

Nuclear and Radiation Engineering Laboratory
ENU 4505L Class # 12391, 12390, 29655
Class Periods: M 5 (Lecture), T 3-4 (lab1), W 4-5 (lab3)
Location: Lecture: WEIL 1076; Lab: UFTR lab room or Rhines B17
Academic Term: Spring 2025

Instructor:

Yong Yang
yongyang@ufl.edu
352-846-4791
Office Hours: Monday (1:00pm-3:00pm)

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

Please contact through the Canvas website

- N/A, however, UFTR staff will lead the reactor laboratory exercises.

Course Description

A laboratory experience integrating practical applications of radiation sources and generators, radiation interactions and transport through matter, radiation detection, and other non-destructive technologies. Students select appropriate forms of radiation and detection methods to design solutions for specific nuclear and radiation engineering problems. The Writing Requirement (WR) ensures students both maintain their fluency in writing and use writing as a tool to facilitate learning.

Course Pre-Requisites / Co-Requisites

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

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.

Materials and Supply Fees

There is a laboratory fee of \$49.67

Relation to Program Outcomes (ABET):

The table below is an example. Please consult with your department's ABET coordinator when filling this out.

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	L
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	L
3. An ability to communicate effectively with a range of audiences	H
4. An ability to recognize ethical and professional responsibilities in engineering situations and make	M

informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	M
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	H
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	M

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbooks and Software

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

Recommended Materials

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 Writing Program helps undergraduate students at the University of Florida achieve their academic and professional goals by offering broad-based instruction in composition. More information (including operating hours) can be found at <http://www.writing.ufl.edu>.

Required Computer

UF student computing requirement: <https://news.it.ufl.edu/education/student-computing-requirements-for-uf/>
<Note to instructor: the above requires a student to have a computer but allows for a Windows or a Mac. Add any particular or additional department or course specific requirements.>

Course Schedule

Date	Period	Lecture Topic	Lab/Homework Topic for that Week	Location
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January 13	5	Course introduction, and Introduction of Eddy Current Testing	Radiation Worker Training (Part 19)	WEIL 0273
January, 20		Holiday, no class		
January, 21,	3-4		Lab 1: Eddy Current Testing	Rhines B17
January, 22,	4-5		Lab 1: Eddy Current Testing	Rhines B17
January, 23,	3-4		Lab 1: Eddy Current Testing	Rhines B17
January 27	5	Lecture: Ultrasonic Testing		WEIL 0273
January, 28	3-4		Lab 2: Ultrasonic and Acoustic Emission	Rhines B17
January, 29	4-5		Lab 2: Ultrasonic and Acoustic Emission	Rhines B17
January, 30	3-4		Lab 2: Ultrasonic and Acoustic Emission	Rhines B17
February, 3	5	Lecture: Infrared and Thermal Imaging		WEIL 0273
February, 4	3-4		Lab 3: Thermal Imaging	Rhines B17
February, 5	4-5		Lab 3: Thermal Imaging	Rhines B17
February, 6	3-4		Lab 3: Thermal Imaging	Rhines B17
February 10			Reactor second person training	TBD
February 17	5	Lecture: HPGe Detector Calibration		WEIL 0273
February, 18	3-4		Lab 4: Detector Calibration and Activity Concentration Calculations	UFTR detection lab room
February, 19	4-5		Lab 4: Detector Calibration and Activity Concentration Calculations	UFTR detection lab room
February, 20	3-4		Lab 4: Detector Calibration and Activity Concentration Calculations	UFTR detection lab room
February, 24	5	Lecture: Neutron Activation Analysis		WEIL 0273
February, 25	3-4		Lab 5: Neutron Activation Analysis – Induced Radioactivity, Isotope ID and Activity Calculations	UFTR detection lab room
February, 26	4-5		Lab 5: Neutron Activation Analysis – Induced Radioactivity, Isotope ID and Activity Calculations	UFTR detection lab room
February, 27	3-4		Lab 5: Neutron Activation Analysis – Induced Radioactivity, Isotope ID and Activity Calculations	UFTR detection lab room
March 3	5	Lecture: Inverse Multiplication and Approach to Criticality		WEIL 0273
March 4	3-4		Lab 6: Approach to Criticality	UFTR control room
March 5	4-5		Lab 6: Approach to Criticality	UFTR control room
March 6	3-4		Lab 6: Approach to Criticality	UFTR control room

March, 10	5	Lecture: Temperature Coefficient Hot Channel Factors		WEIL 0273
March, 11	3-4		Lab 7: Temperature Coefficient & Hot Channel Factors	UFTR control room
March, 12	4-5		Lab 7: Temperature Coefficient & Hot Channel Factors	UFTR control room
March, 13	3-4		Lab 7: Temperature Coefficient & Hot Channel Factors	UFTR control room
Spring Break				
March, 24	5	Lecture: Control Blade Worth II		WEIL 0273
March, 25	3-4		Lab 8: Blade Worth Measurements – Positive Period Method	UFTR control room
March, 26	4-5		Lab 8: Blade Worth Measurements – Positive Period Method	UFTR control room
March, 27	3-4		Lab 8: Blade Worth Measurements – Positive Period Method	UFTR control room
March 31, no lecture or lab (***) this no lab no lecture week might be swapped with the other week, which depends on the Capstone design delivery schedule).				
April 7	5	Lecture: Neutron and X-Ray Radiography		WEIL 0273
			No Lab This Week	
April 14	5	Lecture: Digital Imaging Fundamentals and Transformations		WEIL 0273 HW assignment
			No Lab This Week	
April, 21	5	Course wrap up		
April, 29		Final Exam		Take Home

Attendance Policy, Class Expectations, and Make-Up Policy

Students are expected to attend all lectures and lab sessions. Any anticipated absence should be communicated to the instructor as far in advance as possible. Students must participate in every laboratory exercise and submit an individual report for each. An unexcused absence from a lab session will result in the inability to submit the corresponding lab report.

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies:

<https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Course Attendance	50	5%
1 Homework assignment	100	7%
Rad training quiz	100	6%
8 Lab Reports	800	70%
Final Exam	100	12%
Total		100%

Course grades have two components. To receive writing requirement credit, a student must receive a grade of C or higher and a satisfactory completion of the writing component of the course. The total required minimum written words for this course is **4000**. The students will be required to write one lab report for each of the conducted lab experiments (8 in total). 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, and a lab report template is provided on Canvas course website. 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:

- 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.
- 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.
- Drawing from the conceptual description of each measurement, **predict** the expected result.
- Present your result, with **quantitative** measures of its accuracy (e.g. percent deviation, R^2)
- 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)

- Your goal is to make your reports as understandable as possible. Therefore, use drawings liberally.
- 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. I will evaluate and provide feedback on all the student's written assignments with respect to grammar, punctuation, clarity, coherence, and organization. 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
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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	

Grading Policy

The following is given as an example only.

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluer.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

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://sccr.dso.ufl.edu/process/student-conduct-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.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University’s core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed,

color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Undergraduate Coordinator
- HWC OE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

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.

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: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

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://elearning.ufl.edu/>.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.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://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <https://distance.ufl.edu/getting-help/>; <https://distance.ufl.edu/state-authorization-status/#student-complaint>.