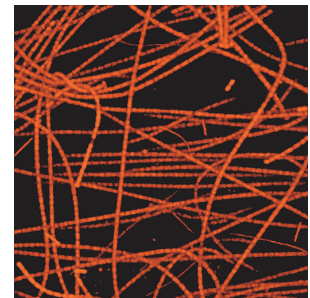
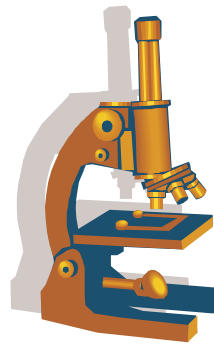
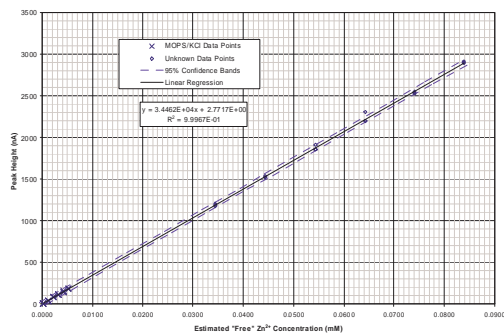
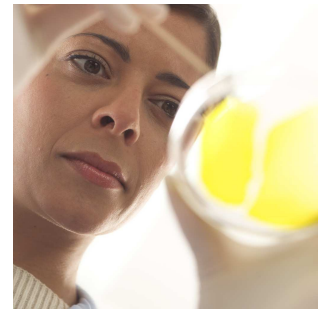
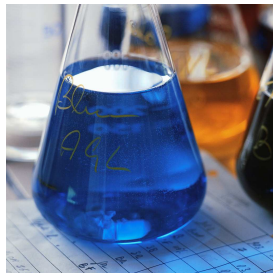


CEE - 365 ENVIRONMENTAL LABORATORY (Winter 2009)



INSTRUCTORS

Jean-François Gaillard (jf-gaillard@northwestern.edu) Office: A324

Neal Blair (n-blair@northwestern.edu) Office: A 228

Luciana Zanella (l-zanella@northwestern.edu) Office A225

Office hours: by appointment

BRIEF OUTLINE

This laboratory course will provide students with hands on experience in chemical analysis for assessing water quality issues. This year we have designed these experiments around ways of ***probing carbon in the environment***. This laboratory class will be divided in 2 modules. In the first module, basic techniques and instrumentation associated with the environmental laboratory workplace will be reviewed. Laboratory work includes the measurement of major and minor elements and species present in freshwater systems. The student will learn how to calibrate instruments as well as to use basic statistical methods to interpret experimental data. The theory and practical applications of a variety of standard laboratory methods and instrumentation will also be examined. In the second module, students will use the techniques that they have learnt to master to follow the chemical evolution of an environmental sample but studying chemical changes related to the decomposition of organic matter.

The primary objective of this laboratory class is to survey a suite of basic analytical methods used by environmental laboratory as well as some engineering practices and cast a critical eye on their usage – stressing for example their limitations and their domain of application.

One of the most important concepts that students should realize during this course is that a measurement provided without an estimate of its uncertainty is essentially useless. Say for example, you obtain an average value of 1.563 from a particular instrument/experiment but the 95% confidence interval is ± 2.0 . Obviously, this result must be regarded with suspicion and the causes for such a large confidence interval have to be investigated.

COURSE OBJECTIVES

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

THE COURSE OBJECTIVES WILL SATISFY THE CEE UNDERGRADUATE PROGRAM OUTCOMES, AS LISTED BY ABET (A-K BELOW):

Students will attain the following outcomes through objectives listed in brackets:

- a. an ability to apply knowledge of mathematics, science, and engineering (including biological and chemical science)
- b. an ability to design and conduct experiments as well as to analyze and interpret data in one focus area (water)
- f. an understanding of professional and ethical responsibility

- g.** an ability to communicate effectively
- i.** a recognition of the need for, and an ability to engage in life-long learning
- k.** an ability to use the techniques, skills, and modern scientific tools necessary for engineering practice, including concepts of professional practice

RECOMMENDED READINGS

There is no required book for this class. Some books will be accessible in the Laboratory class during the quarter. In addition, it is strongly suggested to get to the Library and read passages in analytical chemistry books that are related to the methods rather than simply gathering “stuff” from the web. Material will also be placed on CMS.

Some excellent analytical references:

Analytical Chemistry (2004) – *A Modern Approach to Analytical Science* - edited by: R. Kellner, J.-M. Mermet, M. Otto, M. Valcárcel, and H. M. Widmer, publisher Wiley-VCH. (note: a very complete treatment of analytical methods, a must have if you go in this field)

Fundamentals of Analytical Chemistry by Skoog, West and Holler, publisher Saunders College Publishing. (note: an excellent introductory text that has been a standard reference for many years)

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).

