# Radiation Dosimetry II

**The University of Toledo**
**Department of Radiation Oncology, COMLS**
MPHY 6130/8130 (CRN: 27964/27970)


**Instructor**: Diana Shvydka
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**Office Hours**: By appointment
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**Instructor Phone**: 419-383-5328
**Offered**: Spring, 2022


**Class Location**: Ruppert HC, suit K, #0005
**Class Day/Time**: T, 9:30AM-12:15PM
**Credit Hours**: 3
**Course Website**:
https://www.utoledo.edu/med/depts/radther/graduate/RadiationDosimetryII.html

## SPECIAL COURSE EXPECTATIONS DURING COVID-19

### ATTENDANCE

The University of Toledo has a missed class policy. It is important that students and instructors discuss attendance requirements for the course. Students must perform a daily health assessment, based on based on **CDC guidelines,** before coming to campus each day, which included taking their temperature. Students who are symptomatic/sick should not come to class and should contact the Main Campus Health Center at 419-530-3451. *Absences due to COVID-19 quarantine or isolation requirements **are** considered excused absences*. Students should notify their instructors and these absences may not require written notice.

### FACE COVERINGS

All students must wear face coverings while on campus, except while eating, alone in an enclosed space, or outdoors practicing social distancing. NO students will be permitted in class without a face covering. If you have a medical reason that prevents you from wearing a face covering due to a health condition deemed high-risk for COVID-19 by the Centers for Disease Control and Prevention (CDC), you should submit a request for an accommodation through the Student Disability Services Office (SDS) by completing the online application. Students will need to provide documentation that verifies their health condition or disability and supports the need for accommodations. If a student is already affiliated with SDS and would like to request additional accommodations due to the impact of COVID-19, should contact their accessibility specialist to discuss their specific needs.

### SOCIAL DISTANCING

Students should practice social distancing inside and outside the classroom please follow signage and pay attention to the seating arrangements. Do not remove stickers or tape from seats and/or tables, this is there to provide guidance on the appropriate classroom capacity based on the recommended 6 feet of social distancing between individuals. Please be conscious of your personal space and respectful of others. Also be cognizant of how you enter and exit the room; always try to maintain at least 6 feet of distance between yourself and others.

### DESKS AND WORK SPACES

Students will need to sanitize their desks and/or work space before class with the University provided sanitizing spray and paper towels their desks.

### SPECIAL NOTES

It's important to note that based on the unpredictability of the COVID-19 virus things can change at any time so please be patience and understanding as we move through the semester. I also ask that you keep me informed of concerns you may have about class, completing course work/assignments timely and/or health concerns related to COVID.

## CATALOG/COURSE DESCRIPTION*

Series of lectures covering interactions of ionizing radiation with matter and radiation dosimetry physics fundamentals in-depth. Cavity theories, integrating and pulse-mode dosimeters, dosimetry and calibration of photon and electron beams, and neutron dosimetry are considered in details.

## COURSE OVERVIEW

The second part of the Radiation Dosimetry course offers a more detailed study of high-energy photon, neutron, and charged particle interactions with matter. Apart from the regular activities of attending lectures, having in-depth discussions, and solving homework problems in a pen-and-paper format, students will be given assignments requiring some familiarity with using electronic spreadsheet software. An additional assignment of completing a mini-research project (Paper/Project) and producing a "protocol" in either a step-by-step instruction or an electronic spreadsheet format serves the purpose of preparing students for an independent investigation of a dosimetric problem, having a documented solution in the literature.

## STUDENT LEARNING OUTCOMES*

Upon successful completion of the course, the student will be able to:

1) Utilize stochastic and deterministic quantities for description of radiation field and interactions of ionizing radiation with matter
2) Formulate principles of charged-particle and radiation equilibria (CPE and RE), transient CPE
3) Apply concepts of radioactive decay and governing equations to radioactive parent-daughter relationships
4) Describe interactions of high-energy photons with matter and their main trends depending on photon energy and interacting medium properties
5) Describe interactions of charged particles with matter and their main trends depending on the particle type and energy and the interacting medium properties
6) Formulate basic concepts of cavity theories, their applicability to radiation dosimetry, and their limitations
7) Name integrating and pulse-mode radiation dosimeters, their applications and limitations
8) Describe the principles of operation of ionization chamber, and use of different types of chambers
9) Demonstrate knowledge of photon and electron beams dosimetry, corresponding dose calculations, and applications to clinical beam reference dosimetry
10) Describe interactions of neutrons with matter, neutron detection principles, and mixed-field dosimetry approaches

