

**Advanced Analytical Chemistry**  
**CHEM 3220 (CRN 2362)**  
**Fall Quarter, 2017**

**Instructor:** Dr. J. Alex Huffman  
**Office:** SGM 180  
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**Class Time:** MWF, 10:00 – 10:50 AM  
**Class Location:** Olin 103  
**Office Hours:** None specifically posted / open door policy.

**REQUIRED COURSE ITEMS**

**Textbook:** No books required for purchase.  
Reading materials will be scanned and distributed via Canvas.

**COURSE DESCRIPTION**

Advanced Analytical Chemistry is a graduate/upper division undergraduate course and will combine portions of lecture with independent learning expected of advanced students. The course is somewhat of an overview of a few instrumental techniques widely utilized by chemists, but we will not have time in ten weeks to go in great detail in many area. As a result of this limited time frame we will focus on a few selected areas to varying depths, but the course will focus most heavily on aspects of mass spectrometry (MS).

Whether your career path is one towards research, teaching, industry, or some other area of science, your marketability will depend on both your knowledge and your skill. Thus, the over-arching goals of this course are to further your knowledge of analytical chemistry and instrumentation as well as to help you practice your quantitative and independent thinking skills. You will not always be told exactly what you need to know, but you will be given resources in order to help you make a reasoned decision and choose an appropriate path.

**COURSE PRE-REQUISITES**

The pre-requisites officially listed in the course catalog are CHEM 3210 (Instrumental Analysis) and CHEM 3621 (Physical Chemistry III). Please see Dr. Huffman within the first week if this is not the case.

**COURSE STRUCTURE & FORMAT**

The format of our meetings will follow a traditional lecture format; we may also arrange a field trip to a local commercial MS facility. The lecture plan will be comprised of the following modules (in unequal measures):

- 1) The analytical process and general instrument basics
- 2) Fundamental chromatography
- 3) Mass spectrometry

Not all skill can be passed on via lecture and homework or tested via examination. Other critical skills for young scientists will be developed in this course, including:

- 1) Quantitative reasoning
- 2) Literature searching
- 3) Scientific presentation
- 4) Idea generation

**SCHEDULE & CANVAS**

A course schedule will be provided and periodically updated as a pdf or Excel document posted on Canvas. All lecture notes will be posted on Canvas within approximately a few hours after the lecture. All assignments, solution sets, exams, and grades will be posted on Canvas as soon as available. Keep in mind that grades may need to be weighted by the scale given on page 3.

## OFFICE HOURS

I have found that for the limited number of students in this course, it is easier to keep an open office door policy rather than post specific office hour times. Feel free to come to my office and talk to me about any aspect of the course, or issues beyond. I will be happy to provide my perspective and advice wherever helpful. You may find it easier to email me ahead of time to make sure I'll be available when you come by.

Depending on your personality and background, coming to instructor office hours may be uncomfortable. Please know that I am happy to talk to you individually, and you do not need to wait until you have a major problem before coming to my office. You are welcome to come by and discuss at any time.

## READING

Most lectures will have associated reading assignments. A tentative/preliminary lecture and reading schedule is listed at the end of this syllabus. All readings will be made available on the blackboard site or website. You are expected to complete the assigned reading prior to the class lecture in most cases. Not all reading material will be discussed directly in lecture. However, the listed reading assignments are often long and reading all sections in great detail will not always be required. Some of this material will be useful as reference for assignments and for possible future use. We will discuss which reading sections can be skimmed as the quarter progresses.

## GRADED ASSIGNMENTS

Assignments will be given periodically throughout the course. Problem-solving is an important component of all chemistry and most science courses. For most students, successfully solving problems requires practice. The given assignments will be designed to highlight important ideas and concepts, but will not necessarily reflect all types of problems you may encounter on an exam or in the real world.

It is okay to discuss assignment problems in small groups. In fact this is encouraged, because it will help you learn (teach each other, bounce ideas, etc.) and is relevant for preparing you for research. However, everyone is responsible for working out, understanding, and writing their own solution separately. If you don't go through the effort of understanding and solving every problem yourself (after discussion if you want) you will find yourself at a large disadvantage in the exams where you have to solve new problems quickly, and you will not take as much away from this course.

