Objective: Water constitutes a major part of the environment, to which all biological systems and cycles of elements are tied. In accordance to its contents, this course can also be titled "Aquatic Chemistry." The objective of this course is to present chemical principles that are important in aquatic environments, and to treat quantitatively the variables that govern the composition of natural waters. Students will be encouraged to use principles developed in this class to analyze and find application in groundwater and soil remediation. The topics to be presented will follow those divisions by Stumm and Morgan. An important goal is to develop the tools and considerations necessary for tackling environmental problems involving natural waters. Analytical skills using microcomputer software for quantitative description of kinetic and equilibrium processes will also be developed.

Topics: 1. Energetics and Kinetics
   - Kinetics
   - Basic Reactors
   - Laws of Thermodynamics
   - Spontaneous and Reversible Processes
   - Chemical Equilibrium

2. Acid and Bases
   - pH, p\text{H}, activity coefficients
   - Equilibrium Speciation
   - Ionization Fractions
   - Buffer Intensity and Neutralizing Capacity

3. Dissolved Carbon Dioxide
   - Dissolved Carbon Dioxide Equilibria; Open/Closed System
   - Alkalinity, Acidity, Total Dissolved Carbonic Species

4. Precipitation and Dissolution
   - Solubility of Oxides and Hydroxides
   - Stability of Hydroxides, Carbonates, Hydroxy-Carbonates
   - Solubility of Sulfides and Phosphates
   - Coexistence of Phases in Equilibrium

5. Coordination Chemistry
   - Stability of Hydrolysis Species
   - Metal Ions and Ligands
   - Complex Formation and Solubility Solids
   - Chelation Chemistry
6. Oxidation and Reduction
   Redox Equilibrium and Electron Activity
   Electrode Potential; Peters-Nernst Equation
   pe-pH Diagrams

7. Solid-Solution Interface
   Forces at Interfaces
   Electric Double Layer
   Surface Chemistry of Oxide, Hydroxide, and Oxide Minerals

Course Requirements. Homework assignments will be given throughout the semester. You are to submit the homework on time for full credit or request any needed extension in advance. There will be 2 midterms and 1 final. For your term project, you are also required to choose a topic related to concepts developed in this class, and at the end of the semester you will orally present this term project in class. An article (or more) on a timely problem is to be selected from the literature that is relevant to at least one of the topics introduced in this class. You are encouraged to select from current environmental issues, and to analyze it with the tools developed in this class.

Grade: Homework (10%), Examinations (40% midterms + 35% final), Project and Presentation (15%).

Tentative Schedule:

<table>
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<tr>
<th>Weeks</th>
<th>Topics</th>
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| 1-3   | Introduction, reaction kinetics  
|       | Reaction kinetics, reactors/design  
|       | Reactors, spontaneous/reversible processes |
| 4     | pH, p^H, activity coefficients  
|       | Ionization fractions, equilibrium speciation  
|       | Equilibrium pH computation |

Midterm I on Topics 1 & 2

5     Dissolved carbon dioxide system, open/closed Systems  
      Alkalinity, acidity, buffer capacity
6-8   Precipitation and dissolution of natural solids  
      Solubility of hydroxide, oxide, carbonate  
      Equilibrium species computation  
      Equilibrium Computations with MINEQL Computer Program

Midterm II on Topics 3 & 4

9-10  Stability of Hydrolysis Species  
      Metal Ions and Ligands  
      Complex Formation and Solubility Solids  
      Chelation Chemistry

11     Spring Break

12-13 Redox Equilibrium and Electron Activity  
      Electrode Potential; Peters-Nernst Equation  
      pe-pH Diagrams
14     Forces at Interfaces  
      Electric Double Layer  
      Surface Chemistry of Oxide, Hydroxide, and Oxide Minerals
15     Special Project/Topic Presentations

Comprehensive Final Exam: May 2.