## TEACHING METHODOLOGY

The course is taught through regular lectures, discussion of homework problems, and answering student questions. A subset of homework assignments requires working knowledge of an electronic spreadsheet software (MS Excel or similar), often used for automation of clinical QA procedures. Finally, completion of a Paper/Project assignment will facilitate familiarization with electronic publication resources, preparing students for their research project.

## PREREQUISITES AND COREQUISITES*

MPHY 6120/8120 (Radiation Dosimetry I) and/or consent of Department/Instructor

## TEXTS AND ANCILLARY MATERIALS*

Main text: Frank H. Attix, Introduction to Radiological Physics and Radiation Dosimetry, WILEY- Interscience, 1986

Recommended supplemental text: Jerome A. Meli, The Physics of Radiation Dosimetry [AIP Publishing (online), Melville, New York, 2020], available online at: https://doi.org/10.1063/9780735421882

Lecture handouts are posted at http://www.utoledo.edu/med/depts/radther/RadiationDosimetryII.html (Spring class schedule posted on the Medical Physics program website under Curriculum->Courses)

Additional reading materials, including examples of papers suitable for a mini-project, and samples of project reports and spreadsheets completed in previous years, can be found on the shared "Z" drive. Please follow the folder link: Z:\RadiationOncology\Common\Education Materials\RD-II papers and other materials

## TECHNOLOGY REQUIREMENTS

Students are expected to have basic computer skills, and be familiar with Microsoft Word or similar for technical writing, and Microsoft Excel or similar for solving a subset of homework problems and generation of graphs as needed (problems are marked with "*" in a course schedule).

## COURSE EXPECTATIONS

Students are expected to attend all lectures, and solve all assigned homework problems. All problems marked with "*" will require generation of an electronic file with the solution (using Microsoft Excel or similar software); the file should be turned in for grading via email.

Students are required to obtain individual consultations (email communication is acceptable) regarding the choice of a topic for their Paper/Project. The objective of this task is to develop a measurement protocol of a clinical/dosimetric interest. Start with identifying a project/problem by searching an electronic publication database available through the University of Toledo library (https://www.utoledo.edu/library/ ) or other on-line resources such as ScienceDirect (https://www.sciencedirect.com/ ). Examples of relevant publications can be found on the shared Z drive (Z:\RadiationOncology\Common\Education materials\RD-II papers and other materials). Next, briefly discuss a topic of your interest with me through email or in person to finalize the proposal. For the implementation part, you are expected to compose a protocol (using MS Word or similar software), consisting of the following sections:

1. Problem statement
2. General approach
3. Required equipment
4. Step-by-step measurements/procedure instructions
5. Expected results, with any relevant equations, graphs, etc.
6. References

Alternatively, you can create a spreadsheet (using MS Excel or similar) with detailed instructions on how to perform measurements. If you follow this path you could use an existing published protocol, e.g., one of the TG protocols (it has to be sufficiently different from any of the spreadsheets used in our clinic).

Project proposal should be completed by March 16th, the final completed project is due by May 4th. The final version of the Paper/Project should be submitted in electronic format.

## OVERVIEW OF COURSE GRADE ASSIGNMENT*

*Grades will be determined based on relative performance of the class using the following scheme:*

| | | |
|---|---|---|
| Mid-term exam 1 | (SLO 1-3) | 25% |
| Mid-term exam 2 | (SLO 4-6) | 25% |
| Final Exam | (SLO 7-10) | 25% |
| HW * problems | (SLO 1-10) | 10% |
| Paper/Project | (SLO 1-10) | 15% |
| Total | (SLO 1-10) | 100% |



*Required

**Final Grading***

*The final letter grades are derived according to the following grading scale:*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 96-100 | 90-95 | 86-89 | 80-85 | 76-79 | 70-75 | 66-69 | 60-65 | 50-59 | >49 |
| A | A- | B+ | B | B- | C+ | C | C- | D | F |

## ACADEMIC POLICIES*

Graduate Policies: http://www.utoledo.edu/policies/academic/graduate/

## UNIVERSITY POLICIES*

**Policy Statement on Non-Discrimination on the Basis of Disability (ADA)***

The University is an equal opportunity educational institution. Please read The University's Policy Statement on Nondiscrimination on the Basis of Disability Americans with Disability Act Compliance.
Students can find this policy along with other university policies listed by audience on the University Policy webpage (http://www.utoledo.edu/policies/audience.html/#students).

