January 10, 2021

Radiological Physics
Physics 4672/9655A

Instructor Eugene Wong, PhD, FCCPM
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Office hours: by appointment

Time Thursday 1:30-3:30 pm
Place Zoom, Western University

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.

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)

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

1. identify and explain the mechanisms of radiation generation from man-made and natural **sources**.
2. use appropriate defined quantities and terminologies to **describe** radiation.
3. obtain and apply **radioactive decay** data from the National Nuclear Data Center (NNDC).
4. 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.
5. perform numerical computations using Compton scattering and Klein-Nishina differential cross-section.
6. relate elementary electronic/atomic scattering cross sections to macroscopic attenuation coefficients.
7. numerically compute Bremsstrahlung radiation yield from collisional and radiative mass stopping powers.
8. Numerically compute the average fraction of energy transferred from photons to charged particles based on NIST XCOM cross-sections.
9. analyze the effects of different materials on radiation **transport**.
10. perform elementary Monte Carlo simulations of photon radiation transport using linear attenuation coefficients and Compton scattering.
11. explain how charged and uncharged radiation **deposits energy** and quantify such radiation dose deposition.
12. explain the fundamentals on how ionization radiation dose can be **measured**, and strengths and limitations of different dosimeters
13. explain the principles behind radiation safety and perform **quantitative risk analyses** on the safe use of radiation

		Podgorsak 3rd ed. Chap.
January		
	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
February		
	Interactions of x and γ rays with matter II: • Thomson and Compton scattering, (Matlab)	7
	Reading Week	
	Midterm Feb 23rd 2021 1:30-3:30 pm	
	Interactions of x and γ rays with matter III: • Photoelectric effect, Pair production	7
	Interactions of x and γ rays with matter III: • Coherent scattering	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
March		
	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
April		
	Absolute dosimeters: calorimetry, chemical dosimeter Relative dosimeters diodes, film, TLD, OSL, etc.	17

Evaluations:

- 5 homework assignments (25%):
  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.
- 1 end of term group project (written and oral presentation) 8%.
- Weekly Reading Assignments on Perusall (10%).
- Mid-term exam (21%). 18% written, 3% oral.
- Final exam (36%): Scheduled by the office of the registrar. 30% written, 6% oral.
- The written portion of the exam maybe monitored by Proctortrack or Zoom (see remote proctoring software below).
- The Department of Physics and Astronomy may, in exceptional cases, adjust the final course marks in order to conform to Departmental policy.

Co-requisites:

- Phys 3300A/B
- Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

Academic Policies:

The website for Registrarial Services is www.registrar.uwo.ca. In accordance with policy, www.uwo.ca/its/identity/activatenonstudent.html, the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at his/her official university address is attended to in a timely manner.

If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Dean's office as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "*Recommendation of Special Examination*" form must be obtained from the Dean's Office immediately. For further information, see http://www.uwo.ca/sci/undergrad/academic_counselling/.

A. Scholastic Offenses: Cheating and Plagiarism

"Success (and failure) will come and go, but integrity is forever" - Amy Rees Anderson

University Policy states that cheating, including plagiarism, is a major scholastic offence. Scholastic offences are taken seriously, and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following: www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf.
The commission of a scholastic offence is attended by academic penalties that might include expulsion from the program. If you are caught cheating, there will be no second warning.

As per the UWO Academic Policies:

- **Plagiarism:** Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing, such as footnotes or citations.

- 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).
- Computer-marked multiple-choice tests and/or exams may be subject to submission for similarity review by software that will check for unusual coincidences in answer patterns that may indicate cheating.

***B. Online Course Conduct & Netiquette*:**
Note that disruptive behaviour of any type during online classes, including inappropriate use of the chat function, is unacceptable. Students found guilty of Zoom-bombing a class or of other serious online offenses may be subject to disciplinary measures under the Code of Student Conduct.

Only students using their UWO credentials will be permitted to access the course elements. If, for privacy reasons, you wish to use a pseudonym, you must have the pseudonym pre-approved by the course coordinator before being allowed to participate in any online component.

