

CHM 410H-1410H Analytical Environmental Chemistry

Course Syllabus: Fall 2021

Instructor and Laboratory Coordinator: Prof. Jessica D'eon, jessica.deon@utoronto.ca

Classes: Tuesdays and Thursdays 11:00 AM – 12:00 PM

Student Hours: Tuesdays 12:00-1:00 PM and Thursdays 10:00-11:00 AM

For the first two weeks of the course (Thurs Sept 9-23, 2021) all aspects will be virtual and held over zoom using the meeting details below. Starting Friday Sept 24, 2021 all aspects of the course will be held in person. Both virtual and in-person classes will be recorded and posted to Quercus for later viewing.

Student hours will take place directly after class on Tuesdays and directly before class on Thursdays. For the first two weeks of the course student hours will be virtual and held over zoom. Starting in the third week of class (week of September 27) I will run student hours in a hybrid fashion where I will meet with students in-person if they are present, and I will also open the zoom link below and accept questions online.

I want to mention explicitly that I enjoy student hours tremendously and that this is time I have set aside to answer your questions about the lab or class, or to just chat about your research or decisions you are making post-graduation. I want to be clear that I am looking forward to speaking with you, so please attend! Helping you be successful in this class is my job!

Class and Student Hours Zoom Details

<https://utoronto.zoom.us/j/86284078856>; Meeting ID: 862 8407 8856; Passcode: chm410

Laboratory: Friday 9:00 AM – 12:30 PM or Friday 1:15 – 4:45 PM

The first virtual lab session (Friday Sept 17) will be held over zoom (details on Quercus) and recorded and posted. After this first weekly lab sessions must be accessed in person, no recordings will be posted.

Course Goals

This course seeks to produce analysts with a basic conceptual understanding of a broad range of modern analytical equipment and data analysis strategies relevant to trace environmental analysis. 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.

Student Learning Outcomes

Upon successfully completing CHM 410H-1410H, 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 the 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

Unit 1: Chemical Partitioning, Sample Preparation and Quality Control. These techniques ensure the concentrations we observe in the lab reflect the concentrations present in the environment.

Unit 2: Chromatography. Chromatography is relevant both as a separation technique to separate chemicals of interest from each other and possible interferences, as well as an effective means of delivering the compound of interest to the chosen detector.

Unit 3: Mass Spectrometry Instrumentation and Scan Types. we will discuss the major types of mass spectrometers and how their various abilities to scan mass-to-charge ratios affects their applications to different environmentally-relevant chemical analyses.

Unit 4: Ionization for Mass Spectrometric Analysis. We will discuss a variety of ways gas phase ions are produced for analysis by mass spectrometry and how these processes are optimized for environmental applications.

Unit 5: Non-MS Analysis. The majority of the class is focused on the analysis of organic contaminants through mass spectrometry hyphenated to a chromatographic separation. In this unit we will talk about spectroscopic detectors and analyzers and discuss the benefits and drawbacks to the two approaches.

Grading Scheme

R-introduction (Due 5 pm Thursday September 16)	2%
Lab 1: Air Quality	9.5%
Preparation	0.5%
Mini-Report due 5 pm Thursday September 30	9%
Lab 2: Flame Retardants in Dust	10%
Preparation	0.5%
Participation	0.5%
Mini-Report due 5 pm Thursday October 14	9%
Lab 3: Analysis of Fluorinated Contaminants in Lake Niapenco	19%
Preparation	0.5%
Participation	0.5%
Report Outline due 5 pm Thursday November 4	3%
Report due 5 pm Thursday November 18	15%
Lab 4: Analysis of Honey by NMR	10.5%
Preparation	0.5%
Mini-report due 5 pm Tuesday November 16	10%
Lab 5: Nontarget Analysis	33%
Assignment due 5 pm on Wednesday October 20	5%
Analysis Proposal due 5 pm on Tuesday October 26	3%
Presentation and Defense, Friday December 3	10%
Report due 5 pm Thursday December 9	15%
Final Oral Exam	16%
Paper submission due 5 pm Tuesday December 7	3%
Oral exam (final assessment period Dec 13-17)	13%

