CHM1410 Analytical Environmental Chemistry
Fall 2024

Schedule

Classes: Tuesday and Thursday, 4:00–5:00 pm
Lab: Friday 9:00–12:30 or 1:00–4:30 LM 6
Office Hours: Thursday 10:30–11:30 am LM 321, or by request.

Contact Information

Instructor: Dr. Jeremy Gauthier, LM 321, jeremy.gauthier@utoronto.ca
Lab Coordinator: Prof. Jessica D'eon, LM 119, jessica.deon@utoronto.ca

Course Goals

This course seeks to produce analysts with a basic conceptual understanding of a broad range of modern analytical equipment, data analysis strategies, and analysis of trace compounds in the environment. The lab component is designed to provide practical knowledge of sample collection and analysis, as well as data interpretation and visualization involved in environmental analysis.

Learning Objectives

Upon successfully completing CHM1410H, students will be able to design an environmental analysis starting with a literature search through experimental design and data analysis.

To complete this task students must be able to:

1. Search scientific literature for relevant background information and methodologies.
2. Make educated decisions related to analytical methodology and instrumentation.
3. Assess and communicate analytical data quality.
4. Analyze, interpret, and effectively visualize analytical data.
5. Confidently ask for help or advice.

Discussion Topics

U1: Analysis of Contaminants in Environmental Samples– Discussion of techniques we use to extract analytes from a variety of environmentally relevant matrices. Focus on proper laboratory practice, quality assurance and quality control, and data analysis.

U2: Compounds in the Environment – In this section we will discuss the concept of an environmental contaminant. Where are they found? What is their impact? What makes something a chemical of concern? Topics include chemical partitioning, persistence, and environmental transformations.

U3: Environmental Analytical Tools: Spectroscopy – This section will offer an overview of the analytical tools which are routinely available in many universities, but which are not used as often for environmental analysis. Includes UV/Vis, ICP-AES, FTIR, and NMR.

U4A: Environmental Analytical Tools: Chromatography – We will discuss chromatography in this section. Mass spectrometry is the most common analytical tool for environmental chemistry, but most mass spectrometers need some form of sample introduction. In this section we will cover gas and liquid chromatography including instrument design, chromatographic method development, and theory of chromatographic separations.

U4B: Mass Spectrometry– In this section we will discuss mass spectrometry as it applies to environmental analysis. We will focus on the two main types of MS analysis used in environmental chemistry: targeted and non-targeted approaches. We will additionally cover ionization mechanisms, mass scanning operation, advantages and disadvantages, and recent advances in instrumentation.

U5: Intelligent Chemical Design and Sustainable Practices – In this section we will use case studies to examine how our knowledge of environmental chemistry can be used to intelligently design and validate replacement chemicals. We will cover examples where replacement chemicals were designed and implemented by major manufacturers, the advantages and disadvantages, and the unintended or unforeseen consequences. We will conclude this section with a discussion surrounding the sustainability of environmental analysis. Reflecting on your experience in the lab, how green is environmental chemistry?

Lecture Schedule

September	3	T	Class Introduction
	5	R	Lab Format and Discussion
	10	T	U1: Sample Extraction Techniques
	12	R	U1: Sample Extraction Techniques / Quality Control
	17	T	U1: Quality Control
	19	R	U2: Chemical Partitioning
	24	T	U2: Persistent Organic Pollutants
	26	R	U2: Degradation and transformation in the environment
October	1	T	**Field Trip Discussion**
	3	R	U3: UV-Vis, FTIR, ICP
	8	T	U3: NMR **Midterm Report Due**
	10	R	U4A: Gas Chromatography
	15	T	U4A: Liquid Chromatography
	17	R	U4B: Sample Introduction / Ionization
	22	T	U4B: Quadrupoles and Traps
	24	R	U4B: Targeted mass spectrometry
	29	T	**Reading Week – No class**
	31	R	**Reading Week – No class**
November	5	T	U4B: Mass spectrometry scanning types
	7	R	U4B: Non-targeted mass spectrometry
	12	T	U5: Designing replacement compounds
	14	R	U5: Case Study: Trifluoroacetic acid
	19	T	U5: Case Study: 6-PPDQ
	21	R	U5: Case Study: Organochlorine pesticides
	26	T	U5: Sustainable practices in environmental chemistry
	28	R	Review
December	15		**Final Report Due**

Grading Scheme

Laboratory Grade		**60%**
R-introduction	1%	
Average of Labs 1-3 pre-lab exercises	1%	
Lab 1: Kinetics of Dye Lab Report	15%	
Lab 2: Field Trip		
Report Outline	3%	
Lab Report	15%	
Lab 3: Analysis of Honey by NMR report	3%	
Lab 4: Student-Directed Projects		
Group Proposal	3%	
Group Presentation	10%	
Report for Future Students	3%	
Client Deliverable	5%	
Personal Refection	1%	
Midterm Report		**10%**
Final Report		**30%**

Midterm and Final

This class does not have a traditional in-person midterm or final exam. At the beginning of the semester, you will be assigned a chemical or chemical class found in an environmental compartment. Using knowledge gained throughout the labs and lectures as well as literature publications, it will be your job to design an appropriate environmental analysis of your chemical. Details on the midterm report and final report will be provided early in the semester in class and on Quercus.

