

**ENU 4612**  
**Nuclear Radiation Detection and Instrumentation**  
**Fall 2014**

**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**

**Prerequisites for ENU 4612:**

EEL 3003      Elements of Electrical Engineering  
ENU 4605      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)**

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 (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**

Dr. James E. Baciak  
Associate Professor  
100A Rhines Hall  
273-2131  
jebaciak@mse.ufl.edu

Office Hours: Tuesday, Period 8 (3:00 – 3:50 PM)  
                  Wednesday, Period 8 (3:00 – 3:50 PM)  
                  Friday, Period 8 (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), ENU 4612L laboratory sections will be assigned/scheduled during the first week of classes (based upon students' schedules).

## 9. Class Schedule

Three (3) 50-minute lectures each week (Monday, Wednesday, and Friday)

## 10. Meeting Location

Lecture: 227 NSC (Nuclear Science Building)

## 11. Material and Supply Fees

None.

## 12. Textbooks Required

Glenn F. Knoll, *Radiation Detection and Measurement*, 4<sup>th</sup> Ed., John Wiley & Sons, Inc., 1999. (ISBN: 0-471-07338-5)

### Access to 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 chart of nuclides that I use frequently.

1. Joseph R. Parrington, et al., *Nuclides and Isotopes*, 15<sup>th</sup> Ed., Lockheed Martin / GE Nuclear, 1996.
2. <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 Sakai. This will be the location to download other course materials from time to time (e.g., homework, solution sets).

## 13. Recommended Reading

1. Nicholas Tsoufanidis, *Measurement and Detection of Radiation*, 2<sup>nd</sup> Ed., Taylor and Francis, 1995.
2. G. G. Eichholz and J. W. Poston, *Principles of Nuclear Radiation Detection*, Ann Arbor Science, 1985.

## 14. Course Outline

Date	Course Topic	Chapter	ENU 4612L Lab Topic for that Week	
August	25	Introduction, Course Goals and Objectives		
	27	Sources of Radiation	1	
	29	Radiation Interactions	2	
September	1	<b>No Class – Labor Day Holiday</b>	2	
	3	Radiation Interactions	3	
	5	Counting Statistics	3	
	8	Counting Statistics		Lab 0: Introduction & Lab Safety
	10	Error Analysis	3	
	12	Error Analysis	3	
	15	Pulse Shaping	16	Lab 1: Oscilloscope Usage
	17	Pulse Shaping and Processing	16	
	19	NIM Electronics and Circuits	16 & 17	
	22	NIM Electronics	17	
	24	<b>No Class – On Travel</b>		
26	Multi-Channel Analyzers	18		
29	<b>No Class – AREMA Conference*</b>	4	Lab 2: Nuclear Instrument Electronics	
October	1	<b>No Class – AREMA Conference*</b>		
	3	General Detector Properties	4	
	6	General Detector Properties		Midterm Exam 1 during this week
	8	Gas Detectors (Ionization Chambers)	5	
	10	Gas Detectors (G-M Tubes)	7	
	13	Gas Detectors (G-M Tubes and Proportional Counters)	6&7	Lab 3: Geiger-Mueller Detectors
	15	Gas Detectors (Proportional Counters)	6	
	17	<b>No Class - Homecoming</b>		
	20	Scintillation Detectors (Inorganic)	8	Lab 4: Gas-Flow Proportional Counters
	22	Scintillation Detectors (Organic)	8	
	24	Photomultiplier Tubes and Photodiodes	9	
	27	Radiation Spectroscopy	10	Lab 5: NaI Scintillation Detectors
	29	Radiation Spectroscopy	10	
31	Semiconductor Detectors	11		
November	3	Semiconductor Detectors	11	
	5	Semiconductor Detectors	11	
	7	Silicon and Germanium Detectors	11 & 12	
	10	<b>No Class – ANS Conference*</b>	12	
	12	<b>No Class – ANS/IEEE Conferences*</b>		
	14	<b>No Class – IEEE Conference*</b>		
17	Germanium Detectors	12	Lab 6: High-Purity Ge Detectors	

			Midterm Exam 2 during this week
	19	Germanium Detectors	12
	21	Other Semiconductor Detectors	
	24	Thermal Neutron Detection	14
	26	<b>No Class - Thanksgiving Holiday</b>	
	28	<b>No Class - Thanksgiving Holiday</b>	
	1	Neutron Detection	14 & 15    Lab 7: Neutron Detection
December	3	Fast Neutron Detection	15
	5	Environmental Monitoring <sup>1</sup>	Notes
	8	Nuclear Security <sup>1</sup>	Notes
	10	Course Evaluations / Wrap-up	
	12		
	15		
	18	<b>Final Exam (10 AM – 12 PM)</b>	

\* - Make-up classes may be scheduled, depending on if the class has fallen behind schedule. I also reserve the right to hold make-up classes due to forced cancellations (e.g., hurricanes). Note: there may be 1-2 additional classes cancelled due to required travel (e.g., American Society for Nondestructive Testing). I will announce these in advance along with the makeup dates.

<sup>1</sup> – These are more advanced topics that will be covered if time allows.

## 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.

## 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	30%
Mid Term Exams (2)	30%
Final Exam	40%

### Laboratory Grading

### Lecture Grading

#### Homework

From time to time (approximately every couple of weeks), I will provide you with a number of homework problems. Due dates will be indicated on the problem sets I hand out. Be prepared to turn in about 7-8 homework sets throughout the semester. Note: the homework sets will involve both theoretical derivations and analysis of real data.

#### Exams

Two non-cumulative mid-term exams will be given during the semester on dates to be determined later, but you can expect one in early October and one in mid-November as tentatively shown in the schedule above. 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.**

The final exam currently scheduled on **Thursday, December 18** (10:00AM-12:00PM) is cumulative.

All exams are closed book - closed note, however you will be allowed to bring in notes as specified below:

**Midterm Exam #1 – one full sheet (both sides) of 8.5x11 in<sup>2</sup> of paper**

**Midterm Exam #2 - 2 full sheets (both sides) of 8.5x11 in<sup>2</sup> of paper**

**Final Exam – 2 sheets of 8.5x11 in<sup>2</sup> of paper**

## 17. Grading Scale

The grading scale is generally as follows:

### **ENU 4612 Grading Scale**

92-100	A
88-91	A-
84-87	B+
80-83	B
76-79	B-
72-75	C+
68-71	C
64-69	C-
60-63	D+
55-59	D
50-54	D-
0-49	E

Since I do not curve the grading scale, all students can receive an A (or an E)! Note: this scale may be adjusted from semester-to-semester by a couple of points depending on topics covered and difficulty of exams.

### **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.