

**ENU 4630**  
**Fundamental Aspects of Radiation Shielding**  
**Fall 2017**

**1. Catalog Description**

Basic principles of radiation shielding, and the study of radiation sources and shielding design for radiation facilities.

**2. Pre-requisites and Co-requisites**

**Prerequisites for ENU 4630:**

ENU 4605    Interaction of Radiation with Matter

**3. Course Objectives**

Calculate the radiation shielding requirements for commonly encountered sources of photon, neutron, and charged particle radiations and integrate these calculations with materials and optimization parameters to design complete shielded structures for radiation facilities. By developing a complete understanding of the physical phenomena that occur as radiation is attenuated in materials, theoretical and numerical calculational techniques will be developed to predict the resulting radiation fields. Students will develop the ability to estimate uncertainties associated with the various approximation and empirical techniques for determining realistic radiation shielding requirements.

**4. Contribution of Course to Meeting the Professional Component (ABET only)**

1. Graduates will have successful careers in Nuclear Engineering and related disciplines.
2. Graduates will pursue continuing education or advanced degrees.

**5. Relationship of Course to Program Outcomes**

This course supports the following program outcomes:

- a. An ability to apply knowledge of mathematics, science, and engineering
- d. An ability to function on multidisciplinary skills teams
- e. An ability to identify, formulate, and solve engineering problems
- f. An understanding of professional and ethical responsibility
- g. An ability to communicate effectively, using both oral and written presentations, in engineering practice
- n. An ability to work professionally in one or more of the areas of: nuclear power systems, nuclear instrumentation and measurement, radiation protection and shielding and radiation sources and applications

## **6. Instructor**

Dr. James E. Baciak  
Interim Chair, Materials Science and Engineering  
100 Rhines Hall  
273-2131  
jebaciak@mse.ufl.edu

Office Hours: Monday, Period 8 (3:00 – 3:50 PM)  
Tuesday, Period 8 (3:00 – 3:50 PM)  
Wednesday, Period 8 (3:00 – 3:50 PM)  
Thursday, Period 8 (3:00 – 3:50 PM)

## **7. Teaching Assistant**

N/A

## **8. Meeting Times**

Mondays: Periods 4-5  
Wednesdays: Period 4

## **9. Class Schedule**

Three lecture periods per week, with two periods on Mondays and one period on Wednesdays.

## **10. Meeting Location**

Flint-Keene Hall (FLI), Room 115

## **11. Material and Supply Fees**

N/A

## **12. Textbooks Required**

Radiation Shielding, Kenneth Shultis & Richard Faw, American Nuclear Society, 2002  
ISBN: 0-89448-456-7

I will also provide some notes from time-to-time.

## **13. Recommended Reading**

## Recommended Texts and Support to Assist with Project Report Writing

1. The Mayfield Handbook of Technical and Scientific Writing (available at <http://www.mhhe.com/mayfieldpub/tsw/toc.htm>). *Excellent resource and free!*
2. Writing standards for a variety of Nuclear and Radiological Engineering related journal publications, including Nuclear Instruments and Methods, IEEE Transactions on Nuclear Science, and Journal of Health Physics. These are available on the web, but I can provide you with copies by request).
3. The University of Florida Reading and Writing Center is also available to help students become better readers and writers. More information (including operating hours) can be found at <http://www.at.ufl.edu/rwcenter>.

### 14. Course Outline

Date		Lecture Topic	Reading Materials	Special Notes
August	21	Introduction Radiation Sources - Photons	Chapter 3	
	23	Radiation Sources - Neutrons	Chapter 4	
	28	Radiation Dosimetry: Quantities and Units	Chapter 5	
	30	Photon and Neutron Response Functions	Chapter 5	
September	4	<b>No Class – Labor Day Holiday</b>		
	6	Photon and Neutron Response Functions	Chapter 5	
	11	Basic Methods of Radiation Exposure Calculations	Chapter 6	
	13	Radiation Protection Regulations	Notes	
	18	Special Techniques for Photons	Chapter 7	Form Project Teams
	20	Special Techniques for Photons	Chapter 7	
	25	Solving Shielding Problems with Microshield	Code Manual	
	27	<b>In-Class Quiz #1</b>		
October	2	Solving Shielding Problems with Microshield	Code Manual	Select Project Topic
	4	Special Techniques for Neutrons	Chapter 8	
	9	Special Techniques for Neutrons	Chapter 8	
	11	Special Techniques for Electrons	Chapter 9	
	16	Special Techniques for Electrons	Chapter 9	
	18	Monte Carlo Techniques	Chapter 11	
	23	Monte Carlo Techniques	Chapter 11	Team Assessment #1
	25	Solving Radiation Shielding Problems with MCNP	Notes	
	30	<b>No Class – ANS Conference</b>		
November	1	Solving Radiation Shielding Problems with MCNP	Notes	
	6	Ethical Culture in Radiation Protection and Shielding	Notes	
	8	<b>In Class Quiz #2</b>		
	13	Standards and Regulations in Radiation	Notes	

		Shielding at Nuclear Plant Facilities		
	15	Advanced MCNP Techniques for Shielding Applications	Notes	
	20	Advanced MCNP Techniques for Shielding Applications	Notes	
	22	<b>No Class – Thanksgiving Holiday</b>		
	27	Shielding Methods in Medical Facilities	NCRP 147	Team Assessment #2
	29	<b>No Class – NNSA CVT Review</b>		
December	4	Class Wrap and Review	Notes	
	6	Final Project Presentations (4-7 PM) – 125 Rhines Hall		Final Project Reports due by 11:59:59 PM.
	11			
	13			
	14	<b>Final Exam (12:30-2:30 PM)</b>		

Note: Course schedule may also change due my unscheduled travel. I reserve the right to hold make-up classes if necessary (for example, in case of class cancellations due to weather).