Website

All material, including presentation slides and literature resources, when provided, and the lab manual will be available on Quercus. You are responsible for checking this site regularly.

Textbook

There is no textbook requirement for CHM1410. As this course aims to present current topics in environmental analytical chemistry primary scientific literature resources are provided when appropriate and can be accessed via Blackboard. Although students are encouraged to use additional resources these are not mandatory, and evaluations will be based only on the specific material discussed in class.

Other Useful Resources

Chemistry LibreTexts offers a general and broad introduction and overview of many of the analytical techniques covered in this course. The information is offered free of charge on the web and is generally to-the-point and easy to digest. This may be a useful resource for understanding the general theory behind many techniques.

The ChromAcamdemy is a web-based tutorial series offered jointly by LCGC online magazine and Agilent Technologies. This resource is available free of charge to those with an academic email. Depending on your analytical chemistry background this may or may not be a useful resource.

Instructions for creating a CHROMacademy account:

1. Go to http://www.chromacademy.com
2. Click 'Subscribe / Login' on the top right of the website
3. Choose 'Get an Agilent Sponsored Academic License' option on the pop-up menu
4. Click 'FREE university membership'
5. A window will appear where you have to input relevant details to create an account.

Note: You must use an academic email address to receive a free account. The account itself isn't created immediately, but you are sent a confirmation email for full registration.

If necessary, students are encouraged to use any introductory analytical chemistry textbook to review relevant topics discussed in class. Two excellent textbooks are: *Quantitative Chemical Analysis* by Daniel Harris and *Fundamentals of Analytical Chemistry* by Douglas Skoog. A large portion of the latter half of this course is dedicated to mass spectrometry and ionization processes; two excellent textbooks on these topics are *Mass Spectrometry: Principles and Applications* by Edmond de Hoffmann and Vincent Stroobant and *Chemical Ionization Mass Spectrometry* by Alex Harrison. All these textbooks are available from the University of Toronto libraries.

Academic Integrity

While peer discussions are encouraged, laboratory reports, midterm reports, and final reports MUST represent your own independent work and comprehension. Information about academic integrity can be found here: http://www.artsci.utoronto.ca/osai/, and a copy of the University of Toronto's Code of Behavior can be found here: http://www.governingcouncil.utoronto.ca/AssetFactory.aspx?did=4871

Use of Generative AI Tools

Generative Artificial Intelligence (AI) can create writing, computer code, and /or images using minimal human prompting, are proliferating and becoming ubiquitous. This includes not only GPT-4 (and its siblings ChatGPT, Gemini, and others), but many writing assistants that are built on this or similar AI technologies. There are now hundreds of these systems that are readily available. We will discuss the use of these tools in class and specific details on how they may, or may not, be used will be provided on Quercus for each assessment.

Class Recording and Copyright

This course, including your participation, will be recorded and available to students in the course for viewing remotely after each session. Course videos and materials belong to your instructor, the University, and/or other sources depending on the specific facts of each situation and are protected by copyright. Do not download, copy, or share any course or student materials or videos without the explicit permission of the instructor.

Accommodations

All students are welcome in this course. If you have a disability/health consideration that may require accommodations, please feel free to approach Dr. Jeremy Gauthier, Prof. Jessica D'eon, and/or Accessibility Services at (416)-978-8060; http://accessibility.utoronto.ca

Accommodations for Religious Observances

Following the University's policies, reasonable accommodations will be made for students who observe religious holy days that coincide with the due date/time of an assignment, tutorial, class or laboratory session. Students must inform the instructor before the session/assignment date to arrange accommodations.

Plagiarism Detection Tool (Turnitin)

Normally, students will be required to submit their lab reports to the University's plagiarism detection tool for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their reports to be included as source documents in the tool's reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of this tool are described on the Centre for Teaching Support & Innovation web site.

Late Materials

The midterm and final report due dates are listed in the syllabus. Lab deadlines are posted on Quercus. Late submissions will be docked 10% per day including the weekend. If you require an extension on course work contact the instructor or lab coordinator by email.

Absences

Students who miss labs for legitimate reasons should contact Dr. D'eon as soon as possible, and no later than one week after returning to class. Students who miss deadlines for the midterm or final report for legitimate reasons should contact Dr. Gauthier as soon as possible to arrange a new submission deadline. A legitimate reason for an absence or missed deadline due to medical, personal, or family reasons should be documented by one of the following:

1) U of T Student Medical Certificate
2) Student Health or Disability Related Certificate
3) College Registrar's Letter
4) Accessibility Services Letter
5) ACORN absence declaration

Course Policies

Each member of this course is expected to maintain a professional and respectful attitude during all course activities, including classes, laboratories, tutorials, and other online activities. Students are expected to maintain a personal calendar/schedule/organizer to ensure that all course activities are completed, and due dates are met.

The University of Toronto is committed to equity, human rights and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. The CHM1410 Teaching team will neither condone nor tolerate behaviour that undermines

the dignity or self-esteem of any individual in this course and we wish to be alerted to any attempt to create an intimidating or hostile environment. It is our collective responsibility to create an inclusive space that welcomes discussion. Discrimination, harassment, and hate speech will not be tolerated. If you have any questions, comments, or concerns, we encourage you to reach out to the staff in our Equity Offices.

Acknowledgement of Traditional Lands

We wish to acknowledge this land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca and, most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.