CEE 471/671
CEN 461/661
ENVIRONMENTAL CHEMISTRY AND ANALYSIS

TTh 2:00 – 3:20 PM

Link 152

Dr. Svetoslava Todorova

SPRING 2024

Learning Activities

This is an introductory course in water chemistry covering topics in natural and built environmental systems – thermodynamics and kinetics of reactions; acid-base chemistry; carbonate chemistry; behavior of major elements in aquatic ecosystems. The course includes selected laboratory exercises. This course is required for undergraduate environmental engineering students and can be used as an elective in other disciplines, such as Earth Sciences, Chemistry, and Chemical Engineering.

Prerequisites

To be successful in this course the student should have basic knowledge in chemistry and calculus. An introductory year of college-level chemistry (CHE 106 and 116) is required. An introductory environmental engineering course (CEE 341) is encouraged but not required. Knowledge of differential and integral calculus (MAT 295, MAT 296) is expected.

Homework Assignments

Learning based on problem-solving will be encouraged with homework sets. Each homework assignment will require knowledge of the material discussed in class. The objective of the homework assignments is to provide you with an additional practice as well as to help you evaluate your ability to comprehend the material and transfer it into practical problems. Homework assignments will be distributed on Thursday and will be due one week from the assigned date.

Lectures

The lecture periods on will be devoted to introducing you to the theoretical principals and provide you with basic examples of their application. Lectures are not mandatory, and I expect that if you choose to come to lectures, you will be fully engaged and ready to learn!

INSTRUCTOR

Dr. Svetoslava Todorova

Mailbox: 151 Link Hall

Office Location: 139 Link Hall

Office Hours: W 11:00 AM- 12:00 PM

Email: stodorov@syr.edu

TEACHING ASSISTANTS

Mr. Linghui Meng

Mailbox: 151 Link Hall

Office Hours Location: Link 154

Office Hours: M 3:00 -4:00 PM

Email: limeng@syr.edu

SUGGESTED TEXTBOOKS

Langley, R and Moore, J. General Chemistry, Volume 2. Cognella Academic Publishing, 2021.

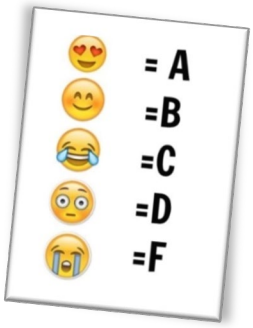
Brezonik, P. and Arnold, W. Water Chemistry: an Introduction to the Chemistry of Natural and Engineered Aquatic Systems. Oxford University Press, New York, NY,2011.

Evaluation and Grading

There will be one in-class exam (midterm) and one take-home exam (final) during the semester.

A weighted average grade will be calculated based on the following:

- 20% problem sets,
- 5% lab quizzes
- 25% lab reports
- 25% mid-term exam
- 25% final exam



Final grades will be assigned as follows:

A	93-100%	**C+**	77-79.99%
A-	90-92.99%	**C**	73-76.99%
B+	87-89.99%	**C-**	70-72.99%
B	83-86.99%	**D**	60-69.99%
B-	80-82.99%	**F**	<59.99%

Students are expected to complete assignments on time. In an event of a family emergency, please, contact me to arrange for extension on your assignments.

GRADUATE STUDENTS

Homework assignments, midterm and the final exam for the graduate students will have either different or additional problems. For the final exam, graduate students will be given a dataset to analyze and write a short scientific paper on the topic. The take-home exam will be **an individual** work!

Syracuse University Shared Competencies

Syracuse University's created university-wide learning goals that aim to help undergraduate students develop competencies in six major areas - Ethics, Integrity, and Commitment to Diversity and Inclusion (EICDI); Critical and Creative Thinking (CCT), Scientific Inquiry and Research Skills (SIRS), Civic and Global Responsibility (CGR), Communication Skills, and Information Literacy and Technological Agility (ILTA). This course helps students develop skills in SIRS.

ABET Engineering Criteria

Engineering programs must demonstrate that their graduates have and ability to:

1. identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. communicate effectively with a range of audiences
4. recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. acquire and apply new knowledge as needed, using appropriate learning strategies.

Course Outcomes

At the completion of the course, you will be able to:

1. apply fundamental concepts of chemistry in environmental solutions;
2. understand errors and uncertainty in laboratory chemical analysis (ABET 6, SIRS);
3. develop the ability to evaluate and solve complex problems in environmental chemistry, involving multiple phases and/or components (ABET 1);
4. build computer skills, particularly in data visualization and analysis (ABET 6);
5. develop scientific writing skills (ABET 3, SIRS);
6. develop critical thinking and critically analyze scientific literature (ABET 6, SIRS);
7. build teamwork skills through group field and laboratory work (ABET 5).