Proper written and oral presentation of your thoughts is also a key scientific skill and will be encouraged through this course. It is often a significant problem to "decode" writing on assignments and exams if the work is poorly organized, or if the writing is too small or messy. As such, Dr. Huffman will take points off for poor legibility. Please make an effort to be very clear in your communication, whether verbal or written. Consider the best way to present your information in each case. In some cases typing the assignment may be the most efficient presentation, and in other cases neatly hand-written work will be best.

Please list units of all results in all cases. SI units are generally preferred.

## EXAMS & QUIZZES

Two (2) exams will be given during the quarter: one mid-term exam (~15% total) and one cumulative final exam (~20%). Material chosen for these exams will be taken from lecture, readings, and group presentations. Only in extremely extenuating circumstances, and with required documentation (e.g., letter from Student Health), will a make-up exam be given. Please advise Dr. Huffman as soon as possible (minimum one week) if you will be out of town for a university sanctioned function (e.g. athletic team or music group).

Quizzes may be given on the quantitative reasoning section. These will count in the assignment grade.

## JOURNAL SKIM & ORAL PRESENTATION

One key skill required of research scientists is the ability to keep up-to-date with recent literature. Another ubiquitous skill required of all scientists is the ability to efficiently present scientific work. Students will practice these skills by periodically scanning recent literature and presenting material in two formats. Each of these assignments will be outlined in detail on subsequent assignment sheets and discussed in class:

- (1) Over the course of the quarter each student will be required to present two very short synopses of research articles. These will be limited to three minutes in length and will require students to convey only the very central themes of a research article. We will use these opportunities to expand the exposure to different analytical techniques.
- (2) Each student will be assigned a group of two students to present a topic as a team. This will require literature research, self-learning, group participation, and presentation skills.

## GRADES

Grading is absolute, and not curved. However, grades may be adjusted based on class performance. Grades will only be increased under this situation and never decreased. I will be very happy for everyone to receive an 'A', however, this grade will only be awarded if earned.

Late assignments will not be graded unless agreed on by Dr. Huffman ahead of time. If they are graded, the grade will be reduced by a minimum of 30% to discourage lateness. If you cannot come to class a day in which an assignment is due, you can (a) turn it in ahead of time or (b) send the file electronically to Dr. Huffman.

Please don't obsess about grades (especially in graduate school)! Indeed they are a measure of output and performance quality, but are much less important than you may often think. Grades should not become an end in themselves (the "professional student syndrome"), rather they should be a feedback tool to help you identify your strengths and weaknesses. You will be given the grade you earn, but historically most students have all done relatively well.

At the end of the quarter, you will be graded according to your performance based on the weighted average of the following course components:

Component	Percentage
Assignments	35%
Exams	35%
Group Presentation	12%
Journal Presentations	12%
Ideas Assignment	5%
Participation and Discussion	1%
<i>Total</i>	<i>100%</i>

Letter	Percentage
A	94.0 - 100
A -	90.0 - 93.9
B +	87.0 - 89.9
B	83.0 - 86.9
B -	80.0 - 83.9
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 -	55.0 - 62.9
F	< 54.9

## ATTENDANCE POLICY

You are required to attend all lectures. However, I realize you are also adults with other life priorities that must be sometimes be balanced. Please do not stress if you need to miss a class lecture. You will be given some grace in attendance, but please notify Dr. Huffman with the reason you have missed a class or if you will need to.

## **LIBRARY RESOURCES**

The University Libraries Research Center answers research questions seven days a week by phone, email, in-person, chat/IM or text. One-on-one research consultations in the Anderson Academic Commons are also available on a drop-in basis or by appointment. Consultations help students at any stage of the research process, from refining a topic, to finding books and articles, to creating a bibliography with RefWorks. Ask a question or make an appointment at 303-871-2905 or [research-help@du.edu](mailto:research-help@du.edu), or contact Science Reference Librarian Naomi Bishop (303-871-4499, [meg.eastwood@du.edu](mailto:meg.eastwood@du.edu)).

Chemistry-specific literature research resources can be found at: <http://libguides.du.edu/chemistry>.

## **CENTRAL UNIVERSITY POLICY AND RIGHTS**

DU affirms: In all that we do, we strive for excellence, innovation, engagement, integrity and inclusiveness.

It is the on-going policy and practice of the University of Denver to provide equal opportunity to all students and employees. No person shall be discriminated against because of race, color, national origin, sex, religion, age, disability, or veteran status. For more information, or if you feel your rights have been impinged upon, please see the following resources at the Office of Diversity and Equal Opportunity: <http://www.du.edu/deo/>; or the Office of Student Life: <http://www.du.edu/studentlife/>.

