HPS 403/603
Radiation Physics & Instrumentation Laboratory
Syllabus

Spring 2022

Instructor: Dr. Dan Koury

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Office Hours: Tuesday & Thursday 1:30 – 2:30 PM & by appointment

Pre/co-requisite: HPS 402/602

Description: Laboratory experiments in radiation physics and detection
Operation of radiation detection instrumentation
Introduction into practical spectroscopy

Schedule
Section I: Monday 11:30 – 2:20 BHS 117
Section II: Wednesday 11:30 – 2:20 BHS 117

Recommended Textbook

Knoll, G. F., *Radiation Detection and Measurement*, 4th Edition, John Wiley (2010)

Supplemental Textbooks

Tsoulfanidis, N., Landsberger, S., *Measurement and Detection of Radiation*, 3rd Edition, CRC Press (2010)
Ahmed, S.N., *Physics & Engineering of Radiation Detection*, 2nd Edition, Elsevier (2014)
L'Annunziata, M.F., *Handbook of Radioactivity Analysis*, 3rd Edition, Academic Press (2012)
Gilmore, G., *Practical Gamma-Ray Spectrometry*, 2nd Edition, John Wiley (2008)
Turner, J.E., Downing, D.J., Bogard, J.S., *Statistical Methods in Radiation Physics*, Wiley-VCH (2012)

Teaching Methods

Practical laboratory experiments
Problem solving in groups and as individuals

Evaluation Methods

Accomplishment of course objectives will be assessed by completing the following tasks:

	HPS 403	HPS 603
Pre-Laboratory Quiz	10%	10%
Laboratory Notebook	10%	10%
Laboratory Reports	60%	60%
Final Exam	20%	20%

Grading Scale

Letter grades for this class will be based on the following grading scale:

Grade Points	Letter Grade
≥ 93	A
90-92	A-
87-89	B+
83-86	B
80-82	B-
77-79	C+
73-76	C
70-72	C-
60-69	D
< 60	F

Course Objectives

The student is expected to gain an understanding of the handling and application of a variety of radiation detectors. The student will be able to operate a variety of radiation detectors independently, and to handle other aspects of the measurements, such as the use of shielding and the choice of appropriate counting times. The knowledge gained by the student in this course can be applied to the daily professional activities of a practicing radiochemist, nuclear engineering, health or medical physicist. After successful completion of this class the student is expected to be able to perform the activities listed below:

1. Operate an oscilloscope and use it to monitor signals from a radiation detector and the associated electronics.
2. Become familiar with the function of different types of nuclear instrumentation, such as preamplifiers, amplifiers, single channel analyzers, ADC's.
3. Set up the electronic modules necessary to process signals from radiation detectors.
4. Operate a variety of radiation detectors, such as gas proportional counters, Geiger-Mueller counters, sodium iodide detectors, high-purity germanium detectors and surface barrier detectors.
5. Use a liquid scintillation counter.
6. Understand the uncertainties associated with radiation and decay measurements and be able to calculate the error of measurements.

7. Determine the absorption coefficients for different types of material and apply this knowledge for radiation shielding.

Quiz

Students are expected to prepare for each class by reading the notes for each experiment in advance. Weekly quizzes will be given at the beginning of each class to test the student's knowledge of the experiment planned for that day.

Laboratory Notebooks

Students are expected to obtain a bound notebook with numbered pages to use as a laboratory notebook. Several pages should be left blank at the beginning for a table of contents. All work should be clearly labeled with the date noted for the start of each lab. Tape any computer printouts or graphs directly into your logbook. Perform all calculations required during class in the logbook.

Laboratory Reports

Students are expected to document the results of each class by writing a laboratory report. The reports are due one week after the experiment was performed. The laboratory report should be written in such a fashion that another experimenter can repeat the experiment without having to consult additional sources. To the extent possible, the report should follow the style of the Health Physics Journal and contain the following:

- A cover page listing the title of the laboratory, the date at which the experiments were conducted and the name of the persons conducting the experiments.
- A statement (abstract) describing the purpose of the laboratory
- An introduction explaining operation of the detectors used and the theoretical basis for the experiments if appropriate.
- A materials and methods section stating the instruments used and describing the procedures followed.
- A results section containing the raw data from the experiment, any calculations performed including the formula used and the results obtained.
- A short section describing the conclusions of the experiments conducted.
- A reference section.

Reports should be prepared using a word processor and printed on letter size paper. Unless stated otherwise, the results should be given in S.I. units. No result section is considered complete without error calculations or error discussion.

Exam

Final examination will consist of individual oral exams of 30-60 minute duration. The exam will cover the theory behind the detectors utilized and the experiments conducted, as well as the methods used and the results obtained. Students are expected to know the material well. Appointments for the exam will be scheduled with the instructor during the finals period.

Please see the Student Syllabus Policies Handout for select, useful information for students. This document can be found at: https://www.unlv.edu/sites/default/files/page_files/27/EVPP-Syllabi-Content.pdf

Tentative Outline of Instruction

Week 1 – 01/19	Introduction & Safety Training
Week 2 – 01/24, 01/26	Laboratory #1: Oscilloscope Usage
Week 3 – 01/31, 02/02	Laboratory #2: Radiation and Contamination Surveys
Week 4 – 02/07, 02/09	Laboratory #3: Counting statistics & Distance Law
Week 5 – 02/14, 02/16	Laboratory #4: Absorption of Beta and Gamma Rays
Week 6 – 02/21, 02/23	**President's Day – No lab**
Week 7 – 02/28, 03/02	Laboratory #5: Geiger-Mueller Counter
Week 8 – 03/07, 03/09	Laboratory #6: Liquid Scintillation Counting
Week 9	**Spring Break**
Week 10 – 03/21, 03/23	Laboratory #7: Spectroscopy using a NaI Detector with SCA
Week 11 – 03/28, 03/30	Laboratory #8: Spectroscopy using a NaI Detector with MCA
Week 12 – 04/04, 04/06	Laboratory #9: Alpha Spectrometry
Week 13 – 04/11, 04/13	Laboratory #10: Measurement of Radon Daughters
Week 14 – 04/18, 04/20	Laboratory #11: Gamma-Ray Spectroscopy using a HPGe Detector
Week 15 – 04/25, 04/27	Laboratory #12: Gamma-Ray Spec. on Environmental Samples
Week 16 – 05/02, 05/04	Study Week
Week 17 – 05/10, 05/12	**Final Exam**