

Fundamental Aspects of Radiation Shielding

ENU 4630

Class Periods: Monday, Periods 4 and 5, 10:40 a.m. – 12:35 p.m.
Wednesday, Period 4, 10:40 a.m. – 11:30 a.m.

Location: McCarty Hall B, Room 2102

Academic Term: Fall 2019

Instructor:

Dr. Donald Wall

Donald.wall@ufl.edu

Phone: 273-2662

Office Hours: Wednesday 1:00 p.m. – 4:00 p.m.

Thursday, 10:00 a.m. – 1:00 p.m.

Additional times are available by appointment.

Room 311, Materials Engineering Building

Teaching Assistants:

- none

Course Description

Three one-hour lectures discussing interaction of ionizing radiation with matter; cross sections and radiation fields with emphasis on photons, heavy charged particles and electrons.

Course Pre-Requisites / Co-Requisites

ENU 4605 with a minimum grade of C.

Course Objectives

The course objectives include comprehension and proficiency in the following topics:

- Determining the shielding requirements that are necessary to provide protection against radiation
- Using the knowledge of the characteristics of shielding materials to determine appropriate shielding design
- Incorporating calculations into the shielding design process to determine an optimum shielding model that provides an appropriate protection for workers, the environment and the public

The course objectives will be addressed by means of:

- textbook study
- lecture material that will compliment and clarify the textbook material
- provide examples of applications, including some in-class problem solving exercises
- homework problems, with emphasis on problems that have applications in the field

Materials and Supply Fees

none

Professional Component (ABET):

3 credits of engineering topics.

Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	High
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	High
3. an ability to communicate effectively with a range of audiences.	Medium
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	High
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	High
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies	High

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbooks and Software

- Radiation Shielding (2000)
- J. Kenneth Shultis, Richard E. Faw
- American Nuclear Society, ISBN: 0-89448-456-7
- 978-3-527-40606-7

Students must have the most recent version of the MCNPX code. The instructor will explain how to obtain a copy.

Recommended Materials

- Nuclides and Isotopes, Chart of the Nuclides
Published by Knolls Atomic Power Laboratory
Publication date: 2010, 17th Edition
Available at www.nuclidechart.com

Note that the current price for a chart directly from Bechtel/KAPL is \$30, which is lower than the prices that are found at some other vendors. The book is the preferable format for classroom use. An earlier Edition is also acceptable.

Course Schedule

Final exam:
December 11, 2019
7:30 a.m. – 9:30 a.m.
MCCB 2102 (unless otherwise notified)

Date	Subject	Reading	Comments
8/21/2019	Course introduction, concepts, acronyms, nomenclature, units		
8/26 and 8/28	Sources of radiation: neutrons, charged particles, photons	Ch. 3 and 4	
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Sept. 2	Labor Day. No classes.		
9/4	Project discussion		HW (9/4)
9/9 and 9/11	Shield design criteria: neutrons, charged particles, X-rays and gamma-rays		
	photon and neutron response functions	Ch. 5, 6	

9/16 and 9/18	photon and neutron response functions	Ch. 5, 6	
	photon shielding	Ch. 5, 6	HW (9/18)
9/23 and 9/25	photon shielding	Ch. 5, 6	
	MCNP for shielding applications	Ch. 11, notes, handouts	Q (9/25)
9/30 and 10/2	neutron shielding	Ch. 8	HW (9/30)
	Exam 1 (Wednesday, October 2)		
10/7 and 10/9	neutron shielding	Ch. 8	
	MCNP for shielding applications	Ch. 8, 11, notes, handouts	
10/14 and 10/16	<i>Team project updates</i>		HW (10/14)
	beta particles (β^- , β^+), accelerators	Ch. 9	
10/21 and 10/23	MCNP for shielding applications	Ch. 11 and handouts	HW (10/21)
	MCNP for shielding applications	Ch. 11 and handouts	
10/28 and 10/30	Radiation safety, biological effects, external and internal dose		Q (10/28)
	Exam 2 (Wednesday, October 30)		
11/4 and 11/6	case studies	notes, handouts	
	case studies		
Nov. 11	Veterans' Day. No classes.		
11/13	Radiation safety: dose response, radiation dosimetry, monitoring	notes, handouts	Q (11/4)
11/18 and 11/20	Practical shielding design: size, weight, materials, cost. Legal requirements. Code of Federal Regulations, ethics, workplace radiation control	notes, handouts, online access to CFR	

