

**Analysis of Equilibrium System  
CHEM 2011-2 (CRN 1923)  
Winter Quarter, 2017**

**Instructor:** Dr. J. Alex Huffman


**Office:** SGM 180

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**Class Time:** MWF, 9:00 – 9:50 AM – Engineering & Computer Science 410

**Recitation:** Th, 9:00 – 9:50 AM – Engineering & Computer Science 410

**Office Hours:** To be determined (survey) and announced during first week

**Help Room:** Staffed by learning assistants (LAs) throughout the week in Anderson Academic Commons.  
See here for more information and schedules: <http://portfolio.du.edu/sec>  @SELCatDU

**REQUIRED COURSE ITEMS**

**Textbook:** *Quantitative Chemical Analysis*, 9<sup>th</sup> Ed., by Daniel C. Harris; Freeman Publ. (QCA)

**Textbook:** An additional General Chemistry text will be required, and any modern text will be sufficient. I will assign supplemental reading assignments out of: *Chemistry* OpenStax College, 1<sup>st</sup> Ed. Textbook content produced by OpenStax College is licensed under a [Creative Commons Attribution License 4.0](https://creativecommons.org/licenses/by/4.0/) license. This means you can access the text for free here: <https://openstaxcollege.org/textbooks/chemistry>

**Calculator:** You will need an inexpensive calculator that has the capability for square roots, logarithms, and exponents. You are responsible for understanding how to perform these operations on your calculator. **Please bring your calculator with you to every class.** Electronics with WiFi (laptops, cell phones, etc.) will NOT be allowed during exams or quizzes.

**SUPPLEMENTAL COURSE ITEMS (Optional)**

**Solutions Manual:** *Solutions Manual for Quant. Chemical Analysis*, 9<sup>th</sup> Ed., D. C. Harris

**COURSE DESCRIPTION**

Analysis of Equilibrium Systems is the fifth course in the six quarter freshman/sophomore chemistry sequence. The course is an introduction to chemical statistics, equilibria, and kinetics. Chemical equilibria will focus on simple aqueous systems, starting with simple systems. Discussions will progress to advanced applications of complex equilibria, including examples from biological and environmental systems.

Please pace yourself and work continuously. Even if you think a topic is easy I recommend that you put in time to make sure you understand details not discussed in lecture. Working more steadily will show both better results and lower stress! Students are expected to put in 2-3 hours outside of class per course credit hour. This means that for CHEM 2011 you should be prepared to spend ~6-9 hours outside of class per week.

Student perspectives of this course vary widely, from some who think it is very easy to others who think it is very difficult. Many who struggle in the course are nervous about or weak in math skills. No math skills beyond basic algebra will be required, but if you think you need help in this area I highly recommend that you seek a tutor or utilize the math help center early so that simple math will not limit you. In all cases, even well prepared and experienced students will find that practicing problems will be critical to success in the course.

## COURSE OBJECTIVES & KEY SKILLS

- Understand the sources of error and uncertainty in chemical analysis
- Identify chemical species that exist in aqueous solutions based on equilibria principles
- Understand the significant role equilibria has on biological and environmental systems
- Understand principles and applications of zero- and first-order reaction kinetics
- Understand quantitative relationships in chemical reactions such as complex formation and acid-base neutralization
- Understand relationships between equilibria and other chemical/physical properties such as free energy, activity, and ionic strength
- Understand and apply basic skills of scientific information literacy, including the use of literature database tools, access rights, and citation requirements
- Use Excel to calculate concentrations of chemical species in solution, and thus facilitate the understanding of both simple and complex equilibria
- Practice systematic logic and problem-solving


## LECTURE

The format of the class meetings will follow traditional lecture format on MWF. I will summarize new material and present illustrations and examples. You will be encouraged to practice problems during and after lectures. I will NOT be able to identify and describe every detail you read in the text and any supplemental materials. You will be expected to finish and understand assigned readings even if I have not gone over that material in great detail. However, I will emphasize important topics covered in the reading as well as problem solving strategies when appropriate. Please stop me at any time if you have questions.

