

**THE UNIVERSITY OF WESTERN ONTARIO**  
**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

**CEE 9642 – Aquatic Chemistry - Course Outline 2016/2017**

**Objectives:**

The objective of this course is to develop an understanding of the field of aquatic chemistry and in particular the behaviour of inorganic species in natural waters. The course content focused on the application of thermodynamics to understand chemical speciation and transformations in natural aquatic systems including aqueous, solid, and gas phase transformations. The geochemical modeling package, PHREEQC, will be used to simulate a variety of reaction processes. The course has applicability to a broad range of areas including water and wastewater treatment, and groundwater and surface water quality. The course requires undergraduate-level chemistry knowledge.

**Topics:**

**1. Introduction**

- The physicochemical properties of water
- Concentration units and definitions
- Introduction to chemical activity

**2. Thermodynamics and chemical equilibrium**

- Laws of thermodynamics
- Gibbes free energy
- Equilibrium constant
- Le Châtelier's Principle
- Solving chemical equilibrium problems

**3. Acid and bases**

- Acid-base equilibrium
- pC-pH graphs for monoprotic and polyprotic acid/bases
- Ionization (alpha) values
- Acid-base titrations
- The carbonate system, alkalinity and acidity
- Buffer capacity

**4. Heterogeneous systems - Solubility equilibria**

- Solubility of gases, Henry's Law
- Solubility of solids, solubility product
- Solubility diagrams

**5. Oxidation-reduction reactions**

- Oxidation state and valence
- The hydrogen half-cell
- Reduction potential

- The Nernst equation
- pe – pH diagrams

#### 6. Chemical kinetics

- Reaction orders
- Arrhenius expression
- Reaction sequences, derivation of rate laws

#### **Prerequisites:**

Completion of BESC. in Civil Engineering, Chemical Engineering or equivalent.

#### **Corequisites:**

None.

#### **Antirequisite:**

None.

Note: It is the **student's responsibility** to ensure that all Prerequisite and Corequisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. It is also the **student's responsibility** to ensure that they have not taken a course listed as an Antirequisite. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

#### **Contact Hours:**

3 lecture hours per week

(Students will be required to do independent review of course materials prior to class each week)

#### **Instructor:**

Dr. Clare Robinson  
SEB 3041, c Robinson@eng.uwo.ca

#### **Course Materials:**

##### Textbook:

A Problem-Solving Approach to Aquatic Chemistry, Jensen (Wiley, 2003)

##### Other References:

Appelo and Postma, Geochemistry, Groundwater and Pollution, (A.A. Balkema Publishers, 2007)

Benjamin, Water Chemistry (McGraw-Hill, 2002)

Langmuir, Aqueous Environmental Geochemistry (Prentice Hall, Inc , 1997).

Morel and Hering, Principles & Applications of Aquatic Chemistry (Wiley, 1993)

Stumm and Morgan, Aquatic Chemistry (Wiley, 1996)

Prepared class notes will be made available through the course OWL site, along with other useful reference material and data for assignments.

**Units:**

SI units will be the primary units used in lectures and examinations.

**Evaluation:**

The final course mark will be determined as follows:

Project	20%
Mid-term Quiz:	20%
Final Examination	50%
Assignments	10%
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Total	100%

Examinations:

Mid-term quiz will be 2 hours and the final examination will be 3 hours. The quiz and examination will be closed book and a sheet will be provided with potentially useful equations.

Students must pass the final examination to pass this course. Students who fail the final examination will be assigned the aggregate mark, as determined above, or 48%, whichever is less.

Assignments:

Two problem-based assignments will be scheduled during the term. The assignments will be individual work. Questions will be of a similar type to those on the midterm and final examination.

Late Assignments: Late assignments will be accepted for 3 days following their due date. 10% per day will be deducted for late assignments. Extensions are to be negotiated with Dr. Robinson. If no assignment is received for a student, the mark assigned is zero for that week. If more than one assignment is missed then a student will not be allowed to write the final exam.

Plagiarism on Assignments: Each person must hand in an assignment that contains only their own work. If an assignment is deemed to be similar to another assignment this will be taken as a case of plagiarism. In such circumstances, both individuals (e.g., the person providing the answer and the person copying it) will both receive a mark of zero on the entire assignment. For a first offense, both individuals will receive a personal warning and the infraction will be recorded. For a second offense, further action will be taken.

Project:

Students will conduct a research project and present their findings via an oral presentation to the class on a specialized topic relevant to the course.

### Problem sets:

Five problem sets will be provided during the term. Students do not need to hand in these problem sets, but they are expected to work through them outside class each week. Questions will be of a similar type to those on the midterm and final examination.

### **Use of English:**

In accordance with Senate and Faculty Policy, students may be penalised up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

### **Scholastic Offences:**

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

[http://www.uwo.ca/univsec/handbook/appeals/scholastic\\_discipline\\_grad.pdf](http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_grad.pdf).

### **Plagiarism:**

University policy states that plagiarism, defined as the “act or an instance of copying or stealing another’s words or ideas and attributing them as one’s own.” (excerpted from Black’s Law Dictionary, West Group, 1999, 7th ed., p. 1170) is a scholastic offence. In submitting any written work as part of the coursework requirements for this course students must ensure that this work is written in their own words. Whenever students take an idea or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations.

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

A student who is found guilty of plagiarism in respect of any written work submitted as part of the coursework requirements for this course will be given a grade of zero for the submitted work. Repeated acts of plagiarism, either in this course or any other course subsequent to a first offence, will result in the student being given a failing grade for the course in which the subsequent offence occurs, and may also incur further penalties such as requiring the student to withdraw from the program in which they are enrolled in.

**Attendance:**

Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

**Accessibility:**

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

**Conduct:**

Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others. Late comers may be asked to wait outside the classroom until being invited in by the Instructor. Please turn off your cell phone before coming to a class, tutorial, quiz or exam.

On the premises of the University or at a University-sponsored program, students must abide by the Student Code of Conduct: <http://www.uwo.ca/univsec/board/code.pdf>.

**Sickness and Other Problems:**

Students should immediately consult with the Instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see attached). The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, please see:

[http://www.uwo.ca/univsec/handbook/appeals/accommodation\\_medical.pdf](http://www.uwo.ca/univsec/handbook/appeals/accommodation_medical.pdf).

**Graduate Student Health and Wellness:**

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several on campus health-related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. For example, to support physical activity, all students, as part of their registration, receive membership in Western's Campus Recreation Centre. Numerous cultural events are offered throughout the year. Please check out the Faculty of Music web page <http://www.music.uwo.ca/>, and our own McIntosh Gallery <http://www.mcintoshgallery.ca/>. Information regarding health- and wellness-related services available to students may be found at <http://www.health.uwo.ca/>.

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director

(graduate chair), or other relevant administrators in their unit. Campus mental health resources may be found at [http://www.health.uwo.ca/mental\\_health/resources.html](http://www.health.uwo.ca/mental_health/resources.html)

To help you learn more about mental health, Western has developed an interactive mental health learning module, found here:

[http://www.health.uwo.ca/mental\\_health/module.html](http://www.health.uwo.ca/mental_health/module.html). This module is 30 minutes in length and provides participants with a basic understanding of mental health issues and of available campus and community resources. Topics include stress, anxiety, depression, suicide and eating disorders. After successful completion of the module, participants receive a certificate confirming their participation.

**Notice:**

Students are responsible for regularly checking their email, and the course OWL site for new notices related to the course.