

Nuclear Radiation Detection and Instrumentation

ENU 5615C, Class 12896, Spring 2021

T 0830-1025 (UF Periods 2-3) and R 0935-1025 (UF Period 3)

Hybrid: NEB 0102 (quizzes/exams), RHN B17 (labs) and Online (lectures/discussions)

Final Exam: Thursday, April 29, 2021, 0730-0930

## Instructor

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Office Hours: TBD, and by appointment. Beginning and end times of office hours will be enforced strictly. There are no office hours on days without classes. Zoom meeting links will be provided for office hours. If I do not respond on Zoom or if Zoom is not logged in, please send me an email or message on Microsoft Teams and I will respond as soon as possible.

## Course Description

Interaction of radiation with matter, radiation-detection systems, pulse shaping, amplification, amplitude and time-analyzing circuitry; counting and measuring devices and control systems for nuclear reactors.

## Course Prerequisites

ENU 4144 or 5005 and 4934 or ENU 6935

## Course Objectives

Following successful completion of this course, the student will have developed an understanding of the principles of radiation interactions with matter, radiation detection techniques, and characteristics of radiation detectors. Additionally, students will have developed communication skills, including technical writing and oral presentations.

## Text (Required)

*Radiation Detection and Measurement*, Glenn Knoll, Wiley, 4th edition (2010), ISBN: 978-0470131480

## Course Schedule

There will be three types of lectures/class sessions in this course:

1. **Recorded Lectures:** Recorded lectures will include discussion of slides that are complementary to the course pack materials. Expect slides to be covered concisely and require your full attention. While recorded lectures will vary in length, they will usually be shorter than

a normal class period due to the lack of any Q&A or discussions. You should watch these *before* the associated synchronous discussion.

2. **Synchronous Discussions:** Discussion sessions replace the synchronous portion of a normal class. First, these are the main time to discuss homework assignments and quizzes/exams. Second, questions posed to you during recorded lectures will be revisited. Lastly, these serve as a time to reinforce content that may not have made sense in the recorded lectures.
3. **Laboratory Sessions:** Three-hour laboratory sessions will occur during particular weeks as noted on the course schedule. These will be tentatively scheduled as my teaching times and your other class times permit.

The course outline and schedule below is subject to change depending on the speed in which material is covered. Quiz and Exam dates will not change, barring university closure.

Week	Day	Date	Textbook	Material
1	T	12 Jan		Syllabus and Course Policies
1	R	14 Jan	Ch 1	Sources of Radiation
2	T	19 Jan	Ch 2	Radiation Interactions
2	R	21 Jan	Ch 3	Counting Statistics
3	T	26 Jan	Ch 3	Error Analysis
3	R	28 Jan	Ch 16	Pulse Shaping and Processing
4	T	2 Feb	Ch 16, 17	NIM Electronics and Circuits
4	R	4 Feb	Ch 17, 18	Nuclear Instrument Electronics, Multichannel Analyzers
5	T	9 Feb	Ch 4	General Detector Properties
5	R	11 Feb	Ch 5	Gas Detectors (Ionization Chambers)
6	T	16 Feb		Quiz 1
6	R	18 Feb	Ch 6, 7	Gas Detectors (G-M Tubes, Proportional Counters)
7	T	23 Feb	Ch 8	Scintillation Detectors (Inorganic)
7	R	25 Feb	Ch 8, 9	Scintillation Detectors (Organic)
8	T	2 Mar	Ch 10	Spectroscopy with Scintillators
8	R	4 Mar		Midterm Exam Review
9	T	9 Mar		Midterm Exam
9	R	11 Mar	Ch 19	Thermoluminescent Dosimeters
10	T	16 Mar	Ch 11	Semiconductor Detectors
10	R	18 Mar	Ch 11, 12	Silicon Detectors, Germanium Detectors
11	T	23 Mar	Ch 19	Neutron Activation Analysis
11	R	25 Mar	Ch 14	Thermal Neutron Detection
12	T	30 Mar		Quiz 2
12	R	1 Apr	Ch 15	Fast Neutron Detection
13	T	6 Apr	Ch 15	Pulse Shape Discrimination
13	R	8 Apr		Formal Report Workshop

Week	Day	Date	Due	Material
14	T	13 Apr		Formal Report Workshop
14	R	15 Apr		Final Exam Review
15	T	20 Apr		Open Q&A for Final Exam
16	R	29 Apr	Final Exam	Final Exam

Week	Date	Assessment	Material
1	11 Jan		No Lab
2	18 Jan		Introduction & Lab Safety
3	25 Jan	Worksheet 1	Oscilloscope Usage
4	1 Feb	Worksheet 1	Nuclear Instrument Modules (NIM)
5	8 Feb	Short Report	Neutron Activation
6	15 Feb		No Lab
7	22 Feb	Worksheet 2	Geiger-Mueller Detectors
8	1 Mar	Oral Presentation	Gas-Flow Proportional Counters
9	8 Mar	Short Report	NaI Spectroscopy
10	15 Mar	Short Report	HPGe Spectroscopy
11	22 Mar		No Lab
12	29 Mar	Oral Presentation	Neutron Detection
13	5 Apr	Formal Report	Pulse Shape Discrimination
14	12 Apr		No Lab
15	19 Apr		No Lab

## 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.

## F2F Course Policy in Response to COVID-19

We will have face-to-face instructional sessions to accomplish the student learning objectives of this course. In response to COVID-19, the following policies and requirements are in place to

maintain your learning environment and to enhance the safety of our in-classroom interactions.

