ENU 4505L
Nuclear and Radiation Engineering Laboratory
Spring 2014

1. Catalog Description

A laboratory experience integrating practical applications of radiation sources and generators, radiation interactions and transport through matter, and radiation detection. Students select appropriate forms of radiation and detection methods to design solutions for specific nuclear and radiation engineering problems.

2. Pre-requisites and Co-requisites

Prerequisites for ENU 4505L:

ENU 4605	Interaction of Radiation with Matter
ENU 4612	Nuclear Radiation Detection and Instrumentation

3. Course Objectives

Provide both academic and hands-on experience of applications of radiation in industry. Laboratory exercises will be conducted within the framework of non-destructive testing and evaluations (NDE) using a variety of radiation sources including radioisotopes, machine generated x-rays, reactor generated neutrons, and several forms of non-ionizing radiation. Basic lab exercises will introduce the students to fundamental techniques in NDE and reactor operations. Advanced lab exercises will require the students to select appropriate forms of radiation and detection methods to design solutions to specific NDE problems.

4. Contribution of Course to Meeting the Professional Component

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:

- 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, heath and safety, and reliability
- d. An ability to function on multidisciplinary skills teams
- j. A knowledge of contemporary issues as they relate to professional engineering practice
- m. An ability to measure and interpret measurements of nuclear and radiological processes

6. Instructor

Dr. James E. Baciak
Associate Professor
170 Rhines Hall
(352) 273-2131
jebaciak@mse.ufl.edu

Office Hours: Monday, Period 4 (10:40 – 11:30 AM)
Wednesday, Period 2 (8:30 – 9:20 AM)
Wednesday, Period 8 (3:00 – 3:50 PM)
Friday, Period 7 (1:55 – 2:45 PM)

Note: Office hours may change due to laboratory schedule.

7. Teaching Assistant

NA

8. Meeting Times

Periods 3-4 (9:35 – 11:30 AM) on Tuesdays and Thursday
Lab Sections will be determined during the first day of class.

9. Class Schedule

Two (2) 2-hour class periods each week (Tuesday and Thursday). Tuesdays will generally be devoted towards lecture, and Thursdays will be the associated experiment. Depending on class size, additional laboratory sections can be scheduled on other days of the week. We will discuss this during the first day of class. Note: There may be 1 or 2 Thursday lectures during the semester.

10. Meeting Location

Tuesdays: Nuclear Science Building, Room 227
Laboratories: NSC 125, or UFTR

11. Material and Supply Fees

N/A

12. Textbooks Required

None [However, I will provide notes throughout the course.]

13. Recommended Texts

1. Glenn F. Knoll, *Radiation Measurement and Detection*, 3rd Ed., Wiley and Sons, 1999.
2. Albert Macovski, *Medical Imaging Systems*, Prentice-Hall, 1983.
3. Jerrold T. Bushberf, J. Anthony Seibert, Edwin M. Leidholdt, Jr., and John M. Boone, *The Essential Physics of Medical Imaging*, Williams & Wilkins, 1994.
4. John G. Proakis and Dimitris G. Manolakis, *Digital Signal Processing: Principles, Algorithms, and Applications*, 3rd Ed., Prentice-Hall, 1996.

Recommended Texts and Support to Assist with Report Writing

1. Sheldon Jeter and Jeffery Donnell, "*Writing Style and Standards in Undergraduate Reports*," College Publishing, 2004.
2. The Mayfield Handbook of Technical and Scientific Writing (available at http://www.mhhe.com/mayfieldpub/tsw/toc.htm). *Excellent resource and free!*
3. Writing standards for a variety of Nuclear and Radiological Engineering related journal publications, including Nuclear Instruments and Methods, IEEE Transactions on Nuclear Science, Nuclear Technology, and Journal of Health Physics. These are available on the web, but I can provide you with copies by request).
4. 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. Tentative Course Outline

Date		Lecture Topic	Lab/Homework Topic for that Week
January	7	Introduction	
	9	Radiation Worker Training	
	14	Inverse Multiplication and Approach to Criticality 2nd Person Training Quiz	
	16		Lab 1: Approach to Criticality
	21	Ultrasonic Testing	
	23		Lab 2: Ultrasonic and Acoustic Emission
	28	Eddy Current Testing	
	30		Lab 3: Eddy Current Testing
February	4	Radiographic Imaging Digital Imaging Fundamentals and Transformations	
	6		Digital Imaging Fundamentals
	11	Infrared and Thermal Imaging	
	13		Lab 4: Thermal Imaging
	18	HPGe Detector Calibration	
	20		Lab 5: Detector Calibration and Activity Concentration Calculations
	25	Neutron Activation Analysis I: Induced Radioactivity	
	27		Lab 6: Neutron Activation Analysis I – Induced Radioactivity
March	4	**No Class – Spring Break**	
	6	**No Class – Spring Break**	
	11	Neutron Activation Analysis II	
	13		Lab 7: Neutron Activation Analysis II – Isotope ID and Activity Calculations
	18	Control Blade Worth	
	20		Lab 8: Blade Worth Measurements
	25	**No Class – ASNT Conference**	
	27		**No Lab – Time for Design Projects**
	1	Temperature Coefficient Hot Channel Factors	
April	3		Lab 9: Temperature Coefficient & Hot Channel Factors
	8	Advanced Scintillation Detector Properties	
	10		Lab 10: Scintillation Detector Property Measurements

