

CIV ENG 367: Aquatic Chemistry (Fall 2009)

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MoWeFr 10:00-10:50 in Tech Room M152

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Discussion: Th 11:00-12:30 in Tech Room M152

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Website: Course Management System

Abstract: The distribution and the cycling of chemical elements and their compounds in the environment are controlled by biotic (biological) and abiotic (chemical) processes. The purpose of this course is to introduce you to the theoretical framework needed for understanding the chemical composition and predicting chemical processes in natural waters, soil solutions, and waste waters using a chemical equilibrium approach. At the end of this class you should understand how abiotic and biotic processes interact to control the biogeochemical cycles of elements in aquatic systems.

1 Course Objective

This course presents a general conceptual framework – the tableau method – that is used for solving complex chemical equilibrium problems in aquatic environments. This method is then applied to natural as well as engineered aquatic systems.

2 Course Outcomes

Upon completion of this course students will be able to:

- Understand the tableau method for solving equilibrium problems.
- Use a computer program to find the solution of chemical equilibrium problems.
- Derive and use chemical thermodynamics laws & principles to determine how equilibrium properties vary with T and P.
- Determine the pH of a wide variety of complex, *i.e.*, multiple acid/base species, aqueous solutions and understand in details the carbonate system.
- Compute the chemical speciation of metals in complex aqueous systems.
- Determine the composition of natural waters at equilibrium with various mineral phases.

For the engineering student, the course primarily supports the following ABET program outcome criteria:

(a) An ability to apply knowledge of Chemistry.

In addition it provides some support to address:

- (e) An ability to identify, formulate, and solve engineering problems.
- (h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and social context.
- (j) A knowledge of contemporary issues.
- (k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice, including concepts of professional practice.

3 Textbooks

- Principles and Applications of Aquatic Chemistry: François M.M. Morel & Janet G. Hering, Wiley, 1993.
- Supplemental Reading: Werner Stumm and James Morgan, 3rd Edition, John Wiley and Sons, NY, 1996 (recommended additional text for graduate students)

4 Prerequisites

- Basic Chemistry: CHEM 101, 102, & 103 or equivalent.
- Thermodynamics: CHEM-341 or equivalent.
- Computer Programming/Use: may be helpful for some of the exercises. We will use a computer program available on the net: ChemEq1 that does not require any programming background.

5 Grading

Final Grade = Homework (40%) + Midterm (20%) + Project (20%) + Final (20%)

- Homework (40%): 8 problem sets as per class schedule, assigned on Fridays. Completed problem sets are due in class, just before class starts, on the following Friday (seven days later). You may work with other class members for the purpose of solving the homework problems. However, you are responsible for generating your own solutions for grading. Please do not be late handing out your weekly homework.
- Midterm (20%): Take home handed out at end of class on 10/30, due beginning of class 11/06.
- Final (20%): Take home handed out at the end of class on 12/04, due by 11:00 a.m. on Wednesday 12/09.
- Project (20%): A group project consisting in the chemical investigation of an environmental problem that affects aquatic systems. Groups of 2 students will present in 10 minutes, on the final week of class, the results of their investigations. These investigations have to focus on the application of aquatic chemistry principles to the understanding of environmental issues. Some past examples: As in groundwater; the role of the Ocean in controlling atmospheric CO₂; Pb contamination of soils.... You can select your own topic after approval by the instructor. Please send me your final group presentation on Wednesday 11/25.

6 Additional Information

- **Computer Use:** Students are encouraged to use standard computational programs (i.e., MATLAB or equivalent) to perform some of the homework assignments. In addition, we will use a computer program that is based on the approach used in the book and that will be used in class: ChemEq1 (please download this program with its manual from the EAWAG website, instructions will be given in class).

- **Class Participation:** It is important that you ask questions in class to clarify the concepts discussed, and also the potential problems that you have with the material. The last 5-10 minutes of class time will be reserved for questions. All students are expected to be present (attendance) and participate in all lectures and recitations.

7 Weekly Schedule

The following schedule is subject to change.

Lecture	Topics/Sections	Reading
Week 1	Introduction, Conservation Principles	Chapter #1
Week 2	Chemical Equilibrium, Short review of Thermodynamics	Chapter #2
Week 3	Chemical Equilibrium, Solution Methods	Chapter #2
Week 4	Acids & Bases, Alkalinity	Chapter #4
Week 5	The pH of Natural Waters: The Carbonate System	Chapter #4
Week 6	Dissolution & Precipitation	Chapter #5
Week 7	Complexation Reactions	Chapter #6
Week 8	Oxidation & Reduction	Chapter #7
Week 9	Surface Complexation	Chapter #8
Week 10	Surface Complexation & Recapitulation	Chapter #8
Week 11	Students' presentations	
Week 12	Final is due on December 9	