

Nuclear Radiation Detection and Instrumentation

ENU 4612, Class #12688

Class Periods: MWF, Period 4

Location: Benton Hall, Room 0328

Academic Term: Fall 2022

Instructor:

Dr. James E Baciak

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352-216-3624

Office Hours: Tuesday, Period 8 (3:00 – 3:50 PM)

Wednesday, Period 6 (12:50 – 1:40 PM)

Friday, Period 8 (3:00 – 3:50 PM)

In addition to the above office hours, I will be setting up some office hours on Zoom, at least 1 hour per week to accommodate asking me questions online. I will announce these on the Canvas site as well as updating the course syllabus. Note: Office hours may change once the laboratory schedule is set.

Office Location: 109 Nuclear Annex

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

There is no teaching assistant for this course. However, there will be supervised teaching student(s) in the companion laboratory course, ENU 4612L

Course Description

Physics and electronics of radiation detection and instrumentation systems for application to nuclear energy, radiological sciences, radiation protection, medical physics and imaging, and industrial safety and control systems.

Course Pre-Requisites / Co-Requisites

EEL 3003 Elements of Electrical Engineering (note: this is changing)

ENU 4605 Interaction of Radiation with Matter

Course Objectives

Provide students with the opportunity to learn the principals of radiation interactions with matter, radiation detection techniques and characteristics of different radiation detectors.

Materials and Supply Fees

Not applicable

Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Medium
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	Low

3. An ability to communicate effectively with a range of audiences	
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	
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Medium
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	

*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

- Radiation Detection and Measurement
- G. F. Knoll
- 2010, 4th Edition
- 0470131489

There will also be notes and various articles I will post on the canvas site, based on questions students may ask during lecture as well as supplementary material I may want you to have.

Access to Chart of Nuclides:

You will need access to a chart of nuclides during the course. Feel free to use any one of the numerous resources available (so long as it is accurate). A simple search on Google will give you access to one.

Course Schedule

Date	Course Topic	Chapter	ENU 4612L Lab Topic for that Week
August	24 Introduction, Course Goals and Objectives		
	26 Sources of Radiation	1	
	29 Radiation Interactions	2	
	31 Radiation Interactions	2	
September	2 Counting Statistics	3	
	5 No Class – Labor Day Holiday	3	Lab 0: Introduction & Lab Safety
	7 Counting Statistics		
	9 Error Analysis	3	
	12 Error Analysis	3	Lab 1: Oscilloscope Usage
	14 Pulse Shaping	16	
	16 Pulse Shaping and Processing	16	
	19 NIM Electronics and Circuits	16 & 17	
	21 NIM Electronics	17	
	23 NIM Electronics	17	

	26	In-class Quiz #1		Lab 2: Nuclear Instrument Electronics
	28	Multi-Channel Analyzers	18	
	30	General Detector Properties	4	
October	3	General Detector Properties	4	
	5	Gas Detectors (Ionization Chambers)	5	
	7	No Class - Homecoming	7	
	10	Gas Detectors (G-M Tubes)		Lab 3: Geiger-Mueller Detectors
	12	Gas Detectors (G-M Tubes and Proportional Counters)	6&7	
	14	Gas Detectors (Proportional Counters)	6	
	17	Scintillation Detectors (Inorganic)	8	Lab 4: Gas-Flow Proportional Counters
	19	Scintillation Detectors (Organic)	8	
	21	Photomultiplier Tubes and Photodiodes	9	
	24	Radiation Spectroscopy		Lab 5: NaI Scintillation Detectors
	26	In-Class Quiz #2	10	
	28	Radiation Spectroscopy	10	
	31	Data Science Use in Radiation Detection ¹	Notes	
November	2	Semiconductor Detectors	11	
	4	Semiconductor Detectors	11	
	7	Semiconductor Detectors	11	Lab 6: High-Purity Ge Detectors
	9	Silicon and Germanium Detectors	11 & 12	
	11	No Class - Veterans' Day	12	
	14	Germanium Detectors	12	Lab 7: Neutron Detection
	16	Thermal Neutron Detection	14	
	18	Neutron Detection	14 & 15	
	21	In-Class Quiz #3		
	23	No Class - Thanksgiving Holiday	15	
	25	No Class - Thanksgiving Holiday		
	28	Fast Neutron Detection		
	30	Neutron Activation Analysis	Notes	
December	2	Neutron Activation Analysis	Notes	
	5	Reactor Instrumentation ¹	Notes	
	7	Course Evaluations / Wrap-Up	Notes	
	9			
	12			
	13			
	14	Final Exam (3 - 5 PM)		

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

¹ – These are more advanced topics that will be covered if time allows.

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.

Late-work excuses can be grouped into the categories of professional, medical, and personal.

Professional: Reasonable extensions for job/internship interviews, technical conferences, or other professional/career development reasons should be requested. Requests are typically granted, at my discretion, unless they would grant a student or group of students an unfair advantage over their peers, cause significant disruption to the course or grading schedule, or violate some UF policy.

Medical: Extensions will also be granted for (your own) medical reasons – please do not come to class if you are ill. Per UF policy, in the case of medical absences that are frequent or suspiciously- timed (e.g.; you are repeatedly, suddenly ill at deadlines), I may request a signed note from a physician or similar professional practitioner.

Personal: In addition, UF policies require accommodation for several non-academic, non- medical reasons. Extensions for these personal issues are strictly limited to those mandated by the letter of UF policies. The list of UF-approved personal reasons changes from time to time. If you have a question regarding your personal issue and if it qualifies under one of the excused absence/late-work policies, contact me in advance.

The 12-day rule will be enforced strictly. Note that the count of days is based on a per-student, not per-approved-activity basis. All requests for excused absence or extension must be submitted in writing, preferably via e-mail. 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
Homework Sets (7-8)	Varies	25%
Quizzes (3)	50 each	35%
Final Exam	120	40%
		100%

Homework

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

Quizzes and Exams

Three non-cumulative quizzes will be given during the semester on dates to be determined later, but you can expect one towards the latter half of September, one in late-October, and one in mid-to-late November as tentatively shown in the schedule above. **I will give you a one-week advanced warning for each quiz.** Each quiz will be given during normal class time. Note: I may change these to take home quizzes (particularly quiz #3), should we fall behind in lectures due to class cancellations, hurricanes, or conference attendance by students.

The final exam currently scheduled on **Thursday, December 14** (3-5 PM) is cumulative. These exams and quizzes are closed book - closed note, however you will be allowed to bring in notes as specified below:

Quizzes: one side of a 8.5x11 in² of paper

Final Exam: 1 sheet of 8.5x11 in² of paper (i.e., both sides)

I do reserve the right to make the quizzes and exams open book.

Grading Policy

Percent	Grade	Grade Points
92 - 100	A	4.00
88 - 91.9	A-	3.67
84 - 87.9	B+	3.33
80 - 83.9	B	3.00
76. - 79.9	B-	2.67
72 - 75.9	C+	2.33
68 - 71.9	C	2.00
64 - 67.9	C-	1.67
60 - 63.9	D+	1.33
55 - 59.9	D	1.00
50 - 54.9	D-	0.67
0 - 49.9	E	0.00

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

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.

Online Course Recording

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the “chat” feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

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](mailto:title-ix@ufl.edu), 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://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>.