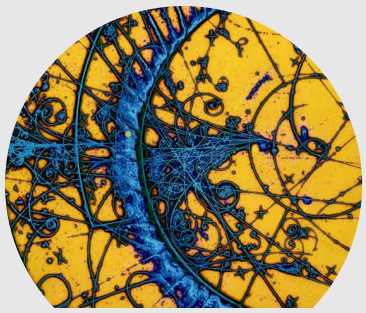

NPRE Laboratory

NPRE 451

Instructor Info

Prof. Angela Di Fulvio

by appointment

Talbot 116

difulvio@illinois.edu

Course Info

Prereq: NPRE 446

Mon & Wed

09:00AM - 09:50AM

3018 CIF

Lab Info

Wed

05:00PM - 08:50PM

101B Talbot Laboratory

TA Info

Gregory Romanchek

Office Hrs: by appointment

225 Talbot Laboratory

Overview

Last edited on 2023/08/15. Radiation detection and instrumentation; radiation dosimetry and shielding; basic measurements in nuclear engineering; engineering applications; digitizer data acquisition and experimental control.

The final oral exam will consist in a presentation of the open lab work and will be Monday Dec. 11 - 8:00am-11:00am CIF 3018.

Reading Material

Required Text

Tsoulfanidis, N., & Landseberger, S. *Measurement and Detection of Radiation* ("MDR"). Fourth Edition. CRC Press. 2015.

Recommended Texts

Knoll, G. F., *Radiation Detection and Measurement*. Fourth Edition. John Wiley & Sons Inc. 2010. ("Knoll")

Leo, W. L., *Techniques for Nuclear and Particle Physics Experiments: A How-To Approach*. Springer Verlag. 1994. ("Leo")

Evans, R.*The Atomic Nucleus*, Krieger Publishing Company, Inc. 1955

Iliadis, C.*Nuclear Physics of Stars – 2nd, Revised and Enlarged Edition*, Wiley, 2015

Slides presented during the lectures are available on Canvas. Any required journal articles and additional book chapters will be provided on Canvas.

Grading Scheme

30	Lab Reports–these are required work products and the course cannot be passed without submission of all the reports
25	*Open Lab* Presentation (10) and Paper (15)
15	Midterm Exam
20	Final Exam
10	In-class quizzes –these are required work products and the course cannot be passed without submission of 75% of the quizzes

Grades will follow the standard scale: A+ = 97.5-100; A = 93.5-97.4; A- = 89.5-93.4; B+ = 86.5-89.4; B = 82.5-86.4; B- = 79.5-82.4; C+ = 76.5-79.4; C = 72.5-76.4; C- = 69.5-72.4; D+ = 66.5-69.4; D = 64.5-66.4; E/F <65. Curving is at the discretion of the instructor.

Notes

Make sure you enable notifications on Canvas

Learning Objectives

- Become familiar with radiation detection principles and techniques.
- Gain skills in conducting experiments and interpreting the results.
- Learn data processing techniques applied to radiation detection.
- Learn to critically review a technical paper and provide helpful criticism to your peers' work and improve scientific writing skills.

Laboratory Reports

After completing each laboratory session, students are expected to write a report of each experiment. Although you are encouraged to discuss the report with fellow students, all lab reports need to be written individually. Report writing guidelines are available on Canvas. The deadline for submitting the lab reports is 8 days after the day of the lab, e.g., on Thursday if the lab was on Wednesday, unless announced otherwise. In a case of extenuating circumstances, please contact the instructor as soon as you are aware of them. Ten points will be subtracted per day (the highest possible score is 100 points), for all late reports. Lab reports are to be submitted electronically on the Canvas portal (in .pdf).

FAQs

Do we use radioactive sources in this course?

Yes, we do. We will use mostly low-activity check sources, therefore radiation dosimeters are not required. However, please take the general Laboratory Safety Training and the Radiation Safety Awareness Training courses at this link: `https://www.drs.illinois.edu/` after enrolling, and before 8/31/22.

Why do we measure radiation?