April	15	Radiography for Non-Destructive Testing and Inspection Protocols Review	
	17		Lab 11: Digital Radiography and Design of Flaw Inspection Protocols
	22	**No lecture – MRS Conference**	
	28	**Final Exam (3-5 PM)**	

Note: Course material and schedule may change due to equipment/facility availability. I will give advanced warning if this is to be the case. Course schedule may also change due my unscheduled travel.

For the Spring 2014 Semester, the UFTR will not be available. However, I have data obtained from the last time we ran the reactor experiments. For these labs, we will go through the experiment, how data were obtained, and analyze results/calculate operating parameters. These labs can then be written up just like any other lab report.

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 in each laboratory exercise and produce and individual laboratory report on each exercise.

16. Grading

Homework and Quizzes	15%
Lab Reports	60%
Final Exam	25%

Homework and Quizzes

There will be about 5-6 homework sets and quizzes (combined) during the course. Quizzes will be based advanced lab preparation (similar to quizzes in 4612L). Homework sets will be due one week after completion of the laboratory experiment. Training quizzes will also be

Final Exam

A 2-hour final exam will take place on **Monday, April 28** from 3-5 PM. This exam will be closed book - closed note and will test your knowledge you should have acquired during the experiments and lectures alike. It will be a combination of multiple choice, diagram drawings, basic calculations, and short answer questions.

Lab Reports

Each student will be required to write seven (7) lab reports during the course. The due date for the reports is 5 PM on the day exactly one week after the experiment. No due date extensions shall be granted. **There is a maximum page limit of 10 pages (single spaced), of approximately 1500-2000 words.** The content and format of the lab reports is described below.

As mentioned, you have to write seven reports during the semester (not including the group project). However, we perform eleven experiments. Thus, you can skip four experiments. Which experiments you write about is left to you, just keep in mind that you MUST write seven lab reports. I would suggest that you do not put off all reports until the end (i.e., I'm letting you skip a couple of reports in case your work from other courses becomes time consuming – such as ENU 4192). Please see the notes below style and content to help you prepare your reports.

1) Your **audience** is a nuclear engineer, unfamiliar with the experiment
   This implies:
   a) Explain **what** you are doing in each part of the lab. This does not mean a step-by-step description of the procedure, but rather a description of the general measurement. If a setup diagram makes the experiment clearer, then include one in the **body** of the report.
   b) Explain **why** you are making a particular measurement. Provide a conceptual (and possibly theoretical) description of the experiment. The reader will require this knowledge so that he may understand your measured results.
   c) Drawing from the conceptual description of each measurement, **predict** the expected result.
   d) Present your result, with **quantitative** measures of its accuracy (e.g.percent deviation,R^2)
   e) **Analyze** your result. Address both the **magnitude** of the deviation and its **direction** (i.e. Is the measured number greater than or less than the proper result ?).

*Your report should concentrate on the **analysis** of the results, not the results themselves. The particular number that you measure is less important than your ability to communicate a complete description of the experiment.*

2) Figures (Drawings and Plots)
   a) Your goal is to make your reports as understandable as possible. Therefore, use drawings liberally.
   b) Do not turn in a report with pencil drawings on it. If the best way to make a drawing is by hand (most of the time, it is not), then photocopy the report after you make the drawing and turn that in to me (so that the drawing and text will be the same in color and consistency).

c) When making plots, use a software package such as MS Excel, SigmaPlot, or the like. Include axes labels (with units) and label each of the figures in your report.

3) Formal writing (textbook style).
   a) Do not use a conversational tone (i.e. write in complete sentences, do a spell check)
   b) Do not write in the first person.
   c) Font size: 10 - 12

4) The Appendix is supplemental to the report. Do not expect it to be read. If you want the reader to see something, then put it in the body of the report.

Successful Completion of Gordon Rule Writing Requirements

I will evaluate your writing on a number of criteria: Content, Organization, Argument and Support, Style, and Mechanics. In order to be a successful writer (and therefore receive a Satisfactory evaluation for your writing/communication requirements), please look over the following guidelines on satisfactory completion of Gordon Rule Writing requirements for this course.