**Academic Accommodations***

The University of Toledo embraces the inclusion of students with disabilities. We are committed to ensuring equal opportunity and seamless access for full participation in all courses. For students who have an accommodations memo from Student Disability Services, I invite you to correspond with me as soon as possible so that we can communicate confidentially about implementing accommodations in this course. For students who have not established affiliation with Student Disability Services and are experiencing disability access barriers or are interested in a referral to healthcare resources for a potential disability or would like information regarding eligibility for academic accommodations, please contact the Student Disability Services Office (http://www.utoledo.edu/offices/student-disability-services/) by calling 419.530.4981 or sending an email to StudentDisability@utoledo.edu.

## ACADEMIC AND SUPPORT SERVICES*

Please follow this link to view a comprehensive list of Student Academic and Support Services (http://www.utoledo.edu/studentaffairs/departments.html) available to you as a student.

## SAFETY AND HEALTH SERVICES FOR UT STUDENTS*

Please use the following link to view a comprehensive list Campus Health and Safety Services available to you as a student.

## INCLUSIVE CLASSROOM STATEMENT

In this class, we will work together to develop a learning community that is inclusive and respectful. Our diversity may be reflected by differences in race, culture, age, religion, sexual orientation, gender identity/expression, socioeconomic background, and a myriad of other social identities and life experiences. We will encourage and appreciate expressions of different ideas, opinions, and beliefs so that conversations and interactions that could potentially be divisive turn, instead, into opportunities for intellectual and personal development.

## COURSE SCHEDULE*

| Chapters/Topics | **Date** | **Homework assignments** |
|---|---|---|
| 1-2. Description of radiation fields. Quantities for describing the interaction of radiation with matter | 01/18 | Ch.1: 3,5,6,7<br>Ch.2: 2,3,4,6* |
| 3. Exponential attenuation | 01/25 | Ch.3: 1*,3,4,5 |
| 4. Charged-particle and radiation equilibria | 02/01 | Ch.4: 1,2,3,5,6 |
| 5-6. Absorbed dose in radioactive media. Radioactive decay | 02/08 | Ch.5: 1,2,3<br>Ch.6: 2,4,5,6,7 |
| **Midterm exam 1** (SLO 1-3) | 02/15 | Chapters 1-6 (HW* problems due) |
| 7&9. Gamma and x-ray interactions in matter. X-ray production and quality | 02/22 | Ch.7: 4*,6,7,10,12<br>Ch.9: 3,4,6 |
| 8. Charged particle interactions in matter | 03/01 | Ch.8: 3,5,9,13,15 |
| *+++ Spring Break* | 03/08 | *+++* |
| 10. Cavity theory | 03/15 | Ch.10: 2,5,6,7<br>Project proposal due |
| 11. Dosimetry fundamentals | 03/22 | Ch.11: 3*,4,5,6 |
| **Midterm exam 2** (SLO 4-6) | 03/29 | Chapters 7-11 (HW* problems due) |
| 12. Ionization chambers | 04/05 | Ch.12: 3,5,6,8* |
| 13. Dosimetry and calibration of photon and electron beams with cavity ion chambers | 04/12 | Ch.13: 5,6,7,9 |
| 14-15. Integrating dosimeters. Dosimetry by pulse-mode detectors | 04/19 | Ch.14: 3*,5,7<br>Ch.15: 2,4,5 |
| 16. Neutron interactions and dosimetry | 04/26 | Ch.16: 1,2,3 |
| **Final exam** (SLO 7-10) | 05/03 | Chapters 12-16 (HW* problems due)<br>Paper/Project due |

*Solution requires use of MS Excel or similar (due by the corresponding exam date)