CHM410-1410 Analytical Environmental Chemistry
Fall 2019

Schedule
Lecture: Tuesdays and Thursdays 4-5 Lash Miller 157
Lab: Friday 9:00-12:30 or 1:15-4:45 LM 9 (ANALEST)
Office Hours: TBD

Contact Information
Instructor: Prof. Hui Peng, hui.peng@utoronto.ca
Lab Coordinator: Shira Joudan, LM 318, shira.joudan@mail.utoronto.ca

Course Goals
The goals of CHM410-1410 are to introduce and apply concepts and techniques of sample collection, preparation, and analysis of trace level concentrations of organic environmental pollutants. This course seeks to produce analysts with a basic conceptual understanding of a broad range of modern analytical equipment 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.

Learning Objectives
Upon completing CHM410-1410 students will be able to design an environmental analysis starting with a literature search through experimental design and data analysis.

To complete this task student 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. Analyze, interpret, and effectively visualize analytical data.
4. Confidently ask for help or advice.

Discussion Topics
U1: Sample Preparation and Quality Control – These techniques ensure the concentrations we observe in the lab reflect the concentrations present in the environment.
U2: 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.
U3: Mass Spectrometry and Other Detectors – We will discuss the general process by which a compound creates a signal in a detector and discuss the workings of mass spectrometer and other detectors. Especially, we will discuss various processes to produce gas phase ions in mass spectrometry and how these processes are optimized for environmental applications.
U4: Mass Spectrometry Instrumentation and Scan Types – We will discuss the major types of mass spectrometers and their advantages/disadvantages in environmental chemical analysis. Scan types of mass spectrometers and their applications to different chemical analysis will be discussed.
U5: Identification of Unknown Compounds – Most of the term is dedicated to quantifying concentrations of known analytes, however environmental issues are complex and sometimes it's not clear which compounds are most important. In this unit we will explore techniques researchers use to identify compounds without *a priori* knowledge.
U6: Environmental Omics– We will discuss the chemistry and computation principles of proteomics, and their applications to environmental science research.

Lecture Schedule

September	5 R	Class Introduction
	10 T	Lab Format and Discussion
	12 R	U1: Chemical Partitioning
	17 T	U1: Sample Extraction and Cleanup
	19 R	U1: Quality Control
	24 T	U2: Introduction to Chromatography
	26 R	U2: Gas and Liquid Chromatography
October	1 T	Field Trip Discussion
	3 R	U3: Non-MS Detectors (UV and fluorescence)
	8 T	U3: Mass Spectrometer and Ionization
	10 R	U3: GC-MS Ionization Interfaces
	15 T	U3: GC-MS Fragmentation
	17 R	U3: LC-MS Ionization Interfaces
	22 T	Midterm Test
	24 R	U4: Mass Spectrometry Instrumentation I
	29 T	U4: Mass Spectrometry Instrumentation II
	31 R	U4: Mass Spectrometry Scan Types and Applications I
November	5 T	**Study Break**
	7 R	**Study Break**
	12 T	U4: Mass Spectrometry Scan Types and Applications II
	14 R	U5: Introduction to Nontargeted Chemical Analysis
	19 T	U5: Isotopes and Fragmentation Patterns
	21 R	U5: MS/MS fragmentation
	26 T	U6: Introduction to Environmental Omics
	28 R	U6: Proteomics and Applications
December	3 T	Review

Grading Scheme

Laboratory Grade			**50%**
Introductory Labs 1-3		**12%**	
(Labs: *Sept 13, 20, & 27*, Reports: *Due one week after the lab*)			
Lab 1 – Short report	2%		
Labs 2 and 3 – Full lab reports	2 x 5%		
Field Trip and Analysis	**10%**		
(Trip: *Fri Oct 4*, Lab Analysis: *Fri Oct 11 & 18*)			
Report outline (*Tues Oct 29*)	2%		
Report (*Tues Nov 12*)	8%		
Student-Directed Group Project		**28%**	
(Labs: *Oct 25, Nov 1, 15, & 22*)			
Proposal (*Thurs Oct 10*)	3%		
Preparation and participation	3%		
Final presentation and defense (*Fri Nov 29)*	10%		
Final report (*Tues Dec 3*)	10%		
Project reflection (*Tues Dec 3*)	2%		
Midterm (*Tues Oct 22 in class*)			**15%**
Final Exam			**35%**

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 CHM410-1410. 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 testing will only include the specific material discussed in class.

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. Relevant sections will be provided for review throughout the term. 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 of these textbooks are available from the University of Toronto libraries.

Academic Integrity

While peer discussions are encouraged, laboratory 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

Accommodations

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

Report Submissions

Students will submit reports online and in person, unless otherwise specified.

Normally, students will be required to submit their course essays to Turnitin.com for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays 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.

Late Materials

Unless otherwise explicitly stated, lab reports are due the following week at the beginning of the lab period. Anything handed in late will be docked 10% per day including the weekend. If the material is completed over the weekend it should be submitted through Quercus (or emailed to Shira Joudan or the relevant TA) and a hardcopy delivered at the beginning of the work week.

Arriving late to the lab

At the beginning of the lab (either 9 am sharp or 1:15 pm sharp) the TAs give an overview and instruction for the day's task. If you are 30 minutes late or more to the lab without an appropriate reason you will not be able to complete the experiment that day and will not be able to write a lab report. Ultimately, this is at the discretion of the lab instructor.

Absences

Students who miss labs or tests for legitimate reasons should contact Shira Joudan as soon as possible, and no later than one week after returning to class. 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

Lab Schedule Date

Date	**Lab 1** ***NMR as a Tool for Quality Control in the Food Industry***		**Lab 2** ***Markers of Polluted Air***		**Lab 3** ***Analysis of Organophosphate Flame Retardants in Dust***	
	9:00-12:30	**1:15-4:45**	**9:00-12:30**	**1:15-4:45**	**9:00-12:30**	**1:15-4:45**
Sept 13	A	D	B	E	C	F
Sept 20	C	F	A	D	B	E
Sept 27	B	E	C	F	A	D
Oct 4	**Field Sampling at Lake Niapenco near Hamilton** All groups working together					
Oct 11 **Oct 18**	**Water, Sediment, and Invertebrate Analysis** All groups working together					
Oct 25 **Nov 1**	**Student-Driven Group Projects** All groups working on separate projects					
Nov 8	***Study Break***					
Nov 15 **Nov 22**	**Student-Driven Group Projects** All groups working on separate projects					
Nov 29	Group Presentations and Defense					