CIV ENV 365: Environmental Laboratory (Winter 2020)

Syllabus

January 8, 2020

Tuesday 1:00–6:00 pm in Tech Room A147/A151
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Website: CANVAS

Abstract: Analytical methods for environmental engineers. Laboratory methods and interpretation of results for the chemical analyses of water samples.

1 Course Objectives

In this laboratory class you will work with a laboratory partner to perform a complete analysis of 3 water samples. You will then interpret the results of these analyses using the concept and the tools that you have learnt in Chemical Processes in Aquatic Systems: CIV ENV 367. Specific objectives are:

1. to learn basic chemistry laboratory skills used by environmental engineers for assessing the chemical quality of a water sample
2. to learn how determine concentrations of key chemical species
3. to be able to plan and conduct and experiment
4. to be able to effectively report, analyze and interpret laboratory results

2 Textbooks

- **Reading**: **Analytical Chemistry 2.1** by David Harvey (2016)
  It is an e-book, that is made available by the author after being printed for a few years by a publisher. It is a great resource, please download your copy from Canvas, you will find it in the first module. For each of the experiments, reference will be made to various chapters of this book.
- **Additional Recommended Readings**: In addition, a few books will be made available in the teaching lab, such as:
  1. **Analytical Chemistry** (2004) – A Modern Approach to Analytical Science - edited by: R. Kellner, J.-M. Mermet, M. Otto, M. Valcrcel, and H. M. Widmer, publisher Wiley-VCH. (note: a very complete treatment of analytical methods, a must have if you go in this field).
  2. **Principles of Instrumental Analysis** (1998 - Fifth Edition) by D.A. Skoog, F.J. Holler, and T.A. Nieman, publisher Saunders College Publishing. *(note: a more advanced text that builds upon the foundation of the text above, in particular it provides detailed information about electronic components entering the design of instrumentation).*

3 Prerequisites

- Chemical Processes in Aquatic Systems: CIV ENV 367
- Computer Programming/Use: Understanding how to use ChemEql, basic knowledge of Python and the Jupyter notebook to write reports.

4 Grading

Final Grade = Laboratory reports (60%) + Final report (30%) + Lab book (10%)

5 Additional Information

- **Computer Use:** Most of the calculations for preparing reports as Jupyter Notebook need to be performed in Python. Examples will be provided on CANVAs and are also present in the textbook using either Excel or R.
- **Class Participation:** Attendance to all the experiments is required as it is laboratory work performed with a partner.

6 Weekly Schedule & List of Experiments

A set of 7 experiments will be performed during the duration of the quarter. The first week of class will consist in an introduction to the instrumentation used and then the experiments will be conducted in parallel by all the groups. In the first week of class, buffer solutions for pH measurements will be prepared - see experiment #1. These solutions will then be uses whenever need be. The next 7 experiments will be performed each week on a rotation basis that will be established in the first week of classes. The last week(s) of the quarter will be devoted to completion of the group analyses and supplemental class experiments that we are implementing this year: metals by ICP-MS and antibacterial agents by HPLC. The interpretation of the analytical results will lead to performing chemical speciation calculations using the methods and tools that were developed in CIV ENV 367: Chemical Processes in Aquatic Systems.

1. **Week #1: pH**: Introduction to instrumentation and course material, preparation of NBS buffer solutions.
2. **Following Weeks**:
   (a) **Alkalinity and determination of** $\mathrm{pK_a}$: Computerized titration method.
   (b) **Hardness, TOTCa & TOTMg**: Flame Atomic Absorption Spectroscopy – FAAS – and EDTA titration
   (c) **TOTNa, TOTK, and TOTLi** : by Flame Atomic Emission Spectroscopy – FAES –
   (d) **Major and Minor Anions**: Ion Chromatography – IC –
   (e) **Dissolved Organic Carbon**: Measurement of DOC by high temperature catalytic oxidation
   (f) **Trace metal analysis**: Analysis of dissolved Cu by Graphite Furnace Atomic Absorption Spectroscopy using Zeeman background correction – ZGFAAS –
   (g) **Nutrients**: $\mathrm{TOTPO_4}$ and $\mathrm{TOTSiO_2}$: Spectrophotometric methods: Soluble Reactive Phosphorus, and Dissolved Silica
3. **Weeks 9 and 10**: Completion of analyses missed, and short presentation of additional methods to determine chemicals in aquatic systems.

The last 2 weeks of the class will be dedicated to:

(a) Redoing analyses that you may have had problems with, *i.e.*, analyses that you think are not accurate or have poor precision, and

(b) Discussing the analytical results and their interpretation during the last week of class and finals' week.

You will have to interpret your analytical results by performing speciation calculations using the skills that you have developed in CIV ENV 367 and characterize the different waters that you have analyzed, *i.e.*, provide a potential source for the water samples based on their chemistry.