Nuclear and Radiation Engineering Laboratory

EGN 4505L Section 1488
Class Periods: M 4 (Lecture), T 3-4 (lab) or R 3-4 (Lab)
Location: Lecture: TUR B310; Lab: UFTR lab room or Rhines B17
Academic Term: Spring 2022

Instructor:
Yong Yang
yongyang@ufl.edu
352-846-4791
Office Hours: Monday, period 3 (9:35-10:25am), Wednesday, period 3-4 (9:35-11:25am), Rhines Hall, 202A

Teaching Assistant/Peer Mentor/Supervised Teaching Student:
Please contact through the Canvas website

- N/A, however, UFTR staff may lead some of the laboratory exercise.

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.

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 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 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.

Course Schedule

(The final schedule is subject to changes due to the UFTR operation condition)

Date	Period	Lecture Topic	Lab/Homework Topic for that Week	Location

January 6, Radiation Worker Training (Part 19)	6			
January, 10	6	Introduction of Eddy Current Testing		**Pre-recorded (video link posted on canvas)**
January, 11	3-4		Lab 1: Eddy Current Testing	Rhines B17
January, 13	3-4		Lab 1: Eddy Current Testing	Rhines B17
January 17	6	Lecture: Ultrasonic Testing		TUR B310
January, 18	3-4		Lab 2: Ultrasonic and Acoustic Emission	Rhines B17
January, 20	3-4		Lab 2: Ultrasonic and Acoustic Emission	Rhines B17
February, 24	6	UFTR second person training and quiz		TBD
February, 25	3-4		No lab, prepare for the quiz	Quiz through canvas
February, 27	3-4		No lab, prepare for the quiz	Quiz through canvas
January 31	6	**Lecture: HPGe Detector Calibration**		
February, 1	3-4		Lab 3: Detector Calibration and Activity Concentration Calculations	UFTR detection lab room
February, 3	3-4		Lab 3: Detector Calibration and Activity Concentration Calculations	UFTR detection lab room
February, 7	6	Lecture: Neutron Activation Analysis		TUR B310
February, 8	3-4		Lab 4: Neutron Activation Analysis – Induced Radioactivity, Isotope ID and Activity Calculations	UFTR detection lab room
February, 10	3-4		Lab 4: Neutron Activation Analysis – Induced Radioactivity, Isotope ID and Activity Calculations	UFTR detection lab room
February, 14	6	Lecture: Inverse Multiplication and Approach to Criticality		Pre-recorded (video link posted on canvas)
February, 15	3-4		Lab 5: Approach to Criticality	UFTR control room
February, 16	3-4		Lab 5: Approach to Criticality	UFTR control room
February, 21	6	Lecture: Temperature Coefficient Hot Channel Factors		TUR B310
February, 22	3-4		Lab 6: Temperature Coefficient & Hot Channel Factors	UFTR control room
February, 24	3-4		Lab 6: Temperature Coefficient & Hot Channel Factors	UFTR control room

February 28	6	Lecture Control Blade Worth I		
March, 1	3-4		Lab 7: Blade Worth Measurements I – Rod Drop Method	UFTR control room
March, 3	3-4		Lab 7: Blade Worth Measurements I – Rod Drop Method	UFTR control room
March, 14	4	Lecture: Control Blade Worth II		TUR B310
March, 15	3-4		Lab 8: Blade Worth Measurements II – Positive Period Method	UFTR control room
March, 17	3-4		Lab 8: Blade Worth Measurements II – Positive Period Method	UFTR control room
March, 21	6	Lecture: Neutron and X-Ray Radiography		HW assignment #1
March, 23/March 24			No Lab This Week	
March, 28	6	Lecture: Radiographic Imaging Digital Imaging Fundamentals and Transformations		TUR B310 HW assignment #2
			No Lab This Week	
April, 4	6	Lecture: Infrared and Thermal Imaging		TUR B310
April, 5			Lab 9: Thermal Imaging	Rhines B17
April, 6			Lab 9: Thermal Imaging	Rhines B17
April, 11		No lecture – prepare for design class		
April, 12			No Lab This Week-prepare for design class	
April, 14			No Lab This Week- prepare for design class	
April, 18	6	Class Wrap and Review		TUR B310
April, 28		**Final Exam**		**Take Home**

Attendance Policy, Class Expectations, and Make-Up Policy

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 each exercises.

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%
2 Homework assignments	150	20%
9 Lab Reports	900	70%
Final Exam	100	15%
Total		100%

Each student will be required to write six (9) 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	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.

	provide adequate discussion but rely on weak support for arguments.	
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**	

Grading Policy

Percent	Grade	Grade Points
90.0 - 100.0	**A**	**4.00**
87.0 - 89.9	**A-**	**3.67**
84.0 - 86.9	**B+**	**3.33**
81.0 – 83.9	**B**	**3.00**
78.0 - 80.9	**B-**	**2.67**
75.0 - 79.9	**C+**	**2.33**
72.0 – 74.9	**C**	**2.00**
69.0 - 71.9	**C-**	**1.67**
66.0 - 68.9	**D+**	**1.33**
63.0 - 65.9	**D**	**1.00**
60.0 - 62.9	**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.bluera.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 Conduct 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. 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 broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every

person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

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 Graduate Program Coordinator
• Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.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/.

COVID-19
- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF

Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus.

- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the UF Health Screen, Test & Protect website for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

Academic Resources

E-learning technical suppor*t*, 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://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*:* http://www.distance.ufl.edu/student-complaint-process.