University of Wisconsin - Madison
Nuclear Instrumentation Laboratory (NE 427) Fall 2019 Syllabus

Course name and number: Nuclear Instrumentation Laboratory (NE 427)

Credits: 2 credits

Canvas URL: https://canvas.wisc.edu/courses/163720

Course designations and attributes:
Required for NE majors
Level - Intermediate
Breadth - Physical Sciences
L&S Credit Type - C

Meeting time and location:

	Day and Time	**Location**
Discussion	Monday 3:30 PM - 4:30 PM	MECH ENGR 1153
Laboratory	Tuesday 9:00 AM - 12:00 PM Tuesday 1:00 PM - 4:00 PM	MECH ENGR B1140

Instructional mode: All face-to-face, with weekly one-hour lecture and three-hour laboratory session

How credit hours are met by course: 45 hours per credit

Instructor: Prof. Jennifer Choy, Department of Engineering Physics

Office: 535 Engineering Research Building
Email and Phone: jennifer.choy@wisc.edu, (608)-263-6974
Office hours: Tuesdays 6:00 PM - 7:00 PM, in 535 Engineering Research Building

Course description:
In this course, critical concepts in radiation-matter interactions are illustrated through radiation counting and spectroscopy experiments using nuclear instrumentation.
Requisites: NE 305 or declared in a Civil and Environmental Engineering, Nuclear Engineering and Engineering Physics, Electrical Engineering, Mechanical Engineering or Physics graduate program

Learning outcomes:
Course learning outcomes:

By the end of the course, you will be able to:

- Explain the operational principles of nuclear radiation detectors in the context of how radiation interacts with matter.
- Identify the best choice of detector for a given type of radiation and its limitations.
- Operate basic nuclear counting instrumentation: gas-ionized and solid-state radiation detectors, nuclear instrumentation module, power supplies, signal amplifiers, oscilloscopes, and single- and multi-channel analyzers.
- Estimate experimental uncertainties in counting measurements and calculate errors associated with quantities derived from such measurements.

- Take laboratory notes and prepare clearly written experimental reports.

ABET learning outcomes:

- An ability to apply knowledge of basic mathematics, science, and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to identify, formulate, and solve engineering problems
- An ability to communicate effectively
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Brief list of topics to be covered:
counting statistics and error propagation, interactions of radiation with matter, Geiger-Mueller and other gas-filled counters, proportional counter including neutron detection, scintillation detectors and gamma spectroscopy, range of heavy charged particles, gamma ray attenuation, neutron activation measurements of trace elements, coincidence measurements and absolute counting

Discussion sessions:
Weekly lecture (Monday 3:30-4:30 pm, Mech Engr 1153) introduces background of laboratory exercise and provides discussion opportunity.

Laboratory sessions:
Laboratory sessions (Tuesday 9 am-12 pm or 1-4 pm, Mech Engr B1140) cover the operation of nuclear electronics, Geiger-Mueller counters, proportional counters, and scintillation counters, and experiments pertaining to range energy, neutron activation, and absolute counting.

Course materials:
Course contents are largely based on "Radiation Detection and Measurement (Third or Fourth Edition)" by G.K. Knoll. Lecture notes, lab manuals, and supplementary readings will be posted on the course website.

Grading policy:
Grades will be based on class participation and submitted work (see next section). There will be no exams for the course. The absolute scale used to assign grades is:

A: 92% – 100%
AB: 87% – 91.9%
B: 82% – 86.9%
BC: 77% – 81.9%
C: 69% – 76.9%
D: 60% – 68.9%
F: 0% – 59.9%

Grading breakdown:
Discussion participation (3%): The class participation grade will be somewhat subjective (since attendance will not be recorded) and based on your engagement during the weekly discussion periods. As a rough benchmark, a full grade will be given if you make a meaningful comment (*e.g.*, ask or answer a question) every 2-3 weeks. I will try to interperse each lecture with a couple of questions posed to the class, so there will be plenty of opportunities for participation.

Lab attendance (2%): Since you will be paired in groups of 2 or 3 for each lab exercise, please try to make it to the lab on time out of courtesy to the rest of the students. If you need to miss a lab, please reach out to me ahead of time and I will try to arrange an alternative time for you to make up the lab. Repeated patterns of lateness and missing labs will result in partial grade for this, but otherwise a full grade will be given.
Assignments (95%): Homework will be in the form of lab-book reports (submitted electronic laboratory notebooks consisting of the abstract, raw data, responses to lab manual questions, and data analysis), and a full report. Instructions for each type of assignment will be provided before the first due date, and a list of all required submissions is shown below. If extensions are needed (for example, due to religious observances or illnesses), please let me know in advance.

Lab	**Assignment**	**Due date**	**% of grade**
Nuclear electronics	Lab-book report	9/16 by 6 pm	5
Geiger-Mueller counters	Lab-book report	9/30 by 6 pm	14
Proportional counters	Lab-book report	10/14 by 6 pm	14
Scintillation counters	Lab-book report	10/28 by 6 pm	14
Range energy	Full report	11/11 by 6 pm	20
Neutron activation	Lab-book report	11/25 by 6 pm	14
Absolute counting	Lab-book report	12/9 by 6 pm	14

Course schedule:

Week	**Discussion**		**Lab**		**Supplemental readings**
1	No session				
2	9/9	Introduction & Nuclear electronics	9/10	Nuclear electronics	Knoll Ch 1, 4, 16, 18
3	9/16	Geiger-Mueller counters	9/17	Geiger-Mueller counters	Knoll Ch 2, 3, 7
4	9/23	Statistics and error analysis	9/24		
5	9/30	Slow neutron detectors	10/1	Proportional counters	Knoll Ch 6, 14
6	10/7	General properties of proportional counters	10/8		
7	10/14	General properties of scintillation counters	10/15	Scintillation counters	Knoll Ch 9, 10, 11
8	10/21	Gamma spectroscopy with scintillation counters	10/22		
9	10/28	Radiation-matter interactions: heavy charged particles	10/29	Range-energy	Knoll Ch 2
10	11/4	Radiation-matter interactions:beta and gamma particles	11/5		
11	11/11	Introduction to neutron activation analysis	11/12	Neutron activation analysis	Handouts on website
12	11/18	Applications of neutron activation analysis	11/19		
13	11/25	Pulse timing and coincidence measurements	11/26	Absolute counting	Knoll Ch 17
14	12/2	Absolute counting	12/3		
15	12/9	Tentative: reactor tour	12/10	No session	

Academic policies:

Academic integrity

By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to https://conduct.students.wisc.edu/academic-integrity/

Accommodations for students with disabilities

McBurney Disability Resource Center syllabus statement: "The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA." http://mcburney.wisc.edu/facstaffother/faculty/syllabus.php

Diversity & Inclusion

Institutional statement on diversity: "Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals. The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world. https://diversity.wisc.edu