The Thursday (Th) recitation meeting will be devoted to review, problem solving, group activities, in-class assignments and quizzes. No new lecture material will be covered on these days. However, material from the lecture will be explored in greater detail. *Assignments for credit may be given and worked during recitation.*

## OFFICE HOURS & HELP CENTER

I have posted hours when I will be available in my office for questions or issues related, or unrelated, to the course. These hours may be changed, if necessary, during the quarter, but this will be announced.

Need extra help? The *Science and Engineering Learning Center* is a collaborative space staffed by undergraduate and graduate learning assistants (LAs) trained to assist students with some first and second year biology, chemistry, physics, computer science and engineering courses. They offer support for both lecture and laboratory courses for certain courses, CHEM 2011 included. Their goal is to help students grow as problem solvers by assisting with homework sets, lab reports, and preparing for exams. The Science and Engineering Learning Center is **not** a one-on-one tutoring center, but is rather a support system where students can get guidance from LAs as well as their peers. This center is open to all DU students. All services are free. Located in the north-west corner of the first floor of the Anderson Academic Commons (west of the writing center). See <http://portfolio.du.edu/sec> for a complete schedule. Please also follow them Twitter for the most up-to-date announcements:  @SELCatDUREADING

You are encouraged to complete the assigned reading prior to the class lecture and often again after the lecture. In addition, you are also encouraged to attempt the example exercises throughout the text while completing the assigned reading. I recommend that you understand the material and how to solve the sample problems before proceeding to the next section. At the end of each chapter, a summary of important equations and terms is provided that should prove helpful in preparation for quizzes and exams.

## **HOMEWORK ASSIGNMENTS**

Homework problems will be assigned to be worked and turned in weekly. The tentative due dates are listed in the syllabus schedule and will always be due by 11 AM on the assigned day. Homework will generally be due Monday morning unless otherwise stated (i.e. HW3 will be due Friday so solution set may be posted early for exam study).

Homework assignments must be turned in *on paper*. Electronic submissions will not be accepted. All work arriving at the solution must be shown. Answers without sufficient work may be given no credit. You may work with a partner or in a group, but all your work must be written by yourself.

These HW assignments will each be worth 20 points, for a total of 200 points or 20% of the course grade. It is likely that not all questions in a given assignment will be graded. Grades will typically be assigned by a combination of (a) assignment completeness and effort, and (b) by evaluating the answers to a small sub-set of questions. This means that if you complete most of the assignment, but skip the one question to be graded, you may miss a significant amount of points.

The homework assignments are a critical piece of the course. If you diligently work on these assignments and understand them thoroughly, you are likely to do well in the course.

## **ASSIGNMENT LATE POLICY**

Assignments are due (a) on my desk by the end of class or (b) in my box in the chemistry office (Olin 202) by 11 AM on the assigned day. Assignments that arrive after this point will receive a late penalty as follows:

- 20% penalty if turned in by 4:30 pm (OR whenever office closes, whichever is sooner)
- 50% penalty if turned in by 11 AM within three working days

## **OTHER GRADED ASSIGNMENTS**

Supplementary assignments will periodically be assigned. These will total 10% of the overall course grade and will focus on work done during recitation. Ten (10) points will be a quiz given during recitation. This may or may not be announced. The schedule attached here gives a tentative list of assignment due dates and point totals. The infographic assignment assigned to the 8 AM section will NOT be assigned in our section.

A math review quiz will be given during Recitation #1 in the first week. This is designed to make sure your math skills are appropriate for the course. The quiz will be worth only 3 points, but **MUST** be passed before continuing. If a passing grade is not attained, a make-up quiz will be given. Students not passing the quiz will receive a 25% penalty on all assignments and exams until passed.

