CHEMISTRY DEPARTMENT
Hunter College, CUNY

Introduction to Radiochemistry CHEM 39200

Introduction to Radiochemistry utilizes concepts of many courses offered in the Chemistry Department; this is due to the interdisciplinary nature of Radiochemistry. For example, General Chemistry teaches kinetics that directly applies to radioactive decay so students should feel comfortable when introduced to this concept. Many of the necessary background information is given in General Chemistry; this includes a quantum mechanical description of the atom, discussion of the nucleus and electrons, brief history of chemistry. Inorganic Chemistry teaches metal ligand complexation that plays a large role in radiometal –complex synthesis and in applications in environment and in medicine. Quantitative Analysis teaches techniques that lay the groundwork for modern radioanalytical and counting methods of analysis. Concepts taught in Biochemistry courses are directly relatable to radiochemical applications in medicine.

A useful web site for nuclear information: http://nucleardata.nuclear.lu.se/nucleardata/toi/index.asp

Introduction to Radiochemistry is an introduction to radiochemistry and radiation detection and applications. Radiochemistry is usually considered to be the use of radioactive materials to study chemical reactions, to trace biological and geological processes. Radiochemistry is central to applications in medicine, environment and energy. Key topics include principles of radioactive decay, interactions of radiation with matter, radiation detectors, health physics, radioactive tracers, and sources of radioactive materials. This course is focused on providing hands-on experience in radiochemistry. We will cover medical, environmental, nuclear security and forensics, and nuclear fuel cycle applications of radioisotopes.

Learning Outcomes: At the end of the course the students will be able to describe:

1) the fundamental principles of radiochemistry including radioactive decay of radioisotopes, half-life, the different types of decay of radioisotopes: (alpha decay, beta minus (negatron) decay, beta plus (positron) decay, electron capture.
2) interaction of radiation with matter for each type of decay
3) the radioactive counting instrumentation: this includes gas filled detectors and their relation to voltage of the detector as well as solid-state scintillation detectors and semiconductor detectors. This also includes liquid scintillation detectors.
4) the principles of gamma spectroscopy (the interaction of gamma rays with matter, the translation of the interaction with matter to events that are detected by the scintillator or semiconductor and the modern counting methods to record the spectrum.
5) calibration and operation of a number of modern radioactivity detectors.
6) isotope production (generators, reactors, accelerators).
7) modern methods of radioanalytical chemistry used in medicinal, environmental and nuclear energy applications.
8) applications of radiochemistry – this includes synthesis of radiopharmaceuticals and applications in environment and nuclear energy.

Methods of Evaluation: includes grading of homework sets, midterm exams (2), a final exam, and the required laboratory reports for each laboratory experiment.

Grading:		
	Homework Sets	10%
	Hour Exam 1	20%
	Hour Exam 2	20%
	Cumulative Final Exam	30%
	Laboratory Reports	20%

Required Readings:
Chart of the Nuclides: Bechtel

- **Paperback, $30.00**
- **Publisher:** Knolls Atomic Power Lab (2010)
- **ISBN-10:** 0984365303
- **ISBN-13:** 978-0984365302

The Chart of the Nuclides contains information for all of the radionuclides discovered to date. This is an important tool for the students. The Chart also contains conceptual information that will be discussed in class.

Recommended Readings: There are a number of textbooks that contain some of the concepts that will be covered but not all. These are often heavily physics focused, medically focused, or out of print. These textbooks will be available for optional reading and general edification.

List of Recommended Books:

1. ***Ehmann and Vance,*** **Radiochemistry and Nuclear Methods of Analysis, any edition**
2. ***Loveland, Seaborg, Modern Nuclear Chemistry,*** **any edition**

Course Content and Organization:

TENTATIVE Syllabus Lecture and Laboratory

Week(s)	**Lecture Topic**	**Laboratory**
1.	Introduction, History, Applications	Check-in , Safety G.M. Tube Plateau
2.	Types of Decay	Dead Time/Statistics
3.	Chart of the Nuclide- usage	Detector Efficiency/inverse square law
4.	Energetics	Cs-Ba generator/ half-life measurement
5.	EXAM 1	Energy and Efficiency Calibration of NaI, gamma ray detector and unknown (1)
6.	Decay Rates, Secular/Transient Equilibria, Generators	Energy and Efficiency Calibration of NaI, gamma ray detector and unknown (2)
7.	Nuclear Reaction/chart of the Nuclides wrap up	Absorption of beta particles and gammas
8.	Absorption and attenuation of radiation Interactions of Radiation	Thickness gauge with beta particles
9.	Health Physics (LET, dose, more units)	Isotope dilution

10.	EXAM 2	Synthesis of radiopharmaceutical (1)
11.	Introduction to Detectors	Synthesis of radiopharmaceutical (2)
12.	Reactors and accelerators Isotope Production	Synthesis of radiopharmaceutical (3)
13.	Applications of radiochemistry: medicine	Solubility Product using Radiotracer
14.	Applications of radiochemistry: environment/ nuclear fuel cycle/security	Complete all labs and write-ups Check out
15.	FINAL EXAM	

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a. Sexual Violence: Students are strongly encouraged to immediately report the incident by calling 911, contacting NYPD Special Victims Division Hotline (646-610-7272) or their local police precinct, or contacting the College's Public Safety Office (212-772-4444).

b. All Other Forms of Sexual Misconduct: Students are also encouraged to contact the College's Title IX Campus Coordinator, Dean John Rose (jtrose@hunter.cuny.edu or 212-650-3262) or Colleen Barry (colleen.barry@hunter.cuny.edu or 212-772-4534) and seek complimentary services through the Counseling and Wellness Services Office, Hunter East 1123.

CUNY Policy on Sexual Misconduct Link: http://www.cuny.edu/about/administration/offices/la/Policy-on-Sexual-Misconduct-12-1-14-with-links.pdf"

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