September 3, 2025

Radiological Physics
Physics 4672/9655A

1. Course Information:

Co-requisites:

- Phys 3300A/B
- Unless you have either the prerequisites for this course or written special permission from the Department of Physics & Astronomy to enroll in it, you may be removed and withdrawn from this course in accordance with university policy. This may be done after the add/drop deadline of the academic term, and the course will be marked as withdrawn (WDN) on your academic record. This decision may not be appealed.

2. Instructor: Eugene Wong, PhD, FCCPM
519-661-2111 ext 80419, email **ewong4@uwo.ca** Office hours: by appointment

3. Learning Outcomes: At the end of the course, students will be able to

- identify and explain the mechanisms of radiation generation from man-made and natural **sources**.
- use appropriate defined quantities and terminologies to **describe** radiation.
- obtain and apply **radioactive decay** data from the National Nuclear Data Center (NNDC).
- utilize tabulated properties from the National Institute of Standards and Technology (NIST) to determine when and what **interactions** are important in different materials for **charged** and **uncharged** particles.
- perform numerical computations using Compton scattering and Klein-Nishina differential cross-section.
- relate elementary electronic/atomic scattering cross sections to macroscopic attenuation coefficients.
- numerically compute Bremsstrahlung radiation yield from collisional and radiative mass stopping powers.
- Numerically compute the average fraction of energy transferred from photons to charged particles based on NIST XCOM cross-sections.
- analyze the effects of different materials on radiation **transport**.
- perform elementary Monte Carlo simulations of photon radiation transport using linear attenuation coefficients and Compton scattering.
- explain how charged and uncharged radiation **deposits energy** and quantify such radiation dose deposition.
- explain the fundamentals on how ionization radiation dose can be **measured**, and strengths and limitations of different dosimeters.

4. Course Materials

Textbook: *Radiation Physics for Medical Physicists*, E.B. Podgorsak, 3rd edition*, Springer-Verlag (2016).
*Note: the 3rd edition contained additional chapters on radiation dose measurements that are not present in the 1st or 2nd editions and will be covered in this course.

Based on the publisher's website, https://link.springer.com/book/10.1007/978-3-319-25382-4, eBook USD 69.99.

References:

1. *Compendium to Radiation Physics for Medical Physicists: 300 Problems and Solutions*, E.B. Podgorsak, Springer-Verlag (2014). (Available in ebook format from Western's library: https://ocul-uwo.primo.exlibrisgroup.com/permalink/01OCUL_UWO/1hdoga6/alma991044351952405163)

2. *Fundamentals of Ionizing Radiation Dosimetry*, Pedro Andreo, David T. Burns, Alan E. Nahum, Jan Seuntjens, Frank Herbert Attix, Wiley (July 31, 2017)

		Podgorsak 3rd ed. Chap.
September		
	Introduction to Ionizing Radiation: • Quantities (fluence, energy fluence, dose), units, • Counting statistics, • Radiation sources (radioactivity, x-ray tubes, accelerators, reactors (neutrons), cyclotrons (protons), synchrotron)	1
	Radioactivity • Modes and kinetics of radioactive decays • NNDC decay mode (how to interpret)	10, 11
	Interactions of x and γ rays with matter I – overview: • interpretation of the exponential attenuation of photons • Matlab attenuation coefficients	7
October		
	Interactions of x and γ rays with matter II: • Thomson and Compton scattering, (Matlab)	7
	Interactions of x and γ rays with matter III: • Coherent scattering	7
	Reading Week	
	Interactions of x and γ rays with matter III: • Photoelectric effect, Pair production	7
	Interactions of charged particles with matter I: • Scattering and stopping powers	6
	Interactions of charged particles with matter II: • X-ray production (Bremsstrahlung)	6
November		
	Inter-relationship of Quantities: Fluence, mass energy transfer/absorption coefficient, collisional/radiative KERMA, absorbed dose, charged particle equilibrium	8, 15
	Convolution dose calculation, charged particle disequilibrium	handout
	Monte Carlo Method (Matlab)	handout
	Fundamentals of Dosimetry: spatial and temporal resolution, accuracy vs precision, absolute vs relative, dynamic range, energy/frequency dependence	15
	Absolute dosimeters • Ionization chambers, • Cavity theory and dose measurement with ion chambers	16 15
December		
	Absolute dosimeters: calorimetry, chemical dosimeter Relative dosimeters diodes, film, TLD, OSL, etc.	17

5. Methods of Evaluation:

- Four homework assignments (24%): These assignments are there to help you learn the subject matter. A portion could be extension of what was taught in class and might contain materials that help you learn on your own. You may talk to each other about the assignments, but it would only help if you compose your thoughts and write your own assignments, rather than simply copying. Please see statement below on plagiarism and use of AI.