- You are required to wear approved face coverings at all times during class and within buildings. Following and enforcing these policies and requirements are all of our responsibility. Failure to do so will lead to a report to the Office of Student Conduct and Conflict Resolution.
- This course has been assigned a physical classroom with enough capacity to maintain physical distancing (6 feet between individuals) requirements. Please utilize designated seats and maintain appropriate spacing between students. Please do not move desks or stations.
- Sanitizing supplies are available in the classroom if you wish to wipe down your desks prior to sitting down and at the end of the class.
- Follow your instructor's guidance on how to enter and exit the classroom. Practice physical distancing to the extent possible when entering and exiting the classroom.
- If you are experiencing COVID-19 symptoms, please use the UF Health screening system and follow the instructions on whether you are able to attend class. [Click here for UF Health guidance on what to do if you have been exposed to or are experiencing Covid-19 symptoms.](#)
- Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work. Find more information in the university attendance policies

## Grading

Assessments in this course are worth a total of 1000 points.

Note that you must receive greater than 330 points in in each section of the course in order to receive a passing grade (e.g. 500 points in lecture and 300 points in lab does not equal a B. It will be recorded as an E). Below is a breakdown for the point values for each assessment.

### Lecture Assessments

- (2) Quizzes – 150 points (75 points each)
- Midterm Exam – 100 points
- Project – 100 points
- Final Exam – 150 points
- Optional Homework – 0 points

### Laboratory Assessments

- (1) Lab Participation – 50 points
- (2) Lab Quizzes – 50 points (25 points each)
- (2) Worksheets – 50 points (25 points each)
- (3) Short Reports – 150 points (50 points each)
- (1) Formal Reports – 100 points
- (2) Oral Presentations – 100 points (50 points each)

Final grades will be assigned using the following scale:

- A: 870+ points
- A-: 850-869 points
- B+: 830-849 points

- B: 750-829 points
- C: 660-749 points
- E: < 660 points

Please note the following:

1. No single item exceeds 15% of your final grade.
2. Grading in this course is plus-based. You are awarded points at each correct step, rather than deducting points for errors. Note that points are awarded for correct steps, and getting the correct final answer. That is, an error at an intermediate step will prevent you from earning points for that step and for the final answer.
3. The grade cut-offs for A, B, and C are lower than some typical scales (90, 80, 70, etc.) under which many UF courses operate. The intention is not to inflate grades, but rather to account for the challenging nature of the course.
4. The gradebook on Canvas is not official. I reserve the right to correct errors, including transcription errors, from the official (spreadsheet) gradebook, until finalization of grades with the UF registrar.

More information on UF grading policy may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

## Course Policies

### Attendance

Attendance is strongly recommended starting January 11 (first class). Attendance is not part of grade calculations.

Pursuant to HWCOE policy, the following statement is required: Excused absences are consistent with university policies in the undergraduate catalog

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance>  
and require appropriate documentation.

### Class Conduct

There is no tolerance for mobile phones or other electronic disruptions. Changing your Zoom settings to mute yourself upon joining a meeting is strongly recommended.

### Assignments

Assignments must be submitted electronically (via Canvas). The following restrictions apply for submission:

- All submissions must be a single PDF document.
- If you do not have access to a physical scanner and you choose to use a phone or tablet to "scan" your handwritten document, you must use the free Adobe Scan app.
- Fully electronic alternatives include a PDF from Word with Equation Editor or L<sup>A</sup>T<sub>E</sub>X.
- Excluding the make-up work policies, no late homework will be accepted.

## Quizzes/Examinations

Before each exam, you will receive an Exam Preview. This will cover the procedures for the exam as well as a preview of the technical content that will be included. Detailed policies are covered on this document. The document will also include specific topics addressed by the problem (for some problems), the way points are distributed among problems, and a brief list of topics within the scope of the exam.

No collaboration is permitted during the quiz or exam, though you may prepare before however you choose. Use of any unauthorized materials or any communications is grounds for being reported to Student Conduct & Conflict Resolution for a violation of the UF Honor Code.

The criteria for make-up exams are the same as for extensions to other assignments. All make-up exams will be held after the regular exam, as organized with me.

The exams are closed book, however you will be allowed to bring in *handwritten* notes as specified below:

- Quiz #1: One side of one sheet of 8.5x11 inch paper.
- Midterm Exam: One full sheet (both sides) of 8.5x11 inch paper
- Quiz #2: One side of one sheet of 8.5x11 inch paper and one full sheet (both sides) of 8.5x11 inch paper. Three sides total.
- Final Exam: Two full sheets (both sides) of 8.5x11 inch paper

That is, each progressive assessment adds another side of paper you are able to use.

## Electronic Communication and Course Website

Canvas is used extensively for the course including, but not limited to:

- Distributing and storing the course syllabus, along with any syllabus updates
- Maintaining student grades
- Regular communication with students through announcements and messages (course email listserv may also be used)
- Providing access to course materials
- Scheduling Zoom meetings

## Changes to Syllabus

Changes to this syllabus will be provided via the Canvas platform. Such changes may include those required by policy changes, changes in the speed of course coverage, university closure, errors in previous syllabus versions, and other reasons.

## Standardized Syllabus Content

### 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 Evaluations

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/>.

## 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.

## 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 Undergraduate/Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, [rbielling@eng.ufl.edu](mailto:rbielling@eng.ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@ufl.edu](mailto:nishida@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](mailto: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:

<http://www.counseling.ufl.edu/cwc>, 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](mailto: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](mailto: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, Various ways to receive assistance with respect to using the libraries or finding resources.

<http://cms.uflib.ufl.edu/ask>

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](https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf)

On-Line Students Complaints:

<http://www.distance.ufl.edu/student-complaint-process>