

ENU 4612
Nuclear Radiation Detection and Instrumentation
Fall 2015

1. Catalog Description

Physics and electronics of radiation detection and instrumentation systems for application to nuclear energy, radiological sciences, radiation protection, medical physics and imaging, and industrial safety and control systems.

2. Pre-requisites and Co-requisites

Pre-requisites for ENU 4612:

- EEL 3003 Elements of Electrical Engineering
- ENU4605 Interaction of Radiation with matter

3. Course Objectives

Provide students with the opportunity to learn the principals of radiation interactions with matter, radiation detection techniques and characteristics of different radiation detectors; Development of communication skills including technical writing and oral presentations; Prepare students for independent research and/or design projects.

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

- a. Graduates will have successful careers in Nuclear Engineering and related disciplines.
- b. Graduates will pursue continuing education or advanced degrees.

5. Relationship of Course to Program Outcomes (ABET only)

This course supports the following program outcomes:

- b. b1. An ability to design and conduct experiments
- b2. An ability to interpret data
- c. An ability to develop an engineering design to meet specific technical requirements within realistic constraints such as economic, environmental, health and safety, and reliability
- e. An ability to identify, formulate, and solve engineering problems
- l. An ability to apply advanced mathematics, science, and atomic and nuclear physics, to nuclear and radiological systems and processes
- m. An ability to measure and interpret measurements of nuclear and radiological processes

- n. An ability to work professionally in one or more areas of: nuclear power systems, nuclear instrumentation and measurement, radiation protection and shielding, and radiation sources and applications

6. Instructor

Jessica Kelley
231 Nuclear Science Building
(407)-491-8084
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Office Hours: Tuesday, Period 6 (12:50 - 1:40 PM)
 Wednesday, Period 4 (10:40 – 11:30 AM)
 Thursday, Period 4 (10:40 – 11:30 AM)

Note: Office hours may change due to laboratory schedule / upcoming travel schedule

7. Teaching Assistant

N/A

8. Meeting Times

Period 3 (9:35-10:25 AM), ENU4612L laboratory sections will be assigned/scheduled during first week of classes based upon students' schedules.

9. Class Schedule

Three (3) 50-minute lectures each week (Monday, Wednesday, and Friday). One (1) 3-hour laboratory session during particular weeks as noted on the course outline

10. Meeting Location

Lecture: CSE E122 (Computer Science and Engineering)

Laboratory: NSC 125 (Nuclear Science Building)

11. Material and Supply Fees

None.

12. Textbooks Required

Glenn F. Knoll, *Radiation Detection and Measurement*, 4th Ed., John Wiley & Sons, Inc., 1999

Chart of Nuclides:

You will need access to a chart of nuclides during the course. Feel free to use any one of the numerous resources available (so long as it is accurate). Below are a couple of suggested chart of nuclides.

- I. Joseph R. Parrington, et al., *Nuclides and Isotopes*, 15th Ed., Lockheed Martin / GE Nuclear, 1996.
- II. <http://atom.kaeri.re.kr> (This is a website maintained by the Korea Atomic Energy Research Institute – Recommended)

Course Notes

I will place course notes ahead of lectures on Canvas. The notes I post will only contain fragments of the entire lecture. Students are required to attend class and fill in the blanks as necessary, according to written lecture notes dictated in class. Canvas will also be the location to download other posted course materials, such as homework, solution sets, and sample problems.

13. Recommended Reading

- I. Nicholas Tsoulfanidis, *Measurement and Detection of Radiation*, 2nd Ed., Taylor and Francis, 1995

14. Course Outline

Date	Course Topic	Chapter	Lap Topic for that Week	
August	24	Introduction, Overview of Syllabus		
	26	Sources of Radiation	1	
	28	Sources of Radiation	2	
	31	Radiation Interactions	2	
September	2	Radiation Interactions	3	
	4	Counting Statistics	3	
	7	No Class- Labor Day Holiday		Lab 0: Introduction & Lab Safety
	9	Counting Statistics	3	
	11	Error Analysis	3	
	14	Error Analysis	3	Lab 1: Oscilloscope Usage
	16	Pulse Shaping	16	
	18	Pulse Shaping & Processing	16	
	21	NIM Electronics and Circuits	16, 17	Lab 2: Nuclear Instrument Electronics
	23	NIM Electronics	17	
	25	Multi-Channel Analyzers	18	
	28	General Detector Properties	4	Midterm Exam 1 during