PROJECT

Laboratory Exercises

The laboratory portion of this course provides the opportunity for "hands-on" explorations of a variety of chemical principles. The lab experiments have been chosen to complement the course material and to stimulate learning. Some labs will relate directly to topics discussed in class, while others will illustrate further applications or related ideas.

Students will perform four (4) laboratory exercises. **The labs will be in the Teaching Lab, Link 405**.

Your participation in the laboratory exercises is required because it is impossible to make them up.

Laboratory Groups

Laboratory groups will consist of two to three (2-3) students. You are free to choose your group members as long as they are from your academic level. Undergraduate students will be in a group with undergraduate students. Graduate students will be in a group with graduate students.

LABORATORY ANALYSIS

Standardization and Analytical Precision (January 25): you will learn the concept and practice of standardization and quality control. An ion-specific electrode will be used to determine copper concentrations in aqueous solutions. You will explore the precision, reproducibility, and uncertainty of laboratory chemical analyses.

Experimental Estimation of Equilibrium Constants (February 13): you will learn how to experimentally determine equilibrium constants using a cupric ion-selective electrode. By studying the extent of formation of aqueous copper complexes and free cupric ion, you will be able to calculate the equilibrium constant for the chemical reaction.

Acid-base Titrations (March 7): you will learn how to determine equivalence points and acid dissociation constants for monoprotic and polyprotic acids/bases and will understand how the degree of dissociation affects the determination of these two parameters. A pH meter and acid-base indicator solution will be used.

Alkalinity and Carbonate System (April 11): you will become familiar with the concept of alkalinity and the chemistry of the carbonate buffering system. The concentrations of components of the carbonate system will be calculated from alkalinity titration measurements. Samples from Onondaga Lake watershed will be used to construct an alkalinity budget for the lake.

FIRST LAB REPORT

You have the option to revise and resubmit your first laboratory report. It is your decision whether to do so. Any revised report will be awarded 5 points less than the maximum to discourage the initial submission of "rough draft" lab reports.

Laboratory Reports

There will be some brief classroom discussion about each experiment, but each group will be responsible to gather the technical resources needed for the completion of the assignment (consult with the textbooks or other references for information on the topic).

Students are encouraged to work with their group members on laboratory analysis (results) and the methods portion of the reports. However, **every student is responsible for preparing for their own laboratory report**, written in their own words. Laboratory reports will be due two weeks from the completion of the experimental work.

Structure of the Lab Reports

The typical structure of the lab reports for this class follows that of a scientific publication:

- Introduction and objectives
- Materials and methods
- Results
- Discussion
- Conclusions

Introduction provides relevant context information and gives enough background information to the reader about the topic and the experiment. Methods state the laboratory procedure the way your group performed it. Results present factual statements about the outcome of the experiment, while the discussion explains the result and their meaning. You restate the primary findings in the conclusions.

POLICIES

Academic Integrity

SU's academic integrity policy reflects the high value that we, as a university community, place on honesty in academic work. The policy holds students accountable for the integrity of all work they submit and for upholding course-specific and university-wide academic integrity expectations. The policy governs citation and use of sources, the integrity of work submitted in exams and assignments, and truthfulness in all academic matters, including course attendance and participation. Upholding Academic Integrity includes protection of instructor's intellectual property. The policy also prohibits students from: 1) submitting the same work in more than one class without receiving advance written authorization from both instructors and, 2) using websites that charge fees or require uploading of course materials to obtain exam solutions or assignments completed by others and present the work as their own, 3) submitting collaborative work and use of editing and artificial intelligence (AI) resources without instructor's permission. **Using AI to complete the assignments and exams in this course is prohibited.** It is my goal to help you develop your scientific writing skills. I will be using Turnitin's built-in AI writing indicator and other tools to evaluate potential inappropriate use of AI in this course. Students found in violation of the policy are subject to grade sanctions/course failure and non-grade sanctions determined by the ECS College, as described in the Violation and Sanction Classification Rubric. The Violation and Sanction Classification Rubric establishes recommended guidelines for the determination of grade penalties by faculty and instructors, while also giving them discretion to select the grade penalty they believe most suitable, including course failure, regardless of violation level. **Any established violation in this course may result in course failure regardless of violation level**. You must have read the University's academic integrity expectations online and electronically signed, agreeing to abide by it during the pre-term check-in on MySlice. For more information see http://academicintegrity.syr.edu.