## EXAMS

Four (4) exams will be given during the quarter: three hour exams and a final. Exam problems will be similar to those given in the weekly homework and to those found on the problem sets. The lowest score from the three hour-exams will be automatically dropped, and only the top two (2) hour-exam scores will be counted towards the final course grade. **Under NO circumstances may the final be dropped or taken early.**

If you will be out of town for a University sanctioned function (e.g. athletic team or music group), you are responsible for making arrangements with Dr. Huffman at least one week in advance to take an hour exam early. **Only in extremely extenuating circumstances, and with required documentation (e.g., letter from Student Health), will a make-up hour exam be given.**

## GRADES

At the end of the quarter, you will be graded according to your performance on assignments and examinations. Cooperative learning is encouraged. Your final grade will be determined by the percentage with the following components and scale. I will not grade on a curve, but grades in both course sections will be monitored and may be slightly increased if necessary in some cases.

Component	Points (Each)	Points (Total)	Percentage (Total)
Weekly homework (HW)	20	200	20%
Additional assignments	5 - 25	100	10%
Hour Exams (top 2 scores at 20% each)	200	400	40%
Final Exam	300	300	30%
<i>Total</i>	-	<i>1000</i>	<i>100%</i>

Final Letter Grade	Percentage
A	93.0 - 100
A -	90.0 - 92.9
B +	87.0 - 89.9
B	83.0 - 86.9
B -	80.0 - 82.9
C +	77.0 - 79.9
C	73.0 - 76.9
C -	70.0 - 72.9
D +	67.0 - 69.9
D	63.0 - 66.9
D -	57.0 - 62.9
F	< 54.9

## IMPORTANT DATES

January 3: Classes begin, Winter Quarter

January 9: Last day to drop classes for full refund or without W

January 16: Martin Luther King Holiday (no class)

\* **February 28: Last day to drop** (for "W"), requires approval (8<sup>th</sup> week)

March 13: Last day of classes

**March 16 (THURSDAY): Final Exam, 8:00 – 9:50 AM**

DU Academic Calendar: <http://www.du.edu/registrar/calendar/index.html>

## **CELLULAR PHONE AND MOBILE DEVICE POLICY**

I respect the need for each individual to stay in contact with family and friends. The use of mobile devices, however, is disruptive to the learning environment. Thus, I request that the ringers of all cellular phones and other mobile devices be muted during class. If an emergency arises, and you need to make a call on your phone, I request that you quietly leave the room and conduct your conversation out in the hallway.

## **LECTURE AND TESTING ACCOMODATIONS**

I will make every effort to accommodate students diagnosed with a learning disability. I will do this in complete confidence. I request that any student requiring these accommodations inform me the first week of class. For further information, please see the University Disability Services' website:

<http://www.du.edu/disability/dsp/index.html>.

## **RELIGIOUS ACCOMODATION**

University policy grants students excused absences from class or other organized activities or observance of religious holy days, unless the accommodation would create an undue hardship. Faculty are asked to be responsive to requests when students contact them *in advance* to request such an excused absence. Students are responsible for completing assignments given during their absence, but should be given an opportunity to make up work missed because of religious observance.

Once a student has registered for a class, the student is expected to examine the course syllabus for potential conflicts with holy days and to notify the instructor by the end of the first week of classes of any conflicts that may require an absence (including any required additional preparation/travel time). The student is also expected to remind the faculty member in advance of the missed class, and to make arrangements in advance (with the faculty member) to make up any missed work or in-class material within a reasonable amount of time.

See: [http://www.du.edu/studentlife/religiouslife/DU\\_religious\\_accommodations\\_policy.html](http://www.du.edu/studentlife/religiouslife/DU_religious_accommodations_policy.html)

## **ACADEMIC DISHONESTY & STUDENT SUPPORT**

While I advocate collaborative learning and teamwork, I also firmly believe that each individual should maintain the highest ethical standards in all of life's endeavors. As such, I support and will strictly enforce the Honor Code of the University of Denver. See links for specific links below:

Pioneer Pledge: <http://www.du.edu/studentlife/ccs/pledge.html>

Honor Code Statement: [http://www.du.edu/studentlife/ccs/honor\\_code\\_2011-2012.pdf](http://www.du.edu/studentlife/ccs/honor_code_2011-2012.pdf)

I also understand that every student has unique personal and educational needs. I will do my best to help you learn or appropriately facilitate your ability to work through personal issues. Please see the Office of Student Life (<http://www.du.edu/studentlife/ccs/index.html>), including the Pioneer Care program (<http://www.du.edu/studentlife/care/>), for more detailed resources.