A precise measurement of radiation is important for many applications. A few examples are the radiation protection of operators working in nuclear power plants, or the characterization of nuclear reactions for physics or astronomy studies.

What is the *Open Lab* section of the course?

The *Open Lab* gives students a unique hands-on opportunity to creatively experiment radiation detection concepts. Further details about the *Open Lab* will be discussed in class.

What is the schedule of the first week of class?

During the first week, instead of the lab session, we will have regular class.

How do I attend lectures and labs online?

Classes and labs will be in person

Laboratory Reports (cont'd)

Plagiarism prevention software will be used to compare submitted reports against a database of academic papers to identify areas of overlap between the submitted assignment and existing papers. Reports will be graded separately for the writing, with the total writing score accounting for 10% of the grade of the laboratory report section. Report writing guidelines are available on Canvas, please review them before writing your first report.

Laboratory Notebook, Attendance, and Homeworks

A laboratory notebook needs to be maintained by the students. It will be graded by the TA during the last lab session (lab 10). Students need to be ready to show all the lab notebooks to the TA (electronic and paper versions of the notebook are acceptable).
To reinforce concepts learned in class, you will submit answers to assigned quizzes in class. The quizzes can be multiple choice or numerical (please bring a calculator) and will concern past topics discussed in class and (on Wed only) the subject of the upcoming lab. The grade will be either pass (1) or fail (0). To get a pass grade you need to answer correctly to at least three of the questions in the quiz. The quiz grade P is P = 10 x (N_P/N), where N_P is number of submitted quizzes evaluated as a *pass*, N is the total number of assigned quizzes.

Open lab Presentation and Paper

Small groups of students (up to 3 students per group) will plan and design an experiment to address a radiation detection problem of their interest. Each group will describe the problem, the methods used in their experiment, and the main findings in an oral presentation (10 out of 25 points) and a written paper (15 out of 25 points). The paper will also include a brief review of the relevant literature.
Each group will also review the paper of, at least, one other group, and receive at least one review by fellow students. Students will incorporate their edits into the final draft, to be submitted to the instructor three days after the date of the final exam, unless otherwise stated. The *Open Lab* reports will be submitted and uploaded on Canvas in one electronic copy. The *Open Lab* talks will be entirely graded by the students, who evaluate the oral presentations given by their fellow students according to a rubric provided by the instructor and available on Canvas.

Diversity and Inclusivity Statement

All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

Accommodations for Students with Disabilities

Students with learning needs that require special accommodation are encouraged to contact the instructor and the Disability Resources and Educational Services (DRES) at +1 (217)333-4603 or disability@illinois.edu, as soon as possible, to make an appointment to discuss your learning needs and to obtain an accommodation letter, if needed. Please note that accommodations are not retroactive to the beginning of the semester, but begin the day you contact your professor with a current letter of accommodation from DRES.

Academic Integrity

The Code of Policies and Regulations Applying to All Students will be applied in all instances of academic misconduct committed by students. This applies to all exams, presentations, assignments and materials distributed in this course. Students are expected to present and submit original written reports, which truthfully represent the time and effort devoted into the work. Plagiarism is an ethical violation in which students copy text, HW solutions, etc from other sources. Students caught plagiarizing can result in reduced or failing grade for a lab or the class, and expulsion from UIUC.

