ENU 4630 – FUNDAMENTAL ASPECTS OF RADIATION SHIELDING – FALL 2014

Catalog Description: (3 Credits) Basic principles of radiation shielding, and the study of radiation sources and shielding design for radiation facilities.

Course Prerequisites: ENU 4605 – Radiation Interactions and Sources 1 –minimum grade of C.

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.

ABET Professional Component:
1. Graduates will have successful careers in Nuclear Engineering or related disciplines.
2. Graduates will pursue advanced degrees or continuing education.
3. Graduates will communicate effectively and work collaboratively in Nuclear Engineering/related disciplines.
4. Graduates will use the knowledge and skills obtained in their undergraduate education to practice high ethical and professional standards in Nuclear Engineering or related disciplines

ABET Program Outcomes:
1. Provide students with the ability to apply advanced mathematics, computational skills, science and engineering science, including atomic and nuclear physics, to identify, formulate, analyze, and solve nuclear and radiological engineering problems
2. Provide students with a knowledge of the fundamentals of radiation transport, interactions, and detection and with the principles required for the analysis, design, and safe operation of radiation producing and using equipment and systems.
3. Provide students with the ability to design and conduct experiments and analyze and interpret data using current experimental, data acquisition and data analysis techniques.
4. Provide students with the skills needed to communicate effectively, work collaboratively, and understand their professional and ethical responsibilities and the impact of engineering solutions in a societal and economic context so they can pursue successful, productive careers in nuclear and radiological engineering.

Instructor:
Dr. Sedat Goluoglu, 168 Rhines Hall, (352) 294-1690, goluoglu@ufl.edu
Office Hours: WMF, 9:00 - 10:00 am

Teaching Assistants:
TBD

Meeting Times: MWF, 4th Period, 10:40 am to 11:30 am
Meeting Location: NSC227

Textbook: *Radiation Shielding*, Kenneth Shultis and Richard Faw
Publisher – American Nuclear Society (2000)
ISBN 0-89448-456-7

Software: MicroShield v9.02 by Grove Software, Inc.
www.radiationsoftware.com

Note *– Educational version to be provided by Dr. Goluoglu*

Software: MCNP Version 6 from the Radiation Safety Information Computational Center (RSICC)
https://rsicc.ornl.gov/Default.aspx
MCNP6.1/MCNP5/MCNPX-EXE (C810 MNYCP 01) *EXE ONLY*810 DVD Only
Note *– Each individual student must register with RSICC and receive their own copy*

Attendance and Expectations:
Students are expected to attend all lectures, notify instructor of expected absence in advance, and make arrangements to make up missed material. Attendance will be monitored through periodic and unannounced verification in class. All laptops and cell phones shall be turned off and put away at the start of all in-class lectures. Late homework is subject to a 20% per day penalty deduction. Professionalism standards will be enforced on the design project and home sets.

Grading Policy:

Class Attendance	5%
Homework Sets	20%
Exam 1	25%
Exam 2	25%
Design Project Final Report	15%
Design Project Oral Presentations	10%

Grading Scale:

93 -100	A	77-79	C+	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: https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx
90-92	A-	73-76	C	
87-89	B+	70-72	C-	
83-86	B	67-69	D+	
80-82	B-	63-66	D	
		60-62	D-	
		<60	E	

Make-Up Exam Policy:
No make-up exams or project presentations will be permitted. If an exam or project presentation is missed due to illness, and the instructor is notified prior to the start of the exam or presentation, a re-weighting of those portions of the final grade will be made on a case-by-case basis.

Course Schedule:
We will try to cover as much of the topics from the table below as possible. In addition, the classes on September 15, 17, 19 are reserved for MicroShield lectures. The classes on September 26, 29, October 1, 3 are reserved for MCNP lectures.

