CEE 680 - WATER CHEMISTRY
Spring Semester 2020

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| Course Description: | CEE 680: Water Chemistry. Credit 4. Chemical equilibrium principles of acids-bases, dissolution-precipitation, oxidation-reduction, and complexation are applied to understanding the chemistry of surface waters, groundwaters, and water and wastewater treatment. Prerequisite: Chm 112. |

Prerequisites by Topic:

1. Chem 112: Basic understanding of chemistry, chemical stoichiometry, and chemical reactions.

Schedule: MWF 8:00, W 10:10 eastern US time (UCT-05:00)

Textbook: Benjamin, Water Chemistry. 2nd Edition, Waveland Press, 2015. (Required)

References:

1. Langmiur, Aqueous Environmental Geochemistry, Prentice-Hall, 1997.
2. Pankow, Aquatic Chemistry Concepts. Lewis Publ., Chelsea, MI, 1991
3. Stumm & Morgan, Aquatic Chemistry. 3rd Ed., John Wiley & Sons., 1995
4. Jensen, A problem Solving Approach to Aquatic Chemistry, Wiley, 2003.
5. Sawyer, McCarty & Parkin, Chemistry for Environmental Engineering, McGraw Hill, 2003.
6. Eby, Principles of Environmental Geochemistry, Cengage Learning, 2016.

Instructor: David A. Reckhow, 16c Marston or 3rd floor Elab II, reckhow@umass.edu
office hours: MF 9:30-noon or as posted

Objectives:

1. To develop a theoretical basis for determining the composition of natural water and the behavior of chemical processes used in the treatment of waters and wastewaters including consideration of variables that affect the above systems;
2. To show how the principles can be applied to understanding the chemistry of natural waters and treatment systems;
3. To provide the student with the background necessary to use the current prevailing approach to water chemistry as presented by Stumm & Morgan, and many others.

Outcomes:

1. Ability to interpret and predict acid/base behavior, and metal-ligand complexation of natural waters and wastewaters.
2. Ability to interpret oxidation/reduction reactions and precipitation/dissolution of minerals and amorphous solids in waters, and predict equilibrium tendencies
3. Ability to solve problems in groups and present the solutions orally
4. Ability to use current software for solving water chemistry problems
5. Ability to understand and communicate new developments in water chemistry

Outcome Measures and Assessment:

1. Weekly homework problems on principles covered in class
2. Two 2-hr long exams of a comprehensive nature testing comprehension from homeworks, class lectures, and readings.
3. Miscellaneous computer assignments and review papers testing the student's ability to extend general course principles to other types of problems
4. In-class evaluation by oral participation and problem-solving.

Grading Criteria: (attendance is required)

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| Mid-term exam | 20% |
| Semester Project | 50% |
| Homework Assignments | 30% |
| | 100% |

| TOPICS: | Chapters in: Benjamin (required) | Stumm & Morgan (optional) | Pankow (optional) |
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| 1. Introduction (1.5 week)<br>Stoichiometry & Review<br>Thermodynamics: Chem. Equilibrium | 1 and 2 | 1 and 2 | 1 and 2 |
| 2. Acids and Bases (2.5 weeks)<br>Nature and Strength<br>Graphical Approach<br>Titration Curves<br>Buffers & Buffer Intensity | 3, 4, 5 & 6 | 3 | 3, 4, 5, 6, 7 & 8 |
| **EXAM** | | | |
| 3. Dissolved Carbon Dioxide (2 weeks)<br>Closed & Open Systems<br>Alkalinity, Acidity, $C_T$<br>Acid Precipitation Effects | 7 | 4 | 9 |
| 4. Coordination Chemistry (2 weeks)<br>Definitions<br>Complex Formation & Solubility<br>Chelates | 8 | 6 | 18 |
| **EXAM** | | | |
| 5. Precipitation and Dissolution (3 weeks)<br>Solubility of Oxides Hydroxides & Carbonates<br>Stability of Same<br>Activity Coefficients | 8 | 7 | 11, 12, 13 & 14 |
| 6. Oxidation and Reduction (2.5 weeks)<br>Redox Equilibria<br>pe-pH Diagrams<br>Redox Conditions in Natural Waters | 9 | 8 | 19 - 23 |
| **FINAL EXAM** | | | |

## CEE 680 Website:

http://www.ecs.umass.edu/cee/reckhow/courses/680/