Spring 2020

ENE 663-002: Water Chemistry

Lucia Rodriguez-Freire

ENE 663 Water Chemistry – Spring 2020
Section: 002

INSTRUCTOR: Dr. Lucia Rodriguez-Freire
Colton 266
lrfreire@njit.edu
973-596-2448

CLASS MEETING: Thursday**,** 6:00 – 8:50 pm
Faculty Memorial Hall 106

OFFICE HOURS: Wednesdays 12 – 2 pm
Thursdays 4 – 5 pm
Also available by appointment

Prerequisite: undergraduate general chemistry. The ability to analyze and solve a wide range of chemical equilibrium problems in water chemistry is developed.

Description: The course provides a comprehensive survey to aqueous-phase equilibria impacting the water quality in natural waters, and water distribution and treatment facilities. We will work to understand the acid-base and metal-ligand equilibria, oxidation-reduction reactions and chemical reaction thermodynamics. There is some emphasis on equilibria governing inter-phase (gas-liquid, solid-liquid) chemical distribution. Mathematical approaches to prediction of equilibrium chemical speciation are stressed.

Course Objectives and Student Learning Outcomes:

1) Students will understand with the equilibrium reactions in close and open systems, the interaction between different phases (liquid, gas and solid), and the reduction-oxidation reactions in environmental systems.
2) Students will learn to predict the chemical composition, pH and redox condition of an aquatic system
3) Students will develop the tools to solve problems with complex chemical reactions in natural and engineer systems

REQUIRED TEXT:

- Water Chemistry, 1st Edition,
  Mark Benjamin, Waveland Press, Inc., 2010.

Supplemental Texts:

- Water Chemistry,
  Vernon L. Snoeyink and David Jenkins, John Wiley & Sons, 1980.
- Aquatic Chemistry, 3rd Edition
  Werner Stumm and James J. Morgan, Wiley-Interscience, 1996.

REQUIRED SOFTWARE:

- MINEQL Software. Available at the Computer Lab in Colton Hall.

POLICIES AND PROCEDURES:
Lectures:

- It's important that you read the assignment (text and/or notes) prior to class. We will try to spend class time summarizing important points from the readings, working examples, and getting practice with quizzes.
- It is required that students attend class. Information will be provided that will be critical to student performance
- Please be on time for lectures, turn off your cell phone and refrain from talking in class, arriving late, leaving class in the middle of a lecture or doing any other activity that could be disruptive to the class.

Homeworks will be due at the beginning of the class period on the date specified by the instructor. You are strongly encouraged to work in groups and to consult with the instructor if questions arise for homework assignments. Everyone in the study-group must read and sign the homework before submission.

Exams are open-book and open-note and they can cover any material presented in the class. Missed exams may not be made up except for special circumstances such as for health reasons, the instructor must be notified of an absence prior to the exam.

NJIT Honor Code *Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at:*

http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. ***Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university.*** *If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu*

GRADING:

- Homework (25%)
- Class Project (20%)
- Midterm Exam (25%)
- Final Exam (25%)
- Participation (5%)

Students need to have a grade in every section to obtain a final grade in the class. Students are required to submit all homework assignments, work in a class project, and

complete all exams. Any extenuating circumstances that might prevent the student to complete a task must be discussed with the instructor prior to the deadline.

The following percentages are guarantee to receive at least the indicated grade:

- A: 90-100%
- B+: 85-89.99%
- B: 80-84.99%
- C+: 75-79.99%
- C: 70-74.99%
- F: < 70%

The grade of Incomplete ("**I**") may be given in rare instances where a student, and for documented (by the Dean of Students) reasons, could not complete parts of the work of the course.

Tentative Course Schedule:

Class Date	Topics	Student Learning Outcomes	Reading
Jan. 23	Introduction, General Chemistry Concepts. Chemical Reactivity	1. Define water chemistry and recognize its importance in environmental systems 2. Describe water and its main properties 3. Calculate concentration in different media/systems	Chapter 1 Chapter 2
Jan. 30	Reaction Kinetics and Equilibrium	1. Balance chemical reactions 2. Quantify reaction rates 3. Define chemical equilibrium	Chapter 2
Feb. 6	Introduction to Acid and Base Chemistry	1. Distinguish between an acid and a base 2. Define water dissociation 3. Know acidity and basicity constant 4. Define and calculate pH	Chapter 3
Feb. 13	Graphical and Numerical Solutions for Acid Base Chemistry 1 *Term paper: Title and objective due*	1. Solve numerical problems to calculate the pH of a solution 2. Estimate the speciation of a solution for a known pH 3. Draw log C-pH diagrams	Chapter 4
Feb. 20	Graphical Solutions for Acid Base Chemistry 2 Titration, Buffers and the Carbonate System 1	1. Solve problems using log C-pH diagrams 2. Identification of the predominant species in a solution 3. Solving problems using Proton Condition approach 4. What is a titration?	Chapter 4 Chapter 5
Feb. 27	Titration, Buffers, and the Carbonate System 2	1. Titration in buffer systems 2. Define alkalinity and understanding the importance in environmental systems 3. Solve problems for the carbonate system	Chapter 5
Mar. 5	**MINEQL laboratory** – In Computer Lab Colton Hall	1. Using the MINEQL software to solve common acid/base chemistry	Chapter 6