11/25	Natural radiation sources, Fukushima, Chernobyl, weapons testing	notes, handouts,	Q (11/25)
Nov. 27 - 29	Thanksgiving break. No classes.		
12/2 and 12/4	Project presentations		
Dec. 12	Final exam		

Note:

Supplemental course material, i.e. handouts/notes will generally be distributed in electronic format—usually as .pdf files.

Q indicates quiz dates. HW indicates homework due dates. Please note that the frequency of the Q and HW are such that they regularly provide me with a diagnostic tool to assess the state of knowledge of each person. In general, the quizzes will be brief.

Attendance Policy, Class Expectations, and Make-Up Policy

Excused absences must be consistent with University policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation.

Makeup Quiz and Exam Policy. Students who need to miss a quiz or exam due to extenuating circumstances and who wish to take a makeup quiz or exam will be required to provide prior notice and to provide evidence that it is necessary to miss the quiz or exam. Missing a quiz or exam without prior notice will only be excused under documented and compelling circumstances. Makeup quizzes or exams will not be permitted if the instructor is not notified of the circumstances within 48 hours after the quiz or exam has been given. Makeup quizzes or exams will only be given under the direct supervision of the instructor and *will not* be the same as the original quiz or exam. A makeup quiz or exam shall be scheduled within 72 hours of the original quiz or exam time, unless there are documented and compelling circumstances and in accordance with University policy.

Electronic Devices. Use of electronic devices for any reason other than immediate course-related purposes is prohibited. This includes cell-phone use, texting, checking email, internet use and similar activities. Laptops may be used to take notes or for specific course-related purposes as authorized by the instructor. Laptops may not be used for other purposes such as checking email or internet use. A person who commits an infraction will be required to leave the classroom for the remainder of the day. Repeated infractions will be subject to sanctions as stated in University policies regarding student conduct.

Quizzes. The quizzes will generally be brief and may be at either the beginning or end of the class period according to the circumstances; the subject matter will be announced on the class period preceding the quiz date. Makeup quizzes will only be given under documented circumstances according to the University policy and as described above.

Late homework. Homework is due at the beginning of the class period. Homework that is late will receive a penalty of 10% per day for the first two calendar days (i.e. 48 hours from the time and date it was due) after the due date. Homework will not be accepted any later than 48 hours following the due time and date. Homework *must* be submitted either directly to the instructor or according specific instructions. *Do not leave homework or other assignments in the instructor's mailbox, at any other place or with any other person unless specifically told to do so.* Note that the Materials Engineering building is locked late in the day and will be inaccessible after hours.

Legibility. The fact is that legibility is generally a non-negotiable requirement in the workplace. Assignments or portions of assignments, (i.e. quizzes, homework *and* exams) that are illegible will receive zero credit. It is true that some people have poor handwriting. If that is the case, write slower, find a way to improve legibility and consult with the instructor for possible solutions. Please provide a sample of your writing to get an opinion if you are not sure whether it is legible. As a guideline, difficult to read (or messy) = illegible. *Assignments that are illegible will receive zero credit.*

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework Sets (5)	150	15%
Quizzes (5)	150	15%
Exam 1	150	15%
Exam 2	150	15%
Project report	100	10%
Project presentation	100	10%
Final Exam	200	20%
	1000	100%

Grading Policy

Percent	Grade	Grade Points
94 - 100	A	4.00
90 - 93	A-	3.67
86 - 89	B+	3.33
83 - 85	B	3.00
80 - 83	B-	2.67
76 - 79	C+	2.33
73 - 75	C	2.00
70 - 72	C-	1.67
66 - 69	D+	1.33
63 - 65	D	1.00
60 - 62	D-	0.67
< 60	E	0.00

More information on UF grading policy may be found at:
<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (<https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. <https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.