9	Review/catch-up	
	12	February 11	Midterm exam #1	
7		February 16-20	Winter Reading Week (no classes)	
8	13	February 23	Brachytherapy – intro, dosimetry	
		February 25	TG-43	Post HW5
9	14	March 2	External beam radiotherapy process, ICRU definitions	
	15	March 4	Point dose calculations (PDD, TAR etc.)	HW5 due, Post HW6
10	16	March 9		
	17	March 11		HW6 due
11	18	March 16	Review/catch-up	
	19	March 18	Midterm exam #2	
12	20	March 23	Correction-based dose calculations	Post HW7
	21	March 25	Model-based dose calculation algorithms	
13	22	March 30		HW7 due
	23	April 1	Proton and heavy-ion radiotherapy	
14	24	April 6	Radiotherapy with neutrons	

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.

Learning Materials

Texts: All four of these textbooks are available as ebooks 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, 2021.
- Battista, J. (ed.), Introduction to Megavoltage X-Ray Dose Computation Algorithms (1st ed.), 2019.

Assessment in this Course

Grade Breakdown

COMPONENT	GRADE VALUE
ASSIGNMENTS (7)	40%
MIDTERM TESTS (2)	20%
FINAL EXAM	20%
ORAL INTERVIEW	10%
PROJECT	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 assignment grade will be dropped.

Late and Missed Assignment Policies:

Late assignments are generally not accepted. If you are unable to meet an assignment deadline due to illness or other circumstances, reach out to me in advance of the deadline to request an extension. Extensions of 1-2 days on assignment deadlines will be granted up to two times during the semester. No additional accommodations for assignments are anticipated due to the lowest grade being dropped.

Midterm Tests

There will be two 70-minute tests held in class, February 11th and March 18th.

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.

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.

Final Exam

The final exam will take place during the final exam period.

Oral interview

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

Project

A course project will be assigned after the second midterm and will be due at the end of the term. More details will be given at a later date.

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.

Accommodations for Missed Work

Carleton recognizes that students may experience unexpected, temporary incapacitation (for example: 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 filled out on the Academic Consideration for Coursework Form webpage.

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.

- Deferred/missed term work for short-term accommodation (5 days or less): write to me via email and we will discuss if accommodations are needed. See page 5 for policies on late/missed assignments.

- Deferred/missed term work for longer term incapacitation (5 days or longer); 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.