Class and Lab Schedule

Week 1 (and a half)	Sept 9	TH	Class Introduction (virtual)	
	Sept 14	TU	Lab Format and Discussion (virtual)	
	Sept 16	TH	Unit 1: Chemical Partitioning (virtual).	Deadline – R Introduction due at 5 pm
	Sept 17	FR	Lab 1: Air Quality	
Week 2	Sept 21	TU	Unit 1: Sample Extraction and Cleanup (virtual)	
	Sept 23	TH	Unit 1: Quality Control (virtual)	
	Sept 24	FR	Lab 2 – Dust Analysis, Experimental	
Week 3	Sept 28	TU	Unit 2: Introduction to Chromatography	
	Sept 30	TH	Unit 2: GC and LC	Deadline – Lab 1: Air Quality due at 5 pm
	Oct 1	FR	Lab 2 – Dust Analysis, Data Analysis	
Week 4	Oct 5	TU	Lab 3 Field Trip Discussion	
	Oct 7	TH	Unit 3: Mass Spectrometry I	
	Oct 8	FR	Lab 3 – PFAAs in Lake Niapenco, Field Trip	
Week 5	Oct 12	TU	Unit 3: Mass Spectrometry II	
	Oct 14	TH	Unit 3: Data Independent Acquisition	Deadline – Lab 2: Dust Analysis due at 5 pm
	Oct 15	FR	Lab 3: PFAAs in Lake Niapenco, Experimental 1	
Week 6	Oct 19	TU	Unit 3: Fragmentation Schemes	
	Oct 20	WE		Deadline – Lab 5: Suspect Screening Assignment due at 5 pm
	Oct 21	TH	Lab 5 Suspect Screening Discussion	
	Oct 22	FR	Lab 3: PFAAs in Lake Niapenco, Experimental 2 and Data Analysis	
Week 7	Oct 26	TU	Unit 3: Isotope Patterns	Deadline – Lab 5: Project Proposals due at 5 pm
	Oct 28	TH	Unit 3: Kendrick Plots	
	Oct 29	FR	Lab 4: Analysis of Honey and Syrups Using NMR	
Week 8	Nov 2	TU	Unit 4: Introduction to MS Ionization	
	Nov 4	TH	Unit 4: GC-MS Ionization Interfaces	Deadline – Lab 3: Field Trip Outline due at 5 pm
	Nov 5	FR	Lab 5: Nontarget Analysis I	
	Nov 9	TU		
	Nov 11	TH	Fall Break	
Nov 12	FR			
Week 9	Nov 16	TU	Unit 4: LC-MS Ionization Interfaces	Deadline – Lab 4: Analysis of Honey and Syrups Using NMR due at 5 pm
	Nov 18	TH	Unit 4: Real-time Ionization Interfaces	
	Nov 19	FR	Lab 5: Nontarget Analysis II	Deadline – Lab 3: Field Trip Report due at 5 pm
Nov 23	TU	Unit 5: Equilibrium Sampling Techniques – SPME and Passive Samplers		
Week 10	Nov 25	TH	Unit 5: Spectroscopy	
	Nov 26	FR	Lab 5: Nontarget Analysis III	
Week 11	Nov 30	TU	Unit 5: Sensor technology	
	Dec 2	TH	Unit 5: Metal Analysis – Extraction	
Week 12	Dec 3	FR	Lab 5: Nontarget Analysis, Group Presentations	
	Dec 7	TU	Unit 5: Metal Analysis – Detection	Deadline – Oral Exam paper and description due at 5 pm
	Dec 9	TH		
	Dec 13 – 17		Final Assessment Period - Final Oral Exam	Deadline – Lab 5: Nontarget Analysis, Report due at 5 pm

Final Oral Exam

This year CHM410H-1410H will not include any typical tests or exams. Instead, the class will include a final 20-minute individual oral exam with Prof. D'eon which will be held during the first week of the final exam period (December 13-17, 2021). The week before the exam you will submit a paper from the scientific literature with a short description and critique which will form the basis for the discussion. Additional details on this assessment will be provided on Quercus.

