University of North Carolina at Chapel Hill
ENVR 419 Chemical Equilibria of Natural Waters
Fall 2019

Instructor: Orlando Coronell (coronell@unc.edu, 163B Rosenau, 919-966-9010)

Meeting time: Tu, Th 11:00 am-12:15 pm **Room:** McGavran-Greenberg 1303

Course website: https://sakai.unc.edu/portal/site/envr419fa19 **Course Credits:** 3

Office hours: Tu, Th 2:00-3:00 pm and whenever else available

Reference texts: Water Chemistry, 2nd Edition, Mark M. Benjamin, Waveland Press (2015)

Water Chemistry, 2nd Edition, Patrick L. Brezonik and William A. Arnold, Oxford University Press (2011)

Water Chemistry, Vernon L. Snoeyink and David Jenkins, John Wiley & Sons (1980)

Course Description: Water-phase chemical equilibria and kinetics are fundamental to many fields within the environmental sciences and engineering, including drinking water systems, waste water treatment processes, geochemistry, atmospheric and marine sciences. The overall goal of this course is to provide students with an understanding of the fundamentals of aqueous chemistry as they apply to both natural and engineered systems. The major topics covered in this course are: (1) chemical thermodynamic principles, (2) basics of reaction kinetics, (3) acid-base equilibria, (4) complexation and speciation of metals, (5) dissolution of gases and solids, and (6) redox chemistry. While the focus of the course is on inorganic species, basic concepts of organic matter in water are covered.

Target Audience and Course Pre-requisites: The course is directed at upper-level undergraduates and beginning graduate students. There are no formal prerequisites, however, some background in undergraduate-level inorganic chemistry is assumed. Students without such a background should contact the instructors prior to registration.

Learning Objectives: Students who take ENVR 419 will (1) understand the thermodynamics principles that determine the concentration of inorganic species in aqueous solution, (2) perform basic analysis of rates of chemical reactions in aqueous solutions, and predict in a quantitative manner (3) the equilibrium concentration and distribution of inorganic species in ground and surface waters under a variety of natural conditions, and (4) the impact of pollutants and of natural and engineered processes on these species.

Course Format: The format of the course will be primarily lecture-based. Students will be assigned readings and problems sets that will provide practice in problem solving techniques. While a large portion of the course material is delivered through lectures by the instructor, students are expected to complete the assigned readings and bring questions to the lectures. Not all material in the assigned readings is covered during the lectures. Instead, lectures focus on the most important aspects of the topics covered, on answering questions that result from reading the assigned material, and on in-class

exercises that help consolidate the understanding of physico-chemical principles or process design.

Bring to Class: Yourself (highly recommended), paper, pen(cil), calculator, questions and a good attitude.

Student Evaluation: Student evaluation will consist of 4 quizzes, 5 homework sets, and three exams, all of which will be graded out of 100% and weighed as follows:

Exam 1:	20%
Exam 2:	20%
Exam 3:	20%
Homeworks:	20%
Quizzes:	20%

For graduate students final grades will be assigned as High Pass (H), Pass (P), Low Pass (L) or Fail (F). For undergraduate students final grades will be assigned as A, B, C, D, E, and F with + or – descriptors when appropriate.

Instructor Approach on Assignment of Final Grade:
Assignment of grades will occur as follows:

- H or A: students with a final average grade above 90%
- P or B, C: students with a final average grade between 70% and 90%
- L or D, E: students who obtain a final average grade between 50% and 70% AND this grade is at least 6 percentage points lower than the lowest P
- F: students who obtain a final average grade below 50% AND this grade is at least 6 percentage points lower than the lowest L grade

Exams Format: Exams will be in-class exams to be completed in a 75 minute period. A typical exam will consist of conceptual questions (i.e., no need for calculator to answer the question) and calculation questions for which formulas and a calculator will likely be required. In general, the conceptual and calculations section of the exams will be worth approximately 30% and 70% of the exam, respectively; however, the stated percentages are non-binding.

Quizzes Format: Quizzes will consist of one or two questions to be answered in 10 minutes. Only material covered in class (unless otherwise specified in advance) will be evaluated in quizzes, i.e., the student should be able to answer the questions in the quizzes by studying from the class notes.

Honor Code: I invite the students to visit the webpage dedicated to the Honor Code of UNC-Chapel Hill students (http://honor.unc.edu/). While in these matters there is no better steering wheel than honesty and good will, the Honor Code and what is referred to as The Instrument of Student Judicial Governance (http:// http://instrument.unc.edu/) serve as a guideline to students in matters related to the good exercise of their freedom at UNC. For what directly concerns this class, students should not lie, cheat or steal and

should be aware of what constitutes academic dishonesty as defined in Section IIB of The Instrument of Student Judicial Governance of which an excerpt is reproduced below (taken from http://instrument.unc.edu/instrument.text.html#academicdishonesty):

"…**(Section II)B. Academic Dishonesty.**

…

1. **Plagiarism** in the form of deliberate or reckless representation of another's words, thoughts, or ideas as one's own without attribution in connection with submission of academic work, whether graded or otherwise.
2. **Falsification, fabrication, or misrepresentation** of data, other information, or citations in connection with an academic assignment, whether graded or otherwise.
3. **Unauthorized assistance or unauthorized collaboration** in connection with academic work, whether graded or otherwise.
4. **Cheating** on examinations or other academic assignments, whether graded or otherwise, including but not limited to the following:
a. Using unauthorized materials and methods (notes, books, electronic information, telephonic or other forms of electronic communication, or other sources or methods), or
b. Representing another's work as one's own.

…"

Schedule of Lectures:

Week	Topic	Benjamin	Brezonik	Snoeyink
August (x4)	1. Nature of water	**1.2-1.3**	1.2	**1.1**
	2. Concentration units of substances in water, and common water quality parameters	**1.4.1-1.4.6 1.4.4-1.4.6**	**1.3 2.2.1-2.2.2**	**1.3** 1.3.6
	3. Chemical composition of waters	**-**	2.1-2.3	**1.2**
	4. Organic matter in waters	-	**6.1-6.8**	-
September (x8)	5. Categories of reactions in waters	**-**	**1.4**	-
	6. Chemical kinetics	3.1-3.8	**5.1-5.2,5.3.2**	2.1-2.7
	7. Chemical thermodynamics	4.12-4.13	**3.14-3.16**	3.3-3.4
	8. Activity-concentration relationships	**2.2.3,2.3-2.4**	4.1-4.8	3.5
October (x8)	9. Acid-base chemistry	**Class notes**		
	10. Carbonate System, alkalinity and acidity			
November (x8)	11. Precipitation and dissolution			
	12. Coordination chemistry (complexation)			
	13. Oxidation-reduction (redox)			
December (x1)	Review Course evaluation	N/A		

EXAM 3 (Thursday December 12, 2019 12:00 p.m., MGG 1303)