If you are experiencing any online harassment or bullying through the course platforms, report the behaviour immediately to the course coordinator. Perusall has a built-in option to flag an inappropriate comment (look for the exclamation icon), with automatic notification sent to the instructors.

Anyone posting inappropriate content or abusing the option to flag inappropriate content will be banned from further interactions, which eliminates any further grades or marks related to the collaborative platforms.

General considerations of "netiquette":
- Use your computer and/or laptop if possible (as opposed to a cell phone or tablet).
- Keep in mind the different cultural and linguistic backgrounds of the students in the course.
- Be courteous toward the instructor, your colleagues, and authors whose work you are discussing.
- Be respectful of the diversity of viewpoints that you will encounter in the class and in your readings. The exchange of diverse ideas and opinions is part of the scholarly environment. "Flaming" is never appropriate.
- Be professional and scholarly in all online postings. Use proper grammar and spelling. Cite the ideas of others appropriately.

C. Remote Proctoring Software Tests and examinations in this course will be conducted using the remote proctoring service, Proctortrack. By taking this course, you are consenting to the use of this software and acknowledge that you will be required to provide **personal information** (including some biometric data) and the session will be **recorded**. More information about this remote proctoring service is available in the Online Proctoring Guidelines at the following link:

https://www.uwo.ca/univsec/pdf/onlineproctorguidelines.pdf

Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. Information about the technical requirements are available at the following link: https://www.proctortrack.com/tech-requirements/

Accommodation:

Please refer to the UWO Academic Policies http://www.uwo.ca/univsec/academic_policies/ for further details on the policies in practice here.

Accommodation Policies — Students with disabilities should work with Western's Accessible Education (formerly SSD), which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The Academic Accommodation for Students with Disabilities policy can be found at:
https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic Accommodation_disabilities.pdf

Academic Consideration for Student Absences and Illness— If you are unable to meet a course requirement due to illness or other serious circumstances, you must seek approval for the absence as soon as possible. Approval can be granted either through a (1.) self-reporting of absence or via (2.) the Dean's Office/Academic Counselling unit of your Home Faculty.

1. Self-reported Absence: Students who experience an unexpected illness or injury or an extenuating circumstance (48 hours or less) that is sufficiently severe to temporarily render them unable to meet academic requirements (e.g., attending lectures or labs, writing tests or midterm exams, completing and submitting assignments, participating in presentations) should self-declare using the online Self-Reported Absence portal. This option should be used in situations where the student expects to resume academic responsibilities within 48 hours or less.

   Students will have up to two (2) opportunities during the regular academic year to use an on-line portal to self-report an absence during the semester, provided the following conditions are met: the absence is no more than 48 hours in duration, and the assessment for which consideration is being sought is worth 30% or less of the student's final grade. Students are expected to contact their instructors within 24 hours of the end of the period of the self-reported absence, unless noted on the syllabus. Students are not able to use the self-reporting option in the following circumstances:
   - for exams scheduled by the Office of the Registrar (e.g., December and April exams)
   - absence of a duration greater than 48 hours,
   - assessments worth more than 30% of the student's final grade,
   - if a student has already used the self-reporting portal twice during the academic year

Religious Accommodation — Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the Western Multicultural Calendar:
https://multiculturalcalendar.com/ecal/index.php?s=c-univwo

Support Services:

Accessibility — 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. You may also wish to contact Student Accessibility Services (SAS) at (519) 661-2147 if you have any questions regarding accommodations.

Western University is committed to a thriving campus as we deliver our courses in the mixed model of both virtual and face-to-face formats. We encourage you to check out the Digital Student Experience website to manage your academics and well-being: https://www.uwo.ca/se/digital/.

Counseling — Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on add/drop courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: https://www.uwo.ca/sci/counselling/

Learning Skills — Learning-skills counsellors at the Student Development Centre (www.sdc.uwo.ca) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

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