LIST OF THE FIRST 4 EXPERIMENTS

- Determination of pH, preparing buffer solutions.
- Exp #1: Titration method: The determination of titration alkalinity: Alkt
- Exp #2: Spectrophotometric Method: Soluble Reactive Phosphorus and Ammonium by Colorimetric Methods
- Exp #3: The measurement of dissolved O₂ and the determination of a thermodynamic
- Exp #4: The determination of hardness, Ca by Flame Atomic Absorption Spectroscopy and Dissolved Organic Carbon (DOC)

LABORATORY SAFETY

Safety issues will be addressed in the first week, and covered at the beginning of each laboratory experiment. There will be a safety quiz to test your knowledge of these rules – it is now a standard procedure that laboratory experimenters pass safety quizzes prior to granting them access to a laboratory environment. In addition to observing general laboratory safety practices (hand out), please pay special attention to the following issues:

- Wear lab coats at all times. If you need to leave the lab, leave your lab coat in the lab.
- Wear safety glasses at all times!
- Wear protective gloves when required. Note: latex gloves protect you against aqueous solutions but not against solutions containing organic solvents. Note: if you are allergic against latex, use nitrile gloves.
- Never wear shorts or open toes shoes in the laboratory.
- Tie back loose, long hair
- Remove gloves prior to leaving the laboratory.
- Eating and drinking are absolutely prohibited in the laboratory.
- All biologically contaminated objects (plates, pipette tips, centrifuge tubes, etc) are to be discarded in special biohazard bags and autoclaved.
- If you spill a culture, immediately cover it with paper towels and saturate them with disinfectant. After 15 minutes of contact, removes contaminated material (wear gloves) and place it into a red biohazard autoclave bag.
- For microbiology experiments, wipe bench tops with a 70% ethanol solution before and after your experiment.
- Keep ethanol and other solvents away from open flame sources.
- Wash your hands before leaving the laboratory.
- Report all accidents (cuts, burns, etc.), even if they seem minor!
- Dispose of all wastes in the appropriate manner. If you don't know, please ask the laboratory assistants.
- Never dispose of glass objects in the regular garbage can. There are special receptacles for glass located in the lab – use these for disposing of glass.
- Get into the habit of labeling all containers containing samples or chemicals.
- Be aware of the locations of: safety showers, fire extinguishers, exit, fume hoods, eye fountains, source of running water and first aid kit.
- Treat all samples and chemicals with caution.
- Always add concentrated acids and bases slowly to water; never add water to concentrated acids or bases.
- Use a pipette bulb to transfer reagents by pipette; never use your mouth!
- Keep the laboratory neat and clean at all times. Keep unnecessary materials away from your work area, including coats and personal belongings.

ORGANIZATION

Students will work with two lab partners. The class will then be divided in 4 groups and the groups will perform each week a different experiment. The first day of class will be devoted to the preparation of pH Buffer solution that will be used for the following experiments. For the first 4 weeks after the first week, students' groups will rotate through the 4 experiments listed above.

STRUCTURE OF LAB REPORTS

The structure of the laboratory report may vary depending upon the type of experiment performed. However, it must contain all basic information such as: title, date, objective(s), materials and methods, expected results, actual results, discussion, conclusions. An outline is provided below.

EVALUATION

- Each student needs to keep a written record of the experiments in a laboratory book. Lab books will be periodically evaluated and collected at the end of the quarter.
- Each group needs to write a laboratory report of the experiment performed during the week. This Laboratory report is due before the beginning of the next laboratory experiment. Some questions will be given for each experiment and answers are to be incorporated within the discussion section of each lab report.

GRADING

- Laboratory reports: 60%
- Final report: 20%
- Lab book: 20%

LABORATORY REPORTS

Lab write-ups will be due at the beginning of next lab class, one week after the lab. These reports should be concise and well organized. You are encouraged to work closely with your lab partner. **REPORTS MUST BE TYPED.**

Chemistry lab reports outline:

1. Introduction

Brief explanation of the purpose and relevance of the lab.

2. Instrumentation

Theoretical description of the method and instrumentation including a schematic diagram of the instrument and instrumental setup – if need be.

3. Methods

Brief summary of the steps taken during the experiment including calibration procedure, sample preparation and any steps taken to prevent interferences.

4. Results

Tabulated data obtained for standards and samples

Calibration curve

Statistical assessment of the slope and intercept

Tabulated results in the form:

Concentration = X.XX +/- X.XX units

EACH GRAPH SHOULD OCCUPY A WHOLE PAGE.

5. Discussion

Assess your results, address additional questions raised by the instructor, discuss any difficulties encountered and include pertinent remarks about the method used.

6. References

THE LABORATORY NOTEBOOK

All students **must** purchase a standard laboratory notebook and bring it to each and every lab period beginning the second week of class. The notebook should be *permanently bound* and *each page numbered*. Typically, the pages are made of graph paper to assist in plotting your data. If the pages are not pre-numbered, you should number them by hand in ballpoint ink. The purpose of numbering the pages is to discourage removal of data from the lab notebook. Since lab notebooks can be used to document the originality of your work, missing pages are cause for suspicion.

At the end of the quarter, you will turn in your lab notebook for review. Don't be nervous about this, we just want to make sure that you understand the basic idea of maintaining a laboratory notebook. This skill will be invaluable to you in all future research.

We've included the following guidance to help you use your lab notebook effectively:

1. Leave the first few pages blank to use as a table of contents.
2. Use an ink pen, preferably ballpoint. Never use pencil!
3. Use only one side of the notebook to record information during lab, e.g., only right hand pages. This leaves room for comments and calculations to be performed later.
4. Write the date and experiment title at the top of each page.
5. Get into the habit of writing all pertinent information into your notebook as you go along. It's impossible to put too much information into your notebook. The following are items to include in your notebook:
 - each step taken during the experiment
 - experimental results
 - calculations (including an example calculation)
 - plots (e.g. pH vs. volume)
 - calibration curves
 - observations about the experiment
 - problems encountered during the experimentTape computer-generated results into your notebook to save the time it would take to manually enter them into your notebook.
6. Never record lab data on scraps of paper, Murphy's Law will inevitably prevail and you will lose the scraps just before you were going to enter the data into your notebook. Start good habits now.
7. Never erase or obliterate results. Simply draw a line through the undesired information such that it is still legible. Obliterated results in a lab notebook achieve the same result as missing pages: suspicion. Furthermore, you never know what information you may need later.