	SATISFACTORY (Y)	**UNSATISFACTORY (N)**
CONTENT	Papers exhibit at least some evidence of ideas that respond to the experiment/laboratory topic with complexity, critically evaluation the results, and provide at least an adequate discussion with basic understanding of experiment.	Papers either include a central discussion that is unclear or off- topic or provide only minimal or inadequate discussion of the experimental results. Papers may also lack sufficient or appropriate discussion of the results, with little or no tie-in with the underlying theory.
ORGANIZATION AND COHERENCE	Documents and paragraphs exhibit at least some identifiable structure for topics, including a clear thesis statement but may require readers to work to follow progression of ideas. Figures, tables and graphs are used in a logical manner to properly explain results, with these items being placed within a logical manner/progression of the experimental result. An outside nuclear engineer should be able to understand your report, and be able to repeat at least some of the experiment.	Documents and paragraphs lack clearly identifiable organization, may lack any coherent sense of logic in associating and organizing ideas, and may also lack transitions and coherence to guide the reader. Poor use of figures, graphs, and tables do not provide any cohesion with the discussion in the report.

ARGUMENT AND SUPPORT	The reports use persuasive and confident presentation of ideas, strongly supported with experimental evidence (including comparisons with what your theoretical expectations). At the weak end of the Satisfactory range, documents may provide only generalized discussion of the experimental results or may provide adequate discussion but rely on weak support for arguments.	Documents make only weak generalizations, providing little or no support, as in summaries or narratives that fail to provide critical analysis. No crucial comparisons with the underlying theory of the experimental results.
STYLE	Documents use a writing style with word choice appropriate to the context, genre, and discipline. Sentences should display complexity and logical sentence structure. At a minimum, documents will display a less precise use of vocabulary and an uneven use of sentence structure or a writing style that occasionally veers away from word choice or tone appropriate to the experiment/topic. Figures, tables and graphs follow an appropriate style/format, and that style is used consistently throughout the document. For additional information on style and format, I will provide you with sample reports. In addition, you can consult the writing formats for a variety of publications, including Nuclear Instruments and Methods in Physics Research, IEEE Transactions on Nuclear Science, or Journal of Health Physics.	Documents rely on word usage that is inappropriate for the context, genre, or discipline. Sentences may be overly long or short with awkward construction. Documents may also use words incorrectly. Figures, tables and graphs are poorly constructed with little adhesion to a consistent format.
MECHANICS	Reports will feature correct or error-free presentation of ideas. At the weak end of the Satisfactory range, reports may contain some spelling, punctuation, or grammatical errors that remain unobtrusive so they do not muddy the paper's argument or points.	Papers contain so many mechanical or grammatical errors that they impede the reader's understanding or severely undermine the writer's credibility.

The student must earn an S (satisfactory) evaluation on the writing requirements of the course. To help you in understanding how your reports are graded, review the rubric below. All reports are graded out of 100 points. Note that I consider both technical and grammatical correctness in determination of your grade.

Grading Rubric for ENU 4505L Reports

	Content	Points
INTRODUCTION	• Paragraph summarizing **work done** and **reasons for the work** (i.e. understand a new concept, prove a hypothesis, determine the system efficiency...). • Include a summary (1-2 paragraphs) on the basic theory of the experiment.	**10**
EXPERIMENTAL SETUP AND PROCEDURE	• A past tense description of the steps you followed, in your own words. You can refer to handouts, and place these handouts in an appendix • If applicable, include a block diagram for the experiment • If applicable, include a table listing all equipment and any necessary settings for each piece of equipment.	**5**
RESULTS & ANALYSIS	• Are all results required by the procedure presented and discussed? • Is all data present? Note: large data sets should be included in the Appendix • Are your results explained IN YOUR OWN WORDS? • Figures, tables and graphs are used in a logical manner to properly explain results, with these items being placed within a logical manner/progression of the experimental result. • Is error analysis included for applicable data? • The report uses persuasive and confident presentation of ideas, strongly supported with experimental evidence (including comparisons with what your theoretical expectations). • Since you already performed the experiment, write in past tense.	**40**

CONCLUSIONS	• A summary of the **major** results of the lab. • Did you accomplish the goals and how did your results compare to the expected behavior? • Did the data support the theory? This should be verified with the major results and % error values from the experiment. • The reader should get all the important results and major findings of your work from the conclusion (the details should be in the Results and Analysis section). • A conclusion section should be able to stand on its own.	**10**
STYLE	• Documents use a writing style with word choice appropriate for nuclear engineers. • Figures, tables and graphs follow an appropriate style/format, and that style is used consistently throughout the document. • Fonts are consistent throughout the document • Page numbers are included in the document, and are at the same location on each page. • Documents and paragraphs exhibit at least some identifiable structure for topics, including a clear thesis statement	**15**
GRAMMAR AND SPELLING	• Clear evidence that the paper was proofread by the student prior to submission for grading • No spelling mistakes • Proper use of verb tense. Normally, when discussing the experiment, use past tense. • Adequate grammar style (no run-on sentences, proper paragraph format, proper sentence structure, etc.)	**15**

OTHER	• Proper referencing of information that is not considered common knowledge (use a standard referencing format). • Are appendices included, and properly referenced within the main document?	**5**
TOTAL SCORE		**100**

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.

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.