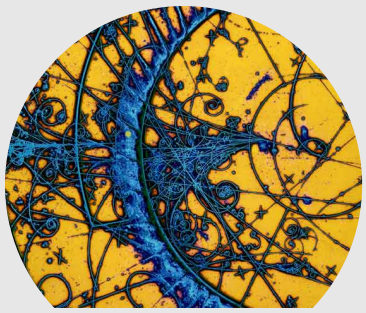

NPRE Laboratory

NPRE 451

Instructor Info

Angela Di Fulvio

Office Hrs: Mon & Fri 1:00PM-2:00PM

116 Talbot Laboratory

difulvio@illinois.edu

Course Info

Prereq: NPRE 446

Mon & Wed

09:00AM - 09:50AM

204 Transportation Building

Lab Info

Wed & Thu

05:00PM - 08:50PM & 12:30PM - 04:20PM

225 Talbot Laboratory

TA Info

Huq Md Fazlul

Office Hrs: after lab sessions

Overview

Last edited on 2018/11/18.

Radiation detection and instrumentation; radiation dosimetry and shielding; basic measurements in nuclear engineering; engineering applications; micro computer data acquisition and experimental control.

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")

Slides presented during the lectures are available on Compass2g. Any required journal articles and additional book chapters will be provided on Compass2g. The course incorporates active learning activities, additional instructions will be provided by the instructor on the first day of class.

Grading Scheme

30	Lab Reports
5	Laboratory Notebook and Attendance
30	*Open Lab* Presentation (10) and Paper (20)
15	Midterm Exams (7.5 each)
20	Final Exam

Grades will follow the standard scale: A = 89.5-100; B = 79.5-89.4; C = 69.5-79.4; D = 60-69.4; F <60. Curving is at the discretion of the instructor and +/- grading will NOT be used.

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
- Improve your scientific writing skills

Laboratory Reports

After completing each laboratory session, students are expected to write a thorough 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 Compass2g.

The deadline for submitting the lab reports is 8 days after the Thursday lab, unless announced otherwise, and 5 points will be subtracted per day (the highest possible score is 100 points) for all late reports. In a case of extenuating circumstances, please contact the instructor as soon as you are aware of them.

Lab reports are to be submitted electronically to SafeAssign on the Compass2g portal (in .doc or .docx format).

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, I strongly recommend to 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 08/27/18.

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, we will not have any labs. However the class location does not change. Lectures on Wednesday 08/29/18 (5:00PM - 7:00PM) and Thursday 08/30/18 (12:30PM - 2:30PM) will be held in 225 Talbot Laboratory.

Laboratory Reports (cont'd)

SafeAssign is a plagiarism prevention software, which compares submitted reports against a database of academic papers and identifies 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. The writing score for the first report is meant solely as input for you, and will not contribute to the final grade. Report writing guidelines are available on Compass2g.

Laboratory Notebook

A laboratory notebook needs to be maintained by the student. The notebook will be graded at the end of the semester. A well-kept notebook contributes to up to 5% of your final numerical grade.

Open lab Presentation and Paper

Small groups of students (up to 3 students per group) will plan, design, and conduct an experiment to address a radiation detection problem of their interest. Each group will describe the problem, the methods and materials used in their experiment, and the main findings in an oral presentation (10% of the grade) and a written paper (20% of the grade). 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 by the day of the final exam (12/18/2018). The *Open Lab* reports will be submitted in two hard copies unless special dispensation is granted, and one electronic copy (in.doc or .docx format) will be submitted to SafeAssign on the Compass2g portal. 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 Compass2g.

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. According to the UIUC Diversity Values Statement, I "support diversity of worldviews, histories, and cultural knowledge across a range of social groups including race, ethnicity, gender identity, sexual orientation, abilities, economic class, religion, and their intersections".

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 (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, students caught plagiarizing will be subject to an academic integrity violation that can result in reduced grade for a lab, reduced grade for the class, failing the class, and expulsion from UIUC.

Class Schedule

MODULE 1: Introduction to Nuclear Measurement

08/27 *M*	Introduction and Radiation Safety	MDR Ch. 1
08/29 *W*	Radiation Interactions with Matter	Knoll Ch. 2
09/03 *M*	Labor Day	
09/05 *W*	Counting Statistics: Examples	MDR Ch. 2, NPRE451-Handout1