## TENTATIVE SCHEDULE

							Homework + Additional Assignments		
	Week #	Lecture #	Date	Week-day	Topic	Reading Section (9th Edition)	HW Due Date (11 AM)	Additional Assignments (Timing Tentative)	Assign. Points
Exam #1 Material	1	1	Jan 4	W	Course overview; Types of error	3.1-3.3			
		R1	Jan 5	Th	Recitation: Chemistry math review + Excel intro			Math Quiz	3
		2	Jan 6	F	Gaussian distributions	4.1		Online survey	2
	2	3	Jan 9	M	Confidence intervals	4.3	HW1		
		4	Jan 11	W	Least squares fitting + calibration curves	4.7-4.9			
		R2	Jan 12	Th	Excel and confidence intervals				
	3	5	Jan 13	F	Reversibility; Introduction to equilibrium	6.1		Excel sheet	15
		-	Jan 16	M	Reaction quotient: Q; Thermodynamics	6.2 + OS: 13.1-13.2	HW2		
		6	Jan 18	W	Disturbing equilibrium (Le Chat)	6.2 + OS 13.3			
R3		Jan 19	Th	Recitation					
Exam #2 Material	4	7	Jan 20	F	ICE Tables; Solubility Product	6.3 + OS: 15.1	HW3*		
		E	Jan 23	M	Exam #1 (Lectures 1-6)	-			
		8	Jan 25	W	Ksp; Common Ion Effect, Complexation	6.4 + OS: 15.1			
		R4	Jan 26	Th	Recitation				
	5	9	Jan 27	F	Precipitation			ICE+ Worksheet	15
		10	Jan 30	M	Acid/Base, pH review; Water autoprotolysis	6.5-6.7	HW4		
		11	Feb 1	W	Weak acids; pKa; conjugates	6.7			
		R5	Feb 2	Th	Recitation				
	Exam #3 Material	6	12	Feb 3	F	Acidity and solub.; Strong acid titration; Ionic str.	7.1-7.3		
13			Feb 6	M	Activity	8.1-8.3	HW5		
E			Feb 8	W	Exam #2 (Lectures 7-12)	-			
R6			Feb 9	Th	Recitation				
7		14	Feb 10	F	Systematic treatment of equilibria	8.4-8.5, 9.1		Activity	15
		15	Feb 13	M	Systematic treatment of equilibria	8.4-8.5, 9.1	HW6		
		16	Feb 15	W	Weak acid/base equilibria	9.2-9.4			
		R7	Feb 16	Th	Recitation				
8		17	Feb 17	F	Buffers (definition; H-H equation)	9.5		Systematic	15
		18	Feb 20	M	Buffers (adding acid/base, preparing)	9.5	HW7		
		19	Feb 22	W	Diprotic acids/bases	10.1			
		R8	Feb 23	Th	Recitation				
Extra Material for Final	9	20	Feb 24	F	Diprotic buffers; Triprot. acids/bases; Princ. species	10.2-10.5			
		21	Feb 27	M	Titrations: Strong acid/weak acid + strong base	11.1-11.2	HW8		
		E	Mar 1	W	Exam #3 (Lectures 13-20)	-			
		R9	Mar 2	Th	Recitation				
	10	22	Mar 3	F	Titrations: Weak base + strong acid; trends	11.3-11.4			
		23	Mar 6	M	Kinetics: reaction rates + rate laws	OS: 12.1-12.3	HW9		
		24	Mar 8	W	Kinetics: integrated rate laws	OS: 12.4			
		R10	Mar 9	Th	Recitation				
	11	25	Mar 10	F	Kinetic theories and mechanisms	OS: 12.5-12.7		Titration	25
26		Mar 13	M	Course review	-	HW10			
		-	Mar 16	Th	FINAL EXAM (Cumulative), 8:00 - 9:50 AM				

### Important Notes:

- Schedule is approximate. Dates of hour exams may be changed, but with appropriate notice.
- \* Note that HW3 will be due early (on Friday) so that solutions will be available for exam study