## 15. Attendance and Expectations

Students are expected to attend each class period. Periods which may be missed should be brought to the attention of the Instructor as far in advance of the class period as possible. In the event of an unexcused absence, it is the student’s responsibility to obtain and review the material that was covered during that class period. Students **MUST** participate during the student presentations at the end of the course in order to successfully complete the course.

## 16. Grading

Homework	30%
Quizzes	20%
Project Final Report	25%
Project Oral Presentation	10%
Final Exam	15%

### Homework

There will be about 6-8 homework sets during the course. Homework sets will be generally due one week after the assignment is issued (by 5 PM). Late homeworks will receive a penalty of 10% per day late.

### Quizzes

Two non-cumulative quizzes will be given during the semester, tentatively scheduled for September 27 and November 8. **I will give you a one-week advanced warning for each quiz.** Each quiz will be given during normal class time

## Final Exam

A 2-hour final exam will take place on **Thursday, December 14** from 12:30-2:30 PM. This exam will be open book and will test your knowledge you should have acquired during semester. The final exam will be cumulative. The exam may consist of multiple choice, calculations, diagram interpretation, and/or short answer questions.

## Project Report

Students are asked to form research groups of 2-3 investigators each. A radiation facility will be selected which is preferably modeled after an existing facility or design. Radiation sources will be specified, source terms estimated, and radiation protection guidelines established. Radiation shielding specifications will then be reported based upon dose calculations, radiation attenuation and scattering estimates, both of which are determined via MicroShield calculations and MCNP radiation transport simulations. The former may be used to establish rough shielding estimates or dose rates, while the later then is used for more final estimates.

We will discuss the projects around mid-September. Some elements of the projects will be included as homework problems

The description of the facility, the radiation protection plan, and the shielding design specifications shall be written up in the format of a peer-reviewed journal article. Two-student teams will submit one manuscript with the division of labor documented in acknowledgement section. The course instructor will verify independently the division of effort on both the project and the manuscript – targeted to be split evenly. As part of this, you will perform team self-assessments as part of your project.

Substantial penalties will result from plagiarism and data falsification including automatic course failure and possible expulsion. Grades for the final design manuscripts will be based upon (1) technical content, and (2) writing style. Students are asked to prepare their papers according to the author instructions for the journal *Health Physics* (but others mentioned in the recommended reading are acceptable too). **I will send out a rubric for the grading of final reports later in the semester.**

Students are asked to follow the instructions to the letter, except for the following:

- Limit your total number of pages of text (Abstract to Conclusions) to no more than 15 pages and no fewer than 10 pages. (single spaced)
- Submit only one copy of the Manuscript per group (including all tables and figures) in pdf format. MS word is also acceptable, but you are held responsible for any formatting changes between computers that can happen with Word.

- Each paper must have at least four tables and figures (combined).
- Each paper must have at least 5 peer-reviewed journal article citations (beyond textbooks or conference proceedings).

Each manuscript will be submitted with a cover letter to the appropriate Editor-in-Chief noting why you think your work is worthy of publication. Final manuscripts are due by email on Wednesday, **December 6**.

### **Project Presentation**

On Wednesday, **December 6** from 4-7 PM, we will meet to hold oral presentations on your shielding design projects. Each project 2-member team will prepare a PowerPoint Presentation for viewing to the class. Each presentation will be limited to 12 minutes with 3 minutes for questions. Typically, one partner will address the introduction of the problem, and give the materials and methods. Then, the other partner will discuss results and conclusions. I will be available prior to your presentation date (schedule to be announced) to review your presentations and load them on my laptop. Note: there will not be regular class hours on your presentation day.

### **17. Grading Scale**

The grading scale is generally as follows:

93-100	A	73-76	C
90-92	A-	70-72	C-
87-89	B+	67-69	D+
83-86	B	63-66	D
80-82	B-	60-62	D-
77-79	C+	0-59	E

Since I do not curve the grading scale, all students can receive an A (or an E)! Note: this scale can be adjusted from semester-to-semester by a couple of points depending on specific topics covered and difficulty. ENU 4630 is also a critical tracking course. “A C- will not be a qualifying grade for critical tracking courses. In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit: <http://www.registrar.ufl.edu/catalog/policies/regulationgrades.html>”

### **18. Make-up Exam Policy**

Make-up Exams and Laboratory Experiments are only allowed through prior requests or DOCUMENTED medical reasons. In cases where students will be out of town, a reasonable attempt to take the exam before the scheduled exam date will be performed.

### **19. 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.

### **20. 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/>.

### **21. 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.

### **22. 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.

### **23. 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: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>

## 24. Campus Resources:

### Health and Wellness

**U Matter, We Care:**

If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) or 352 392-1575 so that a team member can reach out to the student.

**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 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](https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf).

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