MODULE 2: Gamma-ray Detection

09/10*M*	Spectroscopy and Timing	MDR Ch. 9, NPRE451-Handout2
09/12 *W*	Ionization Chambers (I)	MDR Ch. 5
09/17 *M*	Ionization Chambers (II)	MDR Ch. 5, NPRE451-Handout3
09/19 *W*	Scintillators (I)	MDR Ch. 6 and 12, Knoll Ch. 8 Swiderski, L., et al. (2012). Non-proportionality of electron response and energy resolution of Compton electrons in scintillators *IEEE Transactions on Nuclear Science*, 59 , art. no. 06122473, pp. 222-229. Moszynski, M., et al. (1997) Absolute light output of scintillators *IEEE Transactions on Nuclear Science*, 44, pp. 1052-1061.
09/24 *M*	Scintillators (II)	MDR Ch. 6, Knoll Ch. 8 Limkitjaroenporrn, P., et al. (2010) Nonproportionality of electron response using CCT: plastic scintillator. *Applied radiation and isotopes*, 68 (9), pp. 1780-1784. Payne, S.A., et al. (2011) Nonproportionality of scintillator detectors: Theory and experiment. II *IEEE Transactions on Nuclear Science*, 58, pp. 3392-3402.
09/26 *W*	Light Readout Devices	Knoll Ch. 9
10/01 *M*	Special Topics	The Klein Nishina Equation (Knoll Ch. 2), Non-standard Solid Angles (MDR Ch. 8), Branching Ratio
10/03 *W*	Data-processing Software	Scripts Provided by The Instructor
10/08 *M*	Semiconductor Diode Detectors	MDR Ch. 7
10/10*W*	Spectroscopy with Semiconductors	MDR Ch. 7 and 9
10/15*M*	Midterm 1 Review	Exam correction and discussion
10/17 *W*	Analog and Digital Signal Processing Techniques	MDR Ch. 10 Di Fulvio, A. et. al. (2014). Digital pulse processing for NaI(Tl) detectors. *Nucl Instr Meth A*, 806, pp. 169-174.

MODULE 3: Neutron detection

10/22 *M*	Neutron Detection Principles I	MDR 3.9 MDR 4.9
10/24 *W*	Neutron Detection Principles II	Nolte, R. (2015) Detection of neutrons, lecture notes of the *ICTP-IAEA School on Nuclear Data Measurements for Science and Applications*
10/29 *W*	Fast Neutron Detection (I)	MDR Ch. 14.5-14.10 and Becchetti, et al. (1976) Response of plastic scintillator detectors to heavy ions, Z less than equivalent to 35, E less than equivalent to 170 MeV. *Nucl Instrum Methods*, 138 (1), pp. 93-104.
10/31 *M*	Fast Neutron Detection (II)	MDR Ch. 11.5.3 11.5.4 14.8
11/05 *M*	Slow Neutron Detection (I)	MDR Ch. 14.2-14.4
11/07 *W*	Slow Neutron Detection (II)	MDR Ch. 15
11/12 *W*	Advanced Solid State Detectors	MDR 6.10 13.7, Knoll 15.III
11/14 *W*	Midterm 2 Exam	
11/19 *M*		Fall Break
11/21*W*		Fall Break
11/26 *M*	Readout electronics and Time-correlated Measurements	Mihalczo, J.T., et al. (2000) Physical description of nuclear materials identification system (NMIS) signatures *Nucl Instr Meth A*, 450 (2), pp. 531-555.
11/28 *W*	Advanced detection systems: time projection chambers, muon detectors, gamma-neutron scatter cameras	Goldsmith, J.E.M., Gerling, M.D., Brennan, J.S., A compact neutron scatter camera for field deployment (2016) Review of Scientific Instruments, 87 (8) and C. Rubbia, The Liquid-Argon Time Projection Chamber: A New Concept For Neutrino Detector, CERN-EP/77-08 (1977)
12/03 *M*	Passive Detectors (TLDs and TEDs)	NPRE451-Handout6
12/05 *W*	Review of Selected Topics	Review Exercises
12/10 *M*	Unconventional Radiation Detectors	Knoll Ch. 19
12/12 *W*	Review of Selected Topics	Review Exercises
12/18	FINAL EXAM	1:30PM - 4:30PM Location: TBD

Lab Schedule

Lecture	08/29	*W*	Radioactive sources
Lecture	08/30	*R*	Radiation interactions with matter
Lab #1	09/05	*W*	Introduction to Lab Equipment and Counting Statistics Examples of *Open Lab* Projects
Lab #2	09/12	*W*	Proportional Counters and Geiger-Mueller Counters
Lab #3	09/19	*W*	PMTs and Inorganic Scintillation Detectors
Lab #4	09/26	*W*	Alpha Spectroscopy and Review Exercises
EXAM	10/03	*W*	MIDTERM 1
Lab #5	10/10	*W*	HPGe Detectors: Efficiency Calibration and spectroscopy *Open Lab* projects assigned
Lab #6	10/17	*W*	Gas Flow Detectors - Resolution comparison to HPGe
Lab #7	10/24	*W*	Radiation Shielding: Gamma Rays and Neutrons. Thermal Neutron Detection.
Lab #8	10/31	*W*	Fast Neutron Detection: Organic Scintillators, Pulse Shape Discrimination and Spectroscopy
Lab #9	11/07	*W*	Demonstration of the Compton Effect Using Coincidence Measurements
Open Lab	11/14	*W*	Working time
Open Lab	11/15	*R*	Working time
Open Lab	11/28	*W*	Working time
Open Lab	11/29	*R*	Working time
Open Lab	12/05	*W*	Working time
Open Lab	12/06	*R*	Working time
Open Lab	12/12	*W*	Open Lab presentations