				30	General Detector Properties	4	this week?
October	2	General Detector Properties	4				
	5	No Class-AREMA Conference					
	7	No Class-AREMA Conference					
	9	Gas Detectors (Ionization Chambers)	5				
	12	Gas Detectors (Ionization Chambers and G-M Tubes)	7			Lab 3: Geiger-Mueller Detectors	
	14	Gas Detectors (G-M Tubes)	6, 7				
	16	Gas Detectors (Proportional Counters)	6				
	19	Scintillation Detectors (Inorganic)	6			Lab 4: Gas-Flow Proportional Counters	
	21	Scintillation Detectors (Organic)	8				
	23	Photomultiplier Tubes and Photodiodes	8				
	26	Radiation Spectroscopy	9			Lab 5: NaI Scintillation Detectors	
	28	Radiation Spectroscopy	10				
	30	Semiconductor Detectors	11				
November	2	No Class- NSS Conference					
	4	No Class- NSS Conference					
	6	No Class- Homecoming Holiday					
	9	Semiconductor Detectors	11			Midterm Exam 2 during this week?	
	11	No Class-Veterans Day Holiday					
	13	Semiconductor Detectors	11				
	16	Silicon and Germanium Detectors	11, 12			Lab 6: High-Purity Germanium Detectors	
	18	Germanium Detectors	12				
	20	Germanium Detectors	12				
	23	Neutron Detection	14, 15				
	25	No Class-Thanksgiving Holiday					
27	No Class-Thanksgiving Holiday						

	30	Neutron Detection	14	Lab 7: Neutron Detection
December	2	Thermal Neutron Detection	14	
	4	Fast Neutron Detection	15	
	7	Special Topics*		
	9	Jeopardy Final Exam Review		
	11	No Class- Reading Days		
	14	No Class- Reading Days		
	16	No Class- Reading Days		
	17	Final Exam (12:30 - 2:30 PM)		

*If time permits I will cover additional topics such as reactor instrumentation, medical imaging detectors, and/or health physics personnel dosimetry.

15. Attendance and Expectations

Students are required to attend each class period with a percentage of the course grade dependent on random pop quizzes. If the student has to miss a class for an appropriate reason, it should be brought to the attention of the instructor as far in advance 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.

16. Grading

Your overall grade is based on your performance in both the lecture and laboratory, with each weighted equally. Note: you **MUST** receive a passing grade in both parts of the course in order to receive a passing grade (e.g., an A in lecture and an E in lab does not equal a C; it will be recorded as an E!). Below is a breakdown for the grading in the lecture and laboratory:

Lecture Grading

Homework Sets	20%
Pop Quizzes	10%
Mid Term Exams (2)	30%
Final Exam	40%

Laboratory Grading

Short Reports (2)	30%
Worksheets (7)	30%
Quizzes (7)	30%
Presentation	10%

Homework Sets

There will be about 7-8 homework sets covering the major course topics handed out throughout the semester. Due dates will be indicated on the problem sets I hand out. Note: the homework sets will involve both theoretical derivations and analysis of real data.

Pop Quizzes

I will randomly give out pop quizzes during the lecture periods. These will consist of one or two relatively short/simple questions in order to assess how well students have been paying attention to class concepts. They will also make up the attendance portion of the grade in order to ensure students attend every lecture, unless an appropriate excuse is given prior to missing a class.

Exams

Two non-cumulative mid-term exams will be given during the semester. The tentative dates for the weeks they will be given are listed in the course outline above but are subject to change. The midterm exam will be 2 hours in length and will be given from 8-10 PM in the evening (normal assembly exam times). **I will give you a two-week advanced warning for the midterm exam.**

All exams will consist of an open book and closed book portion. The closed book portion will be given first and students will be given an hour to complete this section. The open book portion will be given to students after completion of the closed book section. Textbooks, class notes, and home works will be allowed during the open book portion. However, no laptops or electronic devices (aside from calculators) will be allowed.

The final exam is currently scheduled for **Thursday December 17th (12:30 – 2:30 PM)** and is cumulative. The same open book/closed book exam layout will apply to the final, as well.

17. Grading Scale

The grading scale is generally as follows for both ENU 4612 and ENU 4612L:

95-100	A
89-94	A-
84-88	B+
80-83	B
76-79	B-
72-75	C+
68-71	C
64-67	C-
60-63	D+
55-59	D
50-54	D-
0-49	E

Given that I don't curve, all students can receive an A. Also, students within a point of two grades may be rounded up to the better letter grade if participation and attendance are

good. Otherwise, traditional rounding to the tenth decimal place will decide final letter grade for students in between two grades.

18. Make-up Exam Policy

Make-up Exams 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. 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.

20. 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.

21. UF Counseling Services

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

- University Counseling Center, 301 Peabody Hall, 392-1575, Personal and Career Counseling.
- SHCC mental Health, Student Health Care Center, 392-1171, Personal and Counseling.
- Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161, sexual assault counseling.
- Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling.

22. 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.