EN570 – Environmental Chemistry

1. ***Credits and contact hours***

   3 credits

   3 contact hours per week – 1 150 min session/week

2. ***Instructor's or course coordinator's name:***

   Christos Christodoulatos

3. ***Designation:***

   Required course

4. ***Course (Catalog) Description***

   Principles of environmental reactions with emphasis on aquatic chemistry; reaction and phase equilibria; acid-base and carbonate systems; complexation and precipitation reaction; oxidation-reduction; colloids; organic classes, sources and fates; groundwater chemistry; atmospheric chemistry.

5. ***Prerequisite(s)***

   Two semesters general chemistry (Ch115 and Ch116)

   Corequisite(s)

   None

6. ***Textbook(s) and/or other required material***

   Required: Water Chemistry, Patrick L. Brezonik and William A. Arnold, Oxford University Press, 2011 (ISBN 978-0-19-973072-8).

   Supplementary: Vernon L. Snoeyink and David Jenkins, Water Chemistry, John Wiley & Sons, 1980; Aquatic Chemistry, Stumm & Morgan, Wiley, 1981.

7. ***Course Learning Outcomes***

   1.1-Students should be able to

   - perform chemical arithmetic to solve problems relevant to aqueous environmental systems: balance chemical reactions and use chemical bonding and periodicity in environmental systems; utilize activity coefficients to determine deviations from ideal behavior in aqueous systems
   - apply thermodynamic principles and Gibbs free energy concepts to determine the direction and extent (equilibrium) of chemical transformations in aqueous media

   1.2-Students should be able to

   - analyze and characterize, qualitatively and quantitatively, systems under equilibrium conditions using conservation of mass principles. Students should be able to use these principles to:
     - Find the proton condition of acid-base solutions
     - Determine the concentration of all species in Acid-Base solutions and in natural waters

- Calculate the amount of acid/base required in titrations and preparation of Buffer Solutions;
- Determine the alkalinity of a solution and the effects of the carbonate system
- Compute the solubility of solids and the effects of pH on ligand formation, and chemical speciation

- Solve Oxidation/Reduction problems pertinent to environmental systems

1.3 - Students should be able to identify pertinent system parameters and derive models to predict system responses and performance for specified inputs:

- Students should be able to determine the final pH of a given aqueous solution containing acids, bases, complexes, soluble solids and reducing and oxidizing agents and assess the effects of pH on species distribution.

6.1-Students should be able to:

- utilize statistical software packages to analyze problems to obtain:
  - Analytical/Numerical solutions to acid-base; precipitation/dissolution and oxidation/reduction systems
  - Obtain Concentration-pH and solubility diagrams.

8. Topics covered

1. Introduction; Chemical Arithmetic; Chemical Bonding; Periodicity and Environmental Properties
2. Thermodynamics; Chemical and Phase Equilibria; Chemical Potential; Nonideality
3. Chemical Kinetics; Rate Laws
4. Acid-Base Chemistry; Fundamental Laws; Numerical Calculations; Graphical Analysis; Titrations; Buffer Systems; Alkalinity and the carbonate system
5. Coordination Chemistry; Complex Formation and Equilibrium; Conditional Stability Products; Chemical Speciation
6. Solubility and Precipitation; Effects of Ligands; Nonideal Solution Behavior; Ionic Strength Effects
7. Oxidation/Reduction; Equilibria; Potentials; Nernst Equation; Electron Activity; Corrosion; Disinfection
8. Interfacial Phenomena; physical Chemistry of Surfaces; Colloids; Particle Dynamics
9. Organic Chemistry; Organic Geochemistry; Nomenclature; Classification; Reactions and Pathways in Natural Waters
10. Atmospheric Chemistry

9. Course objectives and relationship of course to program outcomes

This course provides a basic understanding on the behavior of heavy metals as well as organic and inorganic substances such as acid and bases in water. This knowledge is necessary to environmental engineering practitioners for the design of wastewater, water and groundwater treatment processes, remediation systems for soil and site reclamation, implementation of scientifically sound environmental management strategies, and the development and application of sustainable environmental technology and practices.