Mar. 13	**MIDTERM EXAM**		
Mar. 19	**SPRING BREAK**		
Mar. 26	Gas-Liquid Equilibrium *Term paper: First draft due*	1. Working with gas-phase concentration in an ideal gas 2. Using Henry's constant to predict partition between liquid-gas systems 3. Calculate the pH of a solution in an open systems 4. Log C – pH diagrams in open systems 5. Estimate the speciation of a solution in an open system	Chapter 7
Apr. 2	Chemistry of Metals in Aqueous Solutions: Precipitation Reactions	1. Define what a metal is 2. Identify the role of metals in acid-base chemistry 3. Describe metals behavior in water 4. Distinguish between the different dissociation constant for metal systems 5. Calculating metal speciation in water and with other ligands 6. Drawing predominant area diagrams	Chapter 8
Apr. 9	Chemistry of Metals in Aqueous Solutions: Precipitation Reactions	1. Describe the formation of solid in water systems 2. Use the solubility constant to predict the formation of a solid 3. Log C – pH diagrams in the presence of solids 4. Solving problems with solids in open systems	Chapter 8
Apr. 16	Chemical Thermodynamics Redox Chemistry 1	1. Define the Laws of Thermodynamics and their relation with water chemistry 2. Calculate the energy in chemical reactions – Gibbs Energy 3. Define equilibrium based on energy state of a reaction 4. Calculate the equilibrium constant of a chemical reaction 5. What are the oxidation states of atoms? 6. Calculate oxidation states of atoms 7. Balance redox reactions	Chapter 2 Chapter 9
Apr. 23	Redox Chemistry 2 *Term paper: Final draft due*	1. Define electron activity 2. Calculate the electron standard potential using the Nernst equation 3. Calculate the speciation of a solution using the Electron Condition 4. Describe oxidation and reduction of water 5. Solving problems using pe-pH diagrams	Chapter 9
Apr. 30	**Project presentations**		
May. 14	**Final Exam**		*Pending confirmation*

Outcomes Course Matrix- ENE 630 Water Chemistry

Strategies, Actions, Assignments	Assessment Measures	ABET Student Outcomes	Program Educational Objectives
Student Learning Outcome 1: Students will understand with the equilibrium reactions in close and open systems, the interaction between different phases (liquid, gas and solid), and the reduction-oxidation reactions in environmental systems.			
Students will learn and apply chemical concepts to natural water systems	Class and group discussion Homework and examination	2, 6	1,2
Students will learn the importance of water chemistry and the equilibrium processes between environmental compartments: water, air, soil	Class and group discussion Homework and examination Team project: Paper and presentation assessment rubrics	2-7	1,2
4) **Student Learning Outcome 2:** Students will learn to predict the chemical composition, pH and redox condition of an aquatic system			
Students will learn to formulate chemical reactions and formulate equilibrium reactions that define a water system	Class and group discussion Homework and examination	1,2,6	1
Students will use numerical and graphical solutions to solve water chemistry problems	Class and group discussion Homework and examination	1,2,6	1
5) **Student Learning Outcome 3:** Students will develop the tools to solve problems with complex chemical reactions in natural and engineer systems			
Students will learn to use a water chemistry simulator (MINEQL) software to solve complex numerical problems in natural and engineer systems	Class and group discussion Homework and examination	1,2,6,7	1
Students will apply numerical, graphical and software solution to understand a water chemistry problem impacting their daily life	Team project: Paper and presentation assessment rubrics	1-7	1,2

CEE Mission, Program Educational Objectives and Student Outcomes

The mission of the Department of Civil and Environmental Engineering is:

- to educate a diverse student body to be employed in the engineering profession
- to encourage research and scholarship among our faculty and students
- to promote service to the engineering profession and society

Our program educational objectives are reflected in the achievements of our recent alumni:

1 – Engineering Practice: Alumni will successfully engage in the practice of civil engineering within industry, government, and private practice, working toward sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.

2 – Professional Growth: Alumni will advance their skills through professional growth and development activities such as graduate study in engineering, research and development, professional registration and continuing education; some graduates will transition into other professional fields such as business and law through further education.

3 – Service: Alumni will perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, charitable giving and other humanitarian endeavors.

Our Student Outcomes are what students are expected to know and be able to do by the time of their graduation:

1. an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Revised: 2/13/18