

Fundamental Aspects of Radiation Shielding

ENU 4630

Class Periods: Tuesday, Period 6 and 7, 12:50 p.m. – 2:45 p.m.
Thursday, Period 6, 12:50 p.m. – 1:40 p.m.

Location: Tuesday, Black Hall, Room 415
Thursday, Larsen Hall, Room 330

Academic Term: Fall 2022

Instructor:

Dr. Donald Wall

Donald.wall@ufl.edu

Phone: 352-273-2662

Office location: MAE 311

Office Hours:

Tuesday 3:30 p.m. – 4:30 p.m.

Wednesday, 1:00 p.m. – 2:00 p.m.

Additional times are available by appointment.

Teaching Assistants:

- none

Course Description

Three one-hour lectures discussing basic principles of radiation shielding. The course material will include study of radiation sources and shielding design of radiation facilities.

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
- assigned problems, with emphasis on problems that have applications in the field

Materials and Supply Fees

none

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	
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	
3. An ability to communicate effectively with a range of audiences	High
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	Medium
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	
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	

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 MCNP code. The instructor will explain how to obtain a copy.

Additional study materials will be posted on Canvas.

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 14, 2021
8:00 p.m. – 10:00 p.m.
Location TBA

Date	Subject	Reading	Comments and Due Dates
Week 1 (Aug 25)	Course introduction Photon interactions	S&F 2.1 – 2.6, 3.4, 4.2, 4.3, 5.7 RSNE 2.1, 3.1	
Week 2 (Aug 30 & Sept 1)	Photon interactions	S&F 2.1 – 2.6, 3.4, 4.2, 4.3, 5.7 RSNE 2.1, 3.1	A 1 (Sept 1)
Week 3 (Sept 6 & 8)	Analog approaches to photons	RSNE 2.2.3, 2.3, 2.4.1	Q 1 (Sept 8)
Week 4 (Sept 13 & 15)	Analog approaches to photons	RSNE 6.4.1, 6.4.3 (c) and 6.4.3(d)	A 2 (Sept 15)
Week 5 (Sept 20 & 22)	Analog approaches to photons	S&F 6.1, 6.2, 6.3.4, 6.5, 7.1 – 7.3	Q 2 (Sept 22)
Week 6 (Sept 27 & 29)	Monte Carlo method (Sept 27) Thurs, Sept 29 Exam 1	MCNP Criticality Primer MCNP Users Manual Handouts	E 1 (Sept. 29)
Week 7 (Oct 4 & 6)	MCNP	MCNP Criticality Primer MCNP Users Manual Handouts	A 3 (Oct 6)

Week 8 (Oct 11 & 13)	MCNP	MCNP Criticality Primer MCNP Users Manual Handouts	Q 3 (Oct 13)
Week 9 (Oct 18 & 20)	MCNP	MCNP Criticality Primer MCNP Users Manual Handouts	A 4 (Oct 20)
Week 10 (Oct 25 & 27)	neutrons	RSNE 3.2.2, 7.3 S&F 3.5, 4.1, 8.1 – 8.10	Q 4 (Oct 27)
Week 11 (Nov 1 & 3)	neutrons	RSNE 3.2.2, 7.3 S&F 3.5, 4.1, 8.1 – 8.10	A 5 (Nov. 3)
Week 12 (Nov 8 & 10)	Albedo, duct, void, streaming	S&F 7.4, 7.5 RSNE Ch. 7	Q 5 (Nov 10)
Week 13 (Nov. 15 & 17)	Charged particles Exam 3, Nov. 17	S&F Ch. 8	E 2 (Nov 17)
Week 14 (Nov 22) Nov 24 holiday, no class	Charged particles		
Week 15 (Nov 29 & Dec 1)	Presentations Project Report Due Nov 29		A 6 (Dec. 2)
Week 16 (Dec 6 last class period)	TBD		Q 6 (Dec. 6)
December 14	Final Exam		

Note: A# refers to Assignment number. Q# refers to Quiz number.

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

S&F refers to the text by Shultis and Faw, *Radiation Shielding*

RSNE is *Reactor Shielding for Nuclear Engineers* by N.M. Schaeffer, Ed.

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance Policy. Attendance is not mandatory. Attendance is not factored into grading.

Electronics. Use of cell phones or laptops for non-class related activities (checking email, etc.) is not permitted. The instructor reserves the right to instruct individuals to leave the classroom for violating this policy.

Makeup Exam Policy. Students who need to miss an exam due to extenuating circumstances and who wish to take a makeup exam will be required to provide prior notice and to provide evidence that it is necessary to miss the exam. Missing an exam without prior notice will only be excused under documented and compelling circumstances. Makeup exams will not be permitted if the instructor is not notified of the circumstances within 24 hours after the exam has been given. A makeup exam shall be scheduled in accordance with University policy.

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. Makeup quizzes will not be permitted if the instructor is not notified of the circumstances within 24 hours after the quiz has been given. Makeup quizzes will not be permitted after the quiz answer key has been posted. The lowest quiz score will be dropped.

Assignments. Assignments must be submitted via Canvas, *not sent to me as email attachments*. Late assignments will not be accepted. Note carefully the time that the assignment is due (usually 11:59 p.m. on the given date)—any assignment turned in after the due date and time gets flagged by Canvas as submitted late, and will not be accepted. The lowest assignment grade will be dropped.

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies: <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

Legibility. *Assignments or portions of assignments, (including quizzes and exams) that are illegible will receive zero credit.* As a guideline, difficult to read (or messy) = illegible.

Evaluation of Grades

Assignment	Total Points
Assignments (6)*	100
Quizzes (6)*	100
Exam 1	50
Exam 2	50
Project report	50
Project presentation	50
Final Exam	50
Total	450

* Each assignment and each quiz is worth 20 points. The lowest quiz grade and the lowest assignment grade will be dropped.

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 who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluer.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student

participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

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 Conduct Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. 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
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@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: <https://counseling.ufl.edu>, 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 Connections Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.career.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://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <https://distance.ufl.edu/state-authorization-status/#student-complaint>.