- One end of term group project (written and oral presentation) 6%.

- Weekly Reading Assignments on Perusall (10%).

- Mid-term exam (22%). 18% written, 4% oral. Date TBA. The oral portion on the exam will be conducted view Zoom.
- Final exam (38%): 32% written, 6% oral. Written portion will be scheduled by the office of the registrar. The oral portion on the exam will be conducted view Zoom.

- Gradescope will be used for assignment submissions. Email assignments will not be accepted.
- The Department of Physics and Astronomy may, in exceptional cases, adjust the final course marks in order to conform to Departmental policy.

Use of Generative AI Tools
You may use generative AI tools (e.g., ChatGPT, Copilot, Gemini) to help you learn, understand your homework assignments, and prepare for your presentations. However, it is closed book (and closed internet) for the written and oral exams where most grade weighting for the course reside. You are also encouraged to work with your fellow students, or ask the instructor for clarifications in the assignments.

General information about missed coursework
Students must familiarize themselves with the *University Policy on Academic Consideration – Undergraduate Students in First Entry Programs,* posted on the Academic Calendar:
https://www.uwo.ca/univsec/pdf/academic_policies/appeals/academic_consideration_Sep24.pdf,

This policy does not apply to requests for Academic Consideration submitted for **attempted or completed work**, whether online or in person.

The policy also does not apply to students experiencing longer-term impacts on their academic responsibilities. These students should consult Accessible Education.

For procedures on how to submit Academic Consideration requests, please see the information posted on the Office of the Registrar's webpage:
https://registrar.uwo.ca/academics/academic_considerations/
All requests for Academic Consideration must be made within 48 hours after the assessment date or submission deadline.

All Academic Consideration requests must include supporting documentation; however, recognizing that formal documentation may not be available in some extenuating circumstances, the policy allows students to make one Academic Consideration request **without supporting documentation** in this course. However, the following assessments are excluded from this, and therefore always require formal supporting documentation:

- Final Examination scheduled during official examination periods
- Midterm Exam (written and oral) (Designated by the instructor as the one assessment that always requires documentation when requesting Academic Consideration)

When a student *mistakenly* submits their one allowed Academic Consideration request **without supporting documentation** for the assessments listed above or those in the **Coursework with Assessment Flexibility** section below, the request cannot be recalled and reapplied. This privilege is forfeited.

Evaluation Scheme for Missed Assessments

When a student misses the Final Exam and their Academic Consideration has been granted, they will be allowed to write the Special Examination (the name given by the University to a makeup Final Exam). See the Academic Calendar for details (under Special Examinations), especially for those who miss multiple final exams within one examination period.

Coursework with Assessment Flexibility
By policy, instructors may deny Academic Consideration requests for the following assessments with built-in flexibility:

Flexible Completion
Reading Assignments. This course has 9 reading assignments on Perusall with the highest marks from 8 of them are counted towards your final grade. Should extenuating circumstances arise, students do not need to request Academic Consideration for the first missed reading assignment. Academic consideration requests will be denied for the first missed reading assignment. Academic Consideration requests may be granted when students miss more than 1 reading assignment, and these additional (2^{nd}, 3^{rd}, 4^{th}…) missed assignments will be reweighted to the final exam.
Written Assignments. This course has 4 written assignments and all of them are counted towards your final grade. Should extenuating circumstances arise, students do not need to request Academic Consideration for the first missed written assignment. Academic consideration requests will be denied for the first missed written assignment. Academic Consideration requests may be granted when students miss more than 1 written assignment. Any missed written assignments will be reweighted to the final exam.

Deadline with a No-Late-Penalty Period
Assignments (Written and Reading). Students are expected to submit each of the assignments by the deadline listed. Should extenuating circumstances arise, students do not need to request Academic Consideration and they are permitted to submit their assignment up to (1 week) past the deadline without a late penalty. Should students submit their assessment beyond (1 week) past the deadline, it will not be graded and the assignment grade will be reweighed to the final exam. Academic Consideration requests may be granted only for extenuating circumstances that started before the deadline and lasted longer than the No-Late-Penalty Period (1 week).