Class Schedule

MODULE 1: Introduction to Nuclear Measurements		
08/22 *M*	Introduction and Radiation Safety	MDR Ch. 1
08/24 *W*	Radioactive Decay and Counting Statistics	MDR Ch. 2 (2.1-2.14), 3.7, NPRE451-Handout1
08/29 *M*	Uncertainty propagation and dead time	MDR Ch. 2 (2.15-2.18), 2.21, 5.6.2
MODULE 2: Electron and Gamma-ray Detection		
08/31*W*	Review of Nuclear Physics, Radioactive Sources	MDR Ch. 3, NPRE451-Handout2
09/05 *M*	Labor Day	
09/06 *W*	Charged-particle interactions with matter	MDR Ch. 4 (4.1-4.7)
09/12 *M*	Charged-particle interactions with matter and Gas detectors	MDR Ch. 5.1 - 5.6
09/14 *W*	Gamma-ray radiation interactions with matter (I)	MDR Ch. 4.8
09/19 *M*	Gamma-ray radiation interactions with matter (II)	MDR Ch. 4.8 Knoll 3.III
09/21 *W*	Inorganic Scintillators MDR 6.1-2	Knoll 8.II
09/26 *M*	Semiconductor Diode Detectors and midterm preparation	Knoll Ch. 11 MDR Ch 7.1-4
09/28 *W*	MID TERM 1 EXAM	
10/03 *M*	Exam correction. Klein Nishina equation.	
10/05 *W*	From Detection to Measurement: Concepts and Definitions	MDR Ch. 8
10/10 *M*	Semiconductor Diode Detectors (II)	MDR Ch 7
10/12 *W*	Signal Readout Devices (PMTs and SiPMs)	MDR Ch 7
MODULE 3: Neutron detection		
10/17 *M*	Neutron Detection Principles	
10/19 *W*	Neutron Detection Principles (II)	MDR 3.9 MDR 4.9
10/24 *M*	Neutron Detection Principles (III)	MDR 3.9 MDR 4.9
10/26 *W*	Slow Neutron Detection (I)	MDR Ch. 14.1-14.4
10/31 *M*	Fast Neutron Detection (I)	MDR Ch. 14.5-14.10
11/02 *W*	Fast Neutron Detection (II)	MDR Ch. 14.5-14.10
11/07 *M*	Neutron Spectroscopy	MDR 6.10 13.7
11/09 *W*	Neutron activation and time-of-flight	MDR 14.8 14.11
11/14 *M*	Introduction to radiation protection	slides

11/16 *W*	Dosimetry and Passive Detectors	Knoll 19.VII 19.VIII
11/21 *M*	Fall Break	
11/23 *W*	Fall Break	
11/28 *M*	Electronics readout I	slides
12/00 *W*	Electronics readout II	slides
12/05 *M*	Preparation to final exam	
12/07 *W*	Final Exam - second midterm	
12/11	Open lab presentations 8:00am-11:00am., Monday Dec. 11 CIF-3018	
12/16	Submit the final version of open lab report by midnight via the Canvas submission link on the homepage	Send the report to your peers for review by 12/13. Send comments back by 12/15.

Lab Schedule

Lecture	08/24	*W*	Counting Statistics and Report Writing
Lab #1	08/31	*W*	Introduction to Lab Equipment and Counting Statistics Examples of *Open Lab* Projects
Lab #2	09/07	*W*	Proportional Counters and Geiger-Mueller Counters
Lab #3	09/14	*W*	Alpha Spectroscopy
Lab #4	09/21	*W*	Gas Flow Detectors
Lab #5	09/28	*W*	Demonstration of Compton Scattering Using Coincidence Measurements - Preliminary *Open Lab* Projects
Lab #6	10/05	*W*	PMTs and Inorganic Scintillation Detectors
Lab #7	10/12	*W*	HPGe Detectors: Efficiency Calibration and spectroscopy
Lab #8	10/19	*W*	*Open Lab* presentations: motivations and planned objectives. Groups of students present an outline of their proposed open lab project and review one or more papers relevant to their project. By the end of the lab, they discuss an outline of the open lab with the instructor. The assignment for the following week is a literature review relevant to the open lab project.
Lab #9	10/26	*W*	Neutron Radiation Shielding. Thermal Neutron Detection.
Lab #10	11/02	*W*	Fast Neutron Detection: Organic Scintillators, Pulse Shape Discrimination and Spectroscopy
Open Lab	11/09	*W*	Working time
Open Lab	11/16	*W*	Working time
Open Lab	11/23	*W*	Fall Break
Open Lab	11/31	*W*	Working time
Open Lab	12/07	*W*	Preliminary open lab presentations (agenda below)

COVID-19 Announcement

Following University policy, all students are required to engage in appropriate behavior to protect the health and safety of the community to minimize the spread of COVID-19

Logo adapted from CERN courier https://cerncourier.com/in-the-tracks-of-the-bubble-chamber