CEE 2501
Environmental Engineering Chemistry

Course Objective

This course will cover foundational concepts in aqueous chemistry that are fundamental to processes in natural waters as well as wastewater quality management.

General Information

Professor Dr. Leanne M. Gilbertson
202 Benedum Hall
Office hours: Please e-mail to arrange a time
E-mail: LMG110@pitt.edu

Logistics Wednesday 5:30 – 8:00 pm
Benedum Hall, Room 158

Prerequisite CEE 1503 - Introduction to Environmental Engineering

Required Text "Principles and Applications of Aquatic Chemistry", Morel and Hering, 1993, Wiley & Sons; ISBN:0-471-54896-0

Additional Resources

Benjamin, M.M. *Water Chemistry*, McGraw-Hill, New York, NY, 2002

Stumm, W. and Morgan, J.J. *Aquatic Chemistry*, 2nd ed., Wiley Interscience, 1984

Any introductory chemistry textbook for fundamentals

Course Outcomes

The course is designed for students to develop an understanding of chemical fundamentals as applied to the description and evaluation of natural environments and environmental quality control systems. Quantitative techniques used in the evaluation of these areas are emphasized.

Upon completion of this course, students should be able to:

1. Apply the principles of chemistry to predict chemical changes in aqueous environments.
2. Describe the range of chemical composition and speciation that characterizes natural (*e.g.*, aquifers, lakes, rivers, oceans) and engineered (*e.g.*, water and wastewater treatment processes, manufacturing processes) aqueous systems.
3. Use numerical and graphical solution techniques to solve chemical equilibrium problems involving acids and bases, complexation, precipitation/dissolution, and oxidation/reduction.

4. Apply fundamental principles of aqueous chemistry to real-world problems involving natural and engineered aqueous systems. Students should be able to rigorously apply the course material to real data sets and use them as tools in their own research and/or careers.

Course Expectations and Academic Integrity

Performance Assessment: The problem sets, in-class problems, midterm, final, and term project are used to assess student progress and learning.

All students are expected to adhere to the standards of academic honesty. Any student engaged in cheating, plagiarism, or other acts of academic dishonesty would be subject to disciplinary action. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity http://www.provost.pitt.edu/info/ai1.html. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating the University Policy.

Problem sets are mandatory. They are instrumental in helping you grasp fundamental concepts and expose you to techniques and skills for applying these principles to real-life situations. Problem sets should be done in several sittings; you cannot expect to be successful doing homework quickly the night before it is due. Each student is required to submit an original assignment. However, working together in small groups (2-3) is acceptable as long it is a mutual learning experience for all involved. Direct copying of a peer's assignment is unacceptable, as is splitting up an assignment and exchanging solutions later. If you get stuck and cannot solve a given problem after putting in a reasonable effort, it is completely acceptable for another student who has solved the problem to teach you how to solve it; it is not acceptable to offer or accept a completed solution as a guide. I reserve the right to change this policy if I believe it is being abused.

In-class problems are also mandatory. These will be assigned and completed at the beginning of each class period. You will work with your colleagues to complete the assigned problem and each person must turn in an answer. These problems are intended to reinforce concepts from lecture, offer an opportunity to work with and learn from your colleagues, and provide a diverse learning environment that breaks up the 2.5-hour class time.

Students will complete a *term project* on a topic related to this course that incorporates and demonstrates mastery of key concepts through their application to a real-world environmental topic. Requirements for the project are contained and will be outlined in a separate handout.

Midterm and final examinations will be completed during the class meeting times as outlined in the syllabus. Examinations are not collaborative and will be completed independently. Cheating and dishonesty are not tolerated in any form.

Grading Scheme

Problem Sets and In-Class Problems	30 %
Term Project	35 %
Examinations (Midterm + Final)	35 %

Policy on Use of Laptops, Computers, Tablets and Cell Phones in Class

Occasionally you will be asked to use your electronic devices for in-class or group activities. At all other times, students *should not use their cell phones and other electronic devises* during class, unless it is an emergency. Browsing the internet, playing games, and texting friends during class is disrespectful to the instructor and distracts your classmates. Please discuss with Dr. Gilbertson if you wish to use your laptop or tablet for taking notes.

There is now scientific evidence that the use of cell phones and electronic devices is linked to decreased student performance; not only for the user but also their classmates. Check out the article in the Journal of Educational Psychology (https://www.tandfonline.com/doi/full/10.1080/01443410.2018.1489046) or the more digestible summary of the paper (https://phys.org/news/2018-07-students-grade-exams.html)

Standards for Written Work

- Engineers demonstrate their standard of professionalism primarily through the quality of written work; I expect you to do the same. Sloppy work, no matter how technically correct, is unprofessional and potentially dangerous, as it may be misinterpreted. You will suffer significant point reductions for sloppy work.
- I expect your homework submissions to be neat, thorough and logically organized. When you perform engineering calculations, you must explain your work such that an uninformed reader can follow precisely how and why you performed each step. Practicing engineers must maintain very high standards in the quality of their calculations because engineering calculations are *always* checked independently, by other engineers, as part of the design review process.
- Engineers communicate with drawings, tables and graphs. You must learn to supplement your engineering calculations with clear, concise sketches and graphs. Use this course as an opportunity to start developing this skill.