6. Additional Statements:

6.1 Religious Accommodation

When conflicts arise with a religious holiday that requires an absence from the University or prohibits certain activities, students should request an accommodation for their absence in writing to the course instructor and/or the Academic Advising office of their Faculty of Registration. This notice should be made as early as possible, but not later than two weeks prior to the writing of the examination (or one week prior to the writing of the test).

Please visit the Diversity Calendars posted on our university's EDID website for the recognized religious holidays - https://www.edi.uwo.ca

6.2 Academic Accommodation Policies

Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic Accommodation_disabilities.pdf.

6.3 General Academic Policies

The website for Registrar Services is https://www.registrar.uwo.ca/.

Use of @uwo.ca email: In accordance with policy, https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf, the centrally administered e-mail account provided to students will be considered the individual's official university email address. It is the responsibility of the account holder to ensure that emails received from the University at their official university address are attended to in a timely manner.

Requests for Relief (formally known as "appeals")

Policy on Request for Relief from Academic Decision:
https://uwo.ca/univsec//pdf/academic_policies/appeals/requests_for_relief_from_academic_decisions.pdf

Procedures on Request for Relief from Academic Decision (Undergraduate):
https://uwo.ca/univsec//pdf/academic_policies/appeals/undergrad_requests_for_relief_procedure.pdf

Procedures on Request for Relief from Academic Decision (Graduate):
https://uwo.ca/univsec//pdf/academic_policies/appeals/graduate_requests_for_relief_procedure.pdf

6.4 Scholastic Offences

Policy on Scholastic Offences: https://uwo.ca/univsec//pdf/academic_policies/appeals/scholastic_offences.pdf

Procedures on Scholastic Offences (Undergraduate):
https://uwo.ca/univsec//pdf/academic_policies/appeals/undergrad_scholastic_offence_procedure.pdf

Procedures on Scholastic Offences (Graduate):
https://uwo.ca/univsec//pdf/academic_policies/appeals/graduate_scholastic_offence_procedure.pdf

Use of Electronic Devices During Assessments

In courses offered by the Faculty of Science, the possession of unauthorized electronic devices during any in-person assessment (such as tests, midterms, and final examinations) is strictly prohibited. This includes, but is not limited to: mobile phones, smart watches, smart glasses, and wireless earbuds or headphones.

Unless explicitly stated otherwise in advance by the instructor, the presence of any such device at your desk, on your person, or within reach during an assessment will be treated as a *scholastic offence*, even if the device is not in use.

Only devices expressly permitted by the instructor (e.g., non-programmable calculators) may be brought into the assessment room. It is your responsibility to review and comply with these expectations.

Use of Generative AI Tools

Unless otherwise stated, the use of generative AI tools (e.g., ChatGPT, Microsoft Copilot, Google Gemini, or similar platforms) is **not permitted** in the completion of any course assessments, including but not limited to: assignments, lab reports, presentations, tests, and final examinations.

Using such tools for content generation, code writing, problem solving, translation, or summarization—when not explicitly allowed—will be treated as a **scholastic offence**.

If the use of generative AI is permitted for a particular assessment, the conditions of use will be specified by the instructor in advance. If no such permission is granted, students must assume that use is prohibited. It is your responsibility to seek clarification before using any AI tools in academic work.

All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such

checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

6.5 Support Services

Please visit the Science & Basic Medical Sciences Academic Advising webpage for information on adding/dropping courses, academic considerations for absences, requests for relief, exam conflicts, and many other academic-related matters: https://www.uwo.ca/sci/counselling/.

Students who are in emotional/mental distress should refer to Mental Health@Western (https://uwo.ca/health/) for a complete list of options about how to obtain help.

Western is committed to reducing incidents of gender-based and sexual violence (GBSV) and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced GBSV (either recently or in the past), you will find information about support services for survivors, including emergency contacts at:

https://www.uwo.ca/health/student_support/survivor_support/get-help.html.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. If you have any questions regarding accommodations, you may also wish to contact Accessible Education at

http://academicsupport.uwo.ca/accessible_education/index.html