ENU 4505L
Nuclear and Radiation Engineering Laboratory
Spring 2017

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 (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:

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

Office Hours: Monday, Period 2 (8:30 - 9:20 AM)
Wednesday, Period 3 (9:35 – 10:25 AM)
Friday, Period 8 (3:00 – 3:50 PM)

7. Teaching Assistant

N/A

8. Meeting Times

Periods 3-4 (9:35 – 11:30 AM) on Tuesdays and some Thursdays
The Lab Sections are as follows (each student must choose one)

Tuesday: Periods 8 & 9
Wednesday: Periods 6 & 7
Thursday: Periods 3 & 4

9. Class Schedule

Two (2) 2-hour class periods each week (Tuesday, plus a laboratory section). Tuesdays will generally be devoted towards lecture, and there will be the associated experiment during the same week. We will discuss this during the first day of class. Note: There may be 1 or 2 Thursday lectures during the semester during the schedule lecture time.

10. Meeting Location

Tuesday Lectures: MAEB, Room 234
Laboratories: NSC 125, or UFTR

11. Material and Supply Fees

There is a laboratory fee of $38.09

12. Textbooks Required

None. I will post materials from time to time for you to download off the course page.

13. Recommended Reading

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. Course Outline

Date		Lecture Topic	Lab/Homework Topic for that Week
January	5	Introduction	
	10	Ultrasonic Testing	
	12	Inverse Multiplication and Approach to Criticality	Lab 1: Ultrasonic and Acoustic Emission
	17	Eddy Current Testing	
	19		Lab 2: Eddy Current Testing
	24	Radiographic Imaging Digital Imaging Fundamentals and Transformations	
	26		Digital Imaging Fundamentals (Homework)
	31	Radiation Worker Training (Part 19)	
February	2		UFTR 2nd Person Training Quiz (Not a lab)
	7	Infrared and Thermal Imaging	
	9		Lab 3: Thermal Imaging
	14	Inverse Multiplication and Approach to Criticality	
	16		Lab 4: Approach to Criticality
	21	Control Blade Worth	
	23		Lab 5: Blade Worth Measurements
	28	Advanced Scintillation Detector Properties	
March	2		Lab 6: Scintillation Detector Property Measurements
	7	**No Class – Spring Break**	
	9	**No Class – Spring Break**	
	14	HPGe Detector Calibration	
	16		Lab 7: Detector Calibration and Activity Concentration Calculations
	21	Neutron Activation Analysis I: Induced Radioactivity	
	23		Lab 8: Neutron Activation Analysis I – Induced Radioactivity
	28	Neutron Activation Analysis II	
	30		Lab 9: Neutron Activation Analysis II – Isotope ID and Activity Calculations
April	4	Temperature Coefficient Hot Channel Factors	
	6		Lab 10: Temperature Coefficient & Hot Channel Factors
	11	**No Class – SPIE DSS**	
April	13		**No Lab – Time for Working on Design Projects**
	18	**Class Wrap and Review**	
	28	**Final Exam (7:30-9:30 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 2017 Semester, the UFTR will be available. However, I have data obtained from the last time we ran the reactor experiments, in case we have difficulty with operating the reactor. If this is the case, we will go through the experiment, how data were obtained, and analyze results/calculate operating parameters (aka, "dry lab"). These labs can then be written up just like any other lab report. Potential "dry labs" are indicated in red.

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 an individual laboratory report on six laboratory exercises.

16. Grading

Course Attendance	10%
Homework and Quizzes	20%
Lab Reports	50%
Final Exam	20%

Homework and Quizzes

There will be about 5-6 homework sets and quizzes (combined) during the course. Quizzes will be based advanced lab preparation. Homework sets will be due one week after completion of the laboratory experiment. Training quizzes will also be considered as part of grades.

Final Exam

A 2-hour final exam will take place on **Friday, April 28** from 7:30-9:30 AM. 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 six (6) 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).** The content and format of the lab reports is described below.

As mentioned, you have to write six reports during the semester. However, we perform eleven experiments. Thus, you can skip writing up four experiments. Which experiments you write about is left to you, just keep in mind that you MUST write six 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	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.

	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.	
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 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 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.

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