Course Topic	***Reading***
Course Introduction	
Radiation Sources – Photons	Chapter 3
Radiation Sources – Neutrons	Chapter 4
Radiation Dosimetry Quantities and Units	Chapter 5
Radiation Dosimetry Quantities and Units	Chapter 5
Photon and Neutron Response Functions	Chapter 5
Photon and Neutron Response Functions	Chapter 5
Radiation Protection Regulations – External Exposures	Notes
Basic Methods of Radiation Dose Calculation	Chapter 6

Basic Methods of Radiation Dose Calculation	Chapter 6
Special Techniques for Photons	Chapter 7
Special Techniques for Photons	Chapter 7
Special Techniques for Photons	Chapter 7
Special Techniques for Neutrons	Chapter 8
Special Techniques for Neutrons	Chapter 8
Special Techniques for Neutrons	Chapter 8
Special Techniques for Electrons	Chapter 9
Special Techniques for Electrons	Chapter 9
Special Techniques for Electrons	Chapter 9
Monte Carlo Techniques	Chapter 11
Monte Carlo Techniques	Chapter 11
Monte Carlo Techniques	Chapter 11
ANSI Standards / NP Applications	Notes
ANSI Standards / NP Applications	Notes
Shielding Methods in Medical Facilities	NCRP 147
Shielding Methods in Medical Facilities	NCRP 147
Shielding Methods in Medical Facilities	NCRP 147

Homework: Five to six problems may be assigned for each chapter covered in the course text. Problem sets will be due within one week. Grades will be reduced 20% per day late.

Exams: Two non-cumulative exams will be given during the semester (date and time TBD but expect evening exams!). Make-up exams will only be considered for exceptional circumstances and will be implemented by the instructor on a case-by-case basis. Notice of the absence must be given to the instructor prior to the start of each exam.

Design Project: Students are asked to form research groups of exactly two 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 MCNP radiation transport simulations.

Design Project Final Manuscripts: 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 50% / 50%. 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, (2) writing style, and (3) adherence to journal article submission guidelines. Students are asked to prepare their papers according to the Instructions to Authors for the journal *Nuclear Technology (for detailed instructions see http://www.ans.org/pubs/journals/nt/authors/)*.

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 13 pages and no fewer than 8 pages.
- Submit one copy of the Manuscript (including all tables and figures) all in MS Word format
- Use the following file names: Paper – Last Name.docx.
- Each paper must have at least two tables and two figures.
- Each paper must have at least 5 peer-reviewed journal article citations (beyond textbooks or conference proceedings).

Final manuscripts are due by email on Saturday, **November 29.** Reviewed manuscripts will be returned by email to each student team the following week.

Design Project Proposals: On **October 29** and **October 31**, in class oral presentations will be given by the various design project teams outlining their scope of work, design objectives, materials and methods of calculation or possibly measurement, and the time line for completion of the project (team order TBD).

Design Project Presentations: On Saturday Morning, **December 6** from 8:30 am to noon, 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.

Course Policies

Honesty Policy:
All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

Accommodation for Students with Disabilities:
Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

UF Counseling Services:
Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
Career Resource Center, Reitz Union, 392-1601, career and job search services.

Software Use:
All faculty, staff and student 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.

Course Evaluation:
Students are expected to provide feedback on the quality of instruction in this course based on 10 criteria. These evaluations are conducted online at https://evaluations.ufl.edu. 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. "

Homework Policy for ENU 4630
Sedat Goluoglu

1. Homework sets may be assigned in class or through sakai. Grades will be decreased 20% for each day late (20% after the deadline until the next business day same time, 40% the following business day same time, etc.).

2. Homework to be turned in must be neat, legible, stapled, and on one side of the paper only. As a general practice, work each homework problem on a scratch paper and recopy when thought to be correct and complete. All homework problems will be graded; however, **the instructor reserves the right to give zero credit for any problem that does not appear neat, legible, and easy to follow.**

3. For each problem...

   a) Start each problem on a separate page.

   b) Paraphrase the problem to be solved.

   c) State all given and pertinent data, and specify the sources for each.

   d) List all pertinent formulas or laws needed to solve the problem.

   e) State clearly all assumptions made.

   f) Solve the equations specified above with minimal calculation of intermediate values. When reporting intermediate values, carry 2-3 extra significant digits until the final answer is given.

   g) Within each equation to be solved, show units for every numerical value substituted. Perform a unit analysis for both intermediate and final answers.

   h) Label and box your final answer. Give no more than one significant digit beyond those of your input data.

   i) **The instructor reserves the right to give zero credit to a problem if any one of these steps are not followed.**

4. Partial credit will be given for each worked problem.

5. Turn in each homework with the homework assignment as the first page.