SPEA E539 **Aquatic Chemistry** **Spring 2004**

http://www.spea.indiana.edu/whitej/E539

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Suggested Prerequisite: College-level general chemistry (2 semesters) or permission of the instructor.

Course Description

This course will emphasize applications of principles of chemistry to the description of processes affecting the distribution and cycling of chemical compounds in surface waters, and their analysis. In addition, these principles will be applied to understanding treatment systems used to remove pollutants from water. Thermodynamic equilibrium modeling will be used as a tool to assist students in learning about the aqueous chemistry of natural and engineered systems, and will provide a framework for understanding common methods of water quality analysis.

Course Objective

I hope to provide some of the fundamental skills necessary for, 1) analysis and interpretation of water quality data, 2) graduate-level research in the area of water quality, 3) basic expertise in the chemistry of pollution control systems. Inorganic chemical species will be emphasized.

Recommended Text

Stumm, W. and J.J. Morgan. 1996. Aquatic Chemistry, 3rd ed. Wiley Interscience, New York.

Useful Reference Texts

Butler, J.N. 1998. Ionic Equilibrium: Solubility and pH Calculations. Wiley Interscience, New York.

Morel, F.M.M. and J.G. Hering. 1993. Principles and Applications of Aquatic Chemistry. Wiley Interscience, New York.

Pankow, James F. 1991. Aquatic Chemistry Concepts. Lewis Publishers, Inc., Chelsea, MI.

Stumm, W. (Editor). 1990. Aquatic Chemical Kinetics. Wiley Interscience, New York.

Drever, James I. 1988. The Geochemistry of Natural Waters, 2nd ed. Prentice-Hall, Englewood Cliffs, New Jersey.

Butler, J.N. 1982. Carbon Dioxide Equilibria and Their Applications. Addison-Wesley, Reading, Massachusetts.

Benefield, L. et al., 1982. Process Chemistry for Water and Wastewater Treatment, Prentice-Hall, Englewood Cliffs, New Jersey.

Topical Outline

I. Review of Conservation Principles and Chemical Thermodynamics
   A. Mole balance equations
   B. Chemical reactions and equilibria
   C. Equations for systems of variable composition
   D. Influence of temperature and ionic strength on chemical equilibria

II. Acid-Base Chemistry
   A. Equilibrium descriptions of acids and bases
   B. Graphical solutions to acid-base problems
   C. Analysis and interpretation of acidity, alkalinity, pH, and buffer intensity
   D. Equilibrium descriptions of important buffer systems in surface waters and pollution control systems
   E. Solving problems in the acid-base chemistry of surface waters and pollution control systems.

III. Precipitation-Dissolution Chemistry
   A. Solubility of oxides, hydroxides and carbonates
   B. Graphic solutions to solubility problems
   C. Applications of precipitation-dissolution chemistry to water treatment engineering and surface water quality.

IV. Oxidation-Reduction Chemistry
   A. Redox equilibria and electron activity
   B. Redox conditions in surface waters
   C. Redox conditions in engineered systems
   D. The kinetics of redox equilibria in surface waters
   E. Graphic solutions to redox problems in surface waters and engineered systems

V. Trace Metal Ions in Natural Waters
   A. Coordination chemistry of metal ions
   B. Graphic solutions to metal solubility problems
   C. Organic complexation of trace metals
   D. Metal binding in natural waters and pollution control systems

VI. Solid-Solution Chemistry (tentative)
   A. Surface chemistry of oxides and natural colloids
   B. Coagulation chemistry in natural waters
   C. Coagulation chemistry in water treatment systems

Course Mechanics

Lecture:

- T, Th 1:00-2:15 p.m.
- Present lecture material, discuss problems
- Demonstrate and use *MINEQL*$^+$ modeling program

Problem Sets:

Homework problems are designed to reinforce important concepts and to provide an opportunity for students to improve problem-solving skills. You will generally have one week to work on the problems individually or in groups, after which time an answer key will be posted to the course web page (*http://www.spea.indiana.edu/whitej/E539*).

Modeling Work:

The computer model *MINEQL*$^+$ will be used to supplement the solving of most problems. The *MINEQL*$^+$ program is public domain software and will be available to all students in the class for free.

Exams: (take-home, one week each, tentative dates of distribution noted below)

Exam I – February 26 - 50%
Exam II – April 27 - 50%