Technological Requirements

This course requires the use of computers, and of course sometimes things can go wrong when using them. You are responsible for ensuring that you maintain regular backup copies of your files, use antivirus software (if using your own computer), and schedule enough time when completing an assignment to allow for delays due to technical difficulties. Computer viruses crashed hard drives, broken printers, lost or corrupted files, incompatible file formats, and similar mishaps are common issues when using technology, and are not acceptable grounds for a deadline extension.

Specific guidance from the U of T Vice-Provost, Students regarding student technology requirements is available here: <https://www.vicprovoststudents.utoronto.ca/covid-19/tech-requirements-online-learning/>

Advice for students more broadly regarding online learning is available here: <https://onlinelearning.utoronto.ca/getting-ready-for-online/>

Etiquette, Online and In-Person

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. U of T does not condone discrimination or harassment against any persons or communities.

Textbook or Readings

There is no textbook requirement for CHM 410H-1410H. 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 Quercus..

Email Policy

I look forward to communicating with you and welcome your emails. I will try my best to respond to your emails within 24 hours on weekdays.

Late Policy

Anything handed in late, in the lab or the class, will be docked 10% per day including the weekend. If you require an extension on course work contact Prof. D'eon by email.

Academic Integrity

I want you to feel supported in your learning and so you are welcome to seek guidance from the TAs and instructors. You are also welcome to work constructively with your peers on the general content and understanding of the material. However, **all reports and assignments submitted in this class MUST represent your own independent work and comprehension.** Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters (<https://governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019>) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

In papers and assignments: Using someone else's ideas or words without appropriate acknowledgement; Submitting your own work in more than one course without the permission of the instructor; Making up sources or facts; Obtaining or providing unauthorized assistance on any assignment.

On tests and exams: Using or possessing unauthorized aids; Looking at someone else's answers during an exam or test; Misrepresenting your identity.

In academic work: Falsifying institutional documents or grades; Falsifying or altering any documentation required by the University.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see <https://www.academicintegrity.utoronto.ca/>).

Accessibility

Students with diverse learning styles and needs are welcome in this course. The University of Toronto is committed to accessibility: if you require accommodations for a disability, or have any other accessibility concerns about the course, please contact [Accessibility Services](#) as soon as possible.

Additional Services and Support

The following are some important links to help you with academic and/or technical service and support: General student services and resources at [Student Life](#); Full library service through [University of Toronto Libraries](#); Resources on conducting online research through [University Libraries Research](#); Resources on academic support from the [Academic Success Centre](#); Learner support at the [Writing Centre](#); Information for [Technical Support/Quercus Support](#)

Website and Online Interfaces

All material for both class and lab will be provided through Quercus. You are responsible for checking this site regularly. Any online synchronous classes and labs will be conducted over Zoom. Specific details for each meeting will be provided on Quercus.

Class Recording and Copyright

All aspects of the synchronous online classes and labs in this course, including your participation, will be recorded on video and will be available to students in the course for viewing remotely and after each session. Course videos and materials belong to the instructors and TAs and are protected by copyright. In this course, you are permitted to download session videos and materials for your own academic use, but you should not copy, share, or use them for any other purpose without the explicit permission of the specific instructor. For questions about recording and use of videos in which you appear please contact Prof. D'eon.