Diversity, Inclusion, Disabilities

Syracuse University values diversity and inclusion; we are committed to a climate of mutual respect and full participation. **My goal is to create a learning environment that is equitable, inclusive and welcoming.** If there are aspects of my instruction or design of this course that result in barriers to your inclusion and full participation in this course, I invite you to contact me to discuss strategies and/or accommodations that will be essential to your success. You can also reach out to the Center for Disability Resources (CDR) and discuss disability-accommodations or to register with CDR. To so so, please call (315) 443-4498 or email disabilityresources@syr.edu.

The University does not discriminate and prohibits harassment or discrimination related to any protected category including creed, ethnicity, citizenship, sexual orientation, national origin, sex, gender, pregnancy, disability, marital status, age, race, color, veteran status, military status, religion, sexual orientation, domestic violence status, genetic information, gender identity, gender expression or perceived gender. Any complaint of discrimination or harassment related to any of these protected bases should be reported to Sheila Johnson-Willis, the University's Chief Equal Opportunity & Title IX Officer (005 Steele Hall, Syracuse University, Syracuse, NY 13244-1120; by email: titleix@syr.edu; or by telephone: 315-443-0211). **If you have a name and/or set of pronouns that differ from those that appear in your official SU records, please let me know.**

Religious Observances

SU's religious observances policy recognizes the diversity of faiths represented among the campus community and protects the rights of students, faculty, and staff to observe religious holydays according to their tradition. Under the policy, students are provided an opportunity to make up any examination, study, or work requirements that may be missed due to a religious observance provided they notify their instructors **before the end of the second week of classes**. The policy can be found at http://supolicies.syr.edu/emp_ben/religious_observance.htm. An online notification process is available through MySlice from the first day of class until the end of the second week of class.

Email and Personal Electronic Devices

SU has established email as a primary vehicle for official communication. An official syr.edu email address is assigned by ITS for each registered student and will be used for educational dialogue with the students in this class. If you use different primary e-mail, forward your syr.edu email address. **It is my best desire to help you succeed in this class.** Contact me with questions or to schedule an appointment. **On the subject line indicate "{section} {number} – {purpose}"**. Make sure that you use proper introduction and solutation! E-mails will be answered between 24 – 36 hours, in the order received, excluding weekends. Plan accordingly! The use of cell phones and other electronic devices that do not aid your comprehension of the material are **not allowed** in class. It is expected that the students will **turn off** their **electronic devices** for the duration of the class unless instructed otherwise!

Schedule of Activities

Topic	Date	Laboratory Exercises	Location
Introduction – syllabus and projects	1/16		Link 152
Stoichiometry	1/18		Link 152
Quantitative Analysis	1/23		Link 152
	1/25	Analytical Precision	Link 405
Reading and Critiquing Scientific Articles	1/30		Link 152
Balancing Redox Reactions	2/1		Link 152
Reaction Thermodynamics	2/6		Link 152
Activity Concentration Relationships	2/8		Link 152
	2/13	Experimental Estimation of Equilibrium Constants	Link 405
Equilibrium Calculations	2/15		Link 152
Solving Ionic Equilibria Problems	2/20		Link 152
Intellectual Property (virtual)	2/22		Link 152
Acid-base Reactions (Ch.5)	2/27		Link 152
Developing log C-pH diagrams	2/29		Link 152
Solving Problems with log C-pH diagrams	3/5		Link 152
	3/7	Acid-base Titrations	Link 405
Spring Break	3/12		Link 152
Spring Break	3/14		Link 152
Solving Problems with log C-pH diagrams	3/19		Link 152

Review for Midterm	3/21		Link 152
Midterm: thermodynamics, equilibrium calculations, acid-base reactions	**3/26**		**Link 152**
The Carbonate System	3/28		Link 152
Solving Carbonate System Problems	4/2		Link 152
Titrations	4/4		Link 152
Alkalinity	4/9		Link 152
	4/11	Alkalinity and the Carbonate System	Link 405
Solving Alkalinity Problems	4/16		Link 152
Reaction Kinetics (B, Ch. 3)	4/18		Link 152
Application of Reaction Kinetics -Dissolved oxygen.	4/23	Take-home exam assigned to graduate students	Link 152
Application of Reaction Kinetics – Fate of Pollutants	4/25		Link 152
Final Exam per Registrar **Take-home Exam for Graduate Students**	**5/3**	**10:15 AM -12:15 PM** **Send over email by Midnight on May 3**	

NOTES:

Remember

Lab 1: Jan 25

Lab 2: Feb 13

Lab 3: Mar 7

Lab 4: Apr 11

Midterm: Mar 26

Final Exam: May 3

Dr. Svetoslava Todorova
139 Link Hall
stodorov@syr.edu