Dr. Huffman takes the effort to increase inclusiveness as a very important personal goal. I would be very happy to talk with you individually about how I and the university can better support you as a student.

## **RELIGIOUS ACCOMMODATIONS**

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 will 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 will be given an opportunity to make up work missed because of religious observance.

It is your responsibility to examine the course syllabus for potential conflicts with holy days and notify Dr. Huffman by the end of the first week of classes of any conflict that may require an absence (including any required additional preparation/travel time). You will also be responsible to make arrangements to make up any missed work or in-class material within a reasonable amount of time.

## **DISABILITY ACCOMMODATIONS**

Any student who feels s/he may need an accommodation based on the impact of a disability should contact me privately to discuss your specific needs. Please also feel welcomed to contact the Disability Services Program (303-871-2278 / 7432 / 2455) located on the 4<sup>th</sup> floor of Ruffatto Hall to coordinate reasonable accommodation for your disability or medical issue. For further information, please see their website: <http://www.du.edu/disability/dsp/index.html>. See the *Handbook for Students with Disabilities*.

## **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 including the Pioneer Care program (<http://www.du.edu/studentlife/care/>), for more detailed resources.

Class #	Week #	Date	Weekday	Topic	Assignments				Reading Assignment	Journal Pres.		Group Pres.	Class #
					Assigned	Due	Topic						
1	1	Sep 11	M	Syllabus Introduction + Analytical Process									1
2		Sep 13	W	Analytical Process					Skoog (PIA), Chapter 1				2
3		Sep 15	F	Effective Sci. Prez (my 3-min) + Quant					Schultz, Chapters 25 & 26				3
4	2	Sep 18	M	<i>Guest Lecture: Meg Eastwood (Lit. Searching)</i>	PS#1				-	*	*	*	4
5		Sep 20	W	Quantitative Reasoning	PS#2				Helfand (web), Chapters 1 & 2				5
6		Sep 22	F	Chromatography		PS #1 Due	#1: lit. research		-				6
7	3	Sep 25	M	Chromatography					-				7
8		Sep 27	W	Chromatography	PS#3				Braithewaite, Chapters 1 - 2				8
9		Sep 29	F	Chromatography		PS #2 Due	#2: quant. reasoning		-				9
10	4	Oct 02	M	Chromatography	PS#4				-				10
11		Oct 04	W	Mass spectrometry: intro and history					de Hoffmann, Introduction				11
12		Oct 06	F	MS ion sources - EI		PS #3 Due	#3: Seminar Critique		de Hoffmann, Chapter 1				12
13	5	Oct 09	M	MS ion sources - EI		PS #4 Due	#4: Chromatography	4 Ideas Due	-				13
14		Oct 11	W	MS ion sources - CI	PS#5				-				14
15		Oct 13		MS ion sources - CI, ESI					-				15
16	6	Oct 16	M	MS mass analyzers - sector		PS #5 Due	#5: MS-1 ionization		de Hoffmann, Chapter 2.5				16
17		Oct 18	W*	<i>Float day for analytical field trip</i>					-	*	*	*	17
18		Oct 20	F*	Mid-term EXAM					-	*	*	*	18
19	7	Oct 23	M	MS mass analyzers - TOF					de Hoffmann, Chapter 2.4				19
20		Oct 25	W	MS mass analyzers - TOF					-				20
21		Oct 27	F	MS mass analyzers - Quad					de Hoffmann, Chapter 2.1				21
22	8	Oct 30	M	MS mass analyzers - Quad	PS#6				-				22
23		Nov 01	W	MS mass analyzers - Ion Trap					de Hoffmann, Chapter 2.2				23
24		Nov 03	F	MS mass analyzers - FT-ICR + Orbitrap					de Hoffmann, Chapter 2.3, 2.6-2.7				24
25	9	Nov 06	M	MS Interpretation		PS #6 Due	#6: MS-2 analyzers		de Hoffmann, Ch. 3.1, 4.1.4.2				25
26		Nov 08	W	MS Interpretation	PS#7				de Hoffmann, Chapter 6.1-6.5				26
27		Nov 10	F	MS Interpretation					-				27
28	10	Nov 13	M	Multivariate Analysis (PCA)		PS #7 Due	#7: MS-3 interp		Hand-out				28
29		Nov 15	W	Multivariate Analysis (PCA)	PS#8			13 Ideas Due					29
30		Nov 17	F	Multivariate Analysis