Laboratory Objective

The CHM 410H-1410H laboratory provides students with practical experience in the analysis of environmental contaminants. When the labs are presented in person, mastery of the lab skills necessary to perform these high-level analyses is a clear learning objective of the lab. However, this has only ever been a minor objective of the laboratory. The major objective is to solidify the in-class learning by handling, manipulating and visualizing data (third learning objective of the class) and this learning objective is just as relevant online as it was in person.

Laboratory Groups

Each session will be divided into three lab groups (morning – Groups A, B, C and afternoon – Groups D, E, F), each with a maximum of six students. Lab groups will be assigned by Prof. D'eon using the results of an introductory survey. The students in each lab group will work together to complete the physical work of each lab. You are encouraged to work together and form a cohort who moves together through the class. You will sign up for a lab group during the first week of classes.

Lab Preparation

You are required to come to each lab session (whether virtual or in-person) prepared to discuss the relevant topic. Specific preparation for each lab will be outlined on Quercus and each lab module will include a per-lab assignment on Quercus that is due prior to your lab period (9 am for the morning session and 1:15 for the afternoon session). Any questions about the pre-lab material should be directed to Prof. D'eon, the lab coordinator.

Lab Participation

Introductory labs 2 and 3 include a participation grade for reasonable participation during the in-person lab periods. If for any reason you are unable to attend any lab period, please let the lab coordinator know as soon as possible.

Turnitin

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

Laboratory Teaching Assistants

We have a fantastic teaching team in CHM 410H-1410H that includes amazing graduate student teaching assistants. All of the TAs are graduate students in our environmental chemistry program and have either taken the class or TAed it (or both) in the past, and they are looking forward to working with you. This being said, the TAs work on contract with very specific hour allocations for contact with the CHM 410H-1410H students and if you require assistance outside the lab meeting time it is best practice to attend student hours or send an email to the lab coordinator, Prof. D'eon.

Laboratory Content

Over the course of CHM410H-1410H you will complete five experiments. Detailed instructions and deliverables for each experiment are provided on Quercus.

Lab 1: Markers of Polluted Air

Lead TA: Mark Panas, mark.panas@mail.utoronto.ca

Lab 2 involves the use of portable air monitors for the analysis of fine particles, ozone and carbon dioxide to investigate the quality of the indoor or outdoor air in the City of Toronto. The focus of this lab is using data visualization to identify and understand trends between analytes.

Lab 2: Analysis of Organophosphate Flame Retardants in Dust

Lead TA: Andrew Folkerson, andrew.folkerson@mail.utoronto.ca

Lab 1 involves the extraction and analysis of dust samples that students bring to the lab for a suite of six organophosphate flame retardants. This lab provides students with extensive experience in the quality control protocols that are required to ensure data quality and how to present and discuss this type of analytical data.

Lab 3: Analysis of Perfluoroalkyl Acids in Lake Niapenco

Lead TA: Holly Barrett, holly.barrett@mail.utoronto.ca

Lab 3 involves a field trip for the collection of water, sediment and biological (fish, shrimp, snails, bugs...) samples, with subsequent matrix-specific extraction and analysis for four perfluoroalkyl acids (PFAAs). Outside of the practical aspects, this lab provides students with an opportunity to synthesize data from a range of PFAAs in a wide range of sample matrices within the same ecosystem.

Lab 4: NMR as a Tool for Quality Control in the Food Industry

Lead TA: Jeremy Gauthier, jeremy.gauthier@mail.utoronto.ca

Lab 4 involves the analysis of honey using nuclear magnetic resonance spectrometry. Using your generated spectra, you will identify and quantify the sugars present and then compare your entire spectra to previous samples using principle component analysis (PCA) to try to identify honey from different regions or samples that may be adulterated.

Lab 5: Suspect Screening of in High-Resolution Mass Spectral Data

Lead TA: Steven Kutarna, steven.kutarna@mail.utoronto.ca

Lab 5 will walk you through the identification of chemicals in high-resolution mass spectral data from an extracted dust sample. Following this exercise, lab groups will be assigned chemical classes and a set of samples for analysis.