Lateness and Absence

Late homework assignments will not be accepted. Similarly, make-up exams will not be given unless PRIOR coordination is made with the professor or there is an official note from a physician explicitly stating why attending the scheduled test was impossible.

Diversity and Inclusion

I am dedicated to establishing an inclusive learning environment that values all students' experiences. Therefore, disrespectful and demeaning statements, attitudes, and behaviors based on age, ability, color/ethnicity/race, gender identity/expression, immigration status, marital/parental status, military/veteran's status, national origin, political affiliation, religious/spiritual beliefs, sex, sexual orientation, or socioeconomic status will not be tolerated.

In addition, The University of Pittsburgh does not tolerate any form of discrimination, harassment, or retaliation based on disability, race, color, religion, national origin, ancestry, genetic information, marital status, familial status, sex, age, sexual orientation, veteran status or gender identity or other factors as stated in the University's Title IX policy. The University is committed to taking prompt action to end a hostile environment that interferes with the University's mission. For more information about policies, procedures, and practices, see: http://diversity.pitt.edu/affirmative-action/policies-procedures-and-practices

I ask that everyone strives to ensure that other members of this class can learn in a supportive and respectful environment. If there are instances of the aforementioned issues, please contact the Title IX Coordinator, by calling 412-648-7860, or e-mailing titleixcoordinator@pitt.edu. Reports can also be filed online: https://www.diversity.pitt.edu/make-report/report-form. You may also choose to report this to a faculty/staff member; they are required to communicate this to the University's Office of Diversity and Inclusion. If you wish to maintain complete confidentiality, you may also contact the University Counseling Center (412-648-7930).

School of Engineering Statement on Students with Disabilities

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services (DRS), 140 William Pitt Union, (412) 648-7890, drsrecep@pitt.edu, (412) 228-5347 for P3 ASL users, as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

Syllabus

All class materials and resources are available through CourseWeb (e.g., assignments, in-class problems and additional non-textbook readings assignments).

Aug 28	**Introduction, Course Overview, Term Project Intro, Begin Acid-Base Chemistry** **Notes that review general chemistry topics relevant to this course are provided on CourseWeb* Setting Up and Solving Equilibrium Problems (Tableau, Graphical Approx.) M&H: Chapter 1, Sections 1 – 4 Problem Set 1 Assigned
Sept 4	**Acid-Base Chemistry: ANC, Carbonate System, Gases** M&H: Chapter 2, Sections 2 – 4, Chapter 4, Sections 2 & 7 Problem Set 1 Due Problem Set 2 Assigned
Sept 11	**Acid-Base Chemistry: Natural Waters, Mixing** M&H: Chapter 4, Sections 3 – 5, 9 Problem Set 2 Due Problem Set 3 Assigned
Sept 18	**Finish Acid-Base Chemistry, Intro to Thermodynamics,** Organic Acids, Buffering and Buffer Capacity M&H: Chapter 4, Sections 6 & 8 Problem Set 3 Due Problem Set 4 Assigned
Sept 25	**Thermodynamics: Gibbs Free Energy, Equilibrium Expressions, Ionic Strength Effects** M&H: Chapter 2, Section 1 & 5 Problem Set 4 Due Problem Set 5 Assigned
Oct 2	**Thermodynamics Wrap Up and Research Tutorial** (introduce resources available on campus) Problem Set 5 Due
Oct 9	**Midterm Examination** (covers material from Aug 28 – Oct 2)
Oct 16	**Complexation: Stability/Formation Constant (K_f), Inorganic Complexes, Open System** M&H: Chapter 6, Sections 2 – 3, 4.1 – 4.3 Problem Set 6 Assigned
Oct 23	**Complexation: Closed System** Problem Set 6 Due Problem Set 7 Assigned

Oct 30	**Dissolution and Precipitation of Solids**: **Strong and Weak Ligand Binding, Solubility Constants (K_{sp})** M&H: Chapter 5, Sections 1 – 3 Problem Set 7 Due Problem Set 8 Assigned
Nov 6	**Dissolution and Precipitation of Solids: Weathering** M&H: Chapter 5, Sections 4 – 5 Problem Set 8 Due Problem Set 9 Assigned
Nov 13	**'Redox' Chemistry: Electrochemical Scales, Balancing Redox Rxns, Thermodynamics/Nernst eqn, pe – pC plots** M&H: Chapter 7, Sections 1 - 2 Problem Set 9 Due Problem Set 10 Assigned
Nov 20	**'Redox' Chemistry: pe – pH plots** M&H: Chapter 7, Section 4 Problem Set 10 Due Problem Set 11 Assigned
THANKSGIVING (No Class this week)	
Dec 4	**Term Project Due, In Class Presentations** **You will turn in a physical copy of your paper in class as well as email me an electronic version of your term paper* Problem Set 11 Due (you can also turn this in at the Final Exam)
Dec 11	Final Exam