CHEMISTRY 146 -Radiochemical Methods in Nuclear Technology and Forensics (3 UNITS)

COURSE OVERVIEW

Summary

Chemistry 146 is a laboratory course emphasizing the practical techniques used to analyze radioactive materials. Students will focus on learning how to operate four common instruments used in forensic analysis in addition to analyzing spectroscopic data. Each laboratory is followed by an intensive formal laboratory report which is composed of theory, data, calculations, discussion of results, and a multicomponent appendix. The early portion of this course focuses on technology commonly used in forensic analysis where the latter half is composed of a variety of chemical methods and techniques which can aid in analysis of radiochemicals. In addition, the lecture component of this course is a mixed bag. Lectures cover the fundamentals of nuclear science and are followed by broad topics in nuclear chemistry. In addition, guest lectures are given by renowned faculty from UC Berkeley, Lawrence Berkeley National Lab, and Lawrence Livermore National Lab. This section is the highlight of the course as it exposes students to the many possible fields in nuclear forensics in addition to cutting edge research in the nuclear chemistry field from prominent and illustrious scientists. Very few institutions have the capacity to teach a course like Chemistry 146, it truly is a unique and rigorous experience that will give you the ability to characterize unknown radioactive materials and distinct skills that can be used in multiple fields beyond chemistry and nuclear sciences.

Prerequisites

- Chem 4B is strongly recommended. Chem 143 is also recommended but not necessary. Chem 143 will teach the basic nuclear science needed for this course; it will make the theoretical part of this course familiar. The nuclear science depth needed for this course is minimal and is partially taught in the beginning of this course.

Laboratory experiment topics covered (short list)

- Geiger-Muller Detectors
- Alpha Spectroscopy
- Gamma Spectroscopy NaI (Tl) Detectors
- Gamma Spectroscopy HPGe Detectors
- Finger Printing of Uranium

- Isotope Dilution Analysis
- Solvent Extraction
- Ion exchange
- Secular Equilibrium
- Neutron Activation Analysis

Skills learned

- Spectroscopy
    - Alpha Spectroscopy
    - Gamma Spectroscopy
    - 4 different detector types
- Radiochemistry
    - Isotope Dilution
    - Solvent Extraction
    - Ion Exchange
    - Neutron Activation
- Data Analysis
    - Propagation of Error
    - Analysis of Spectra
    - Calibration Curves
- Nuclear Forensics
    - Decay Data Search
    - Isotope Prediction of unknown materials
    - Activity and Mass calculations of unknown materials

WORKLOAD

Course Work

- 10 Formal lab reports over the course of the semester, generally due within one week (may be changed)
- Approximately 4 Problem Sets
- Other miscellaneous assignments such as summaries of literature, lecture, or tours

Time Commitment

4 hours of lab a week for the entire semester. 1.5 hours of lecture a week. Typically students spend 15 hours on lab reports and other assignments, for the duration of the semester.

CHOOSING THE COURSE

When to take

Suggested to take after CHEM 4 and 12 series. This class is spring only. The lab reports involve a great deal of data analysis; plan to spend time doing lab reports every week. It is not recommended to take another laboratory course with this course.

What next?

- Chem 143: Nuclear Chemistry
    - If not taken yet.
- Research: This course presents pathways for research with investigators at UC Berkeley, Lawrence Berkeley National Lab, and Lawrence Livermore National Lab
- Nuclear Related Courses in nuclear engineering or physics such as Nuclear Engineering 102.

ADDITIONAL COMMENTS/TIPS

The lab reports can be lengthy, and will take several days to write. The amount of error propagation and data analysis is beyond what was required in Chem 4B. This course requires basic excel skills but no other programming/computer skill is necessary.

There may or may not be a midterm/ Final Exam in this class depending on who is teaching.

Generally, every semester there is at least one field trip to Lawrence Berkeley National Lab to view the various facilities and network with staff.

This course does not focus on wet lab techniques in the same way that an organic or inorganic chemistry lab course might. A great deal of time is devoted to acquiring spectroscopic data and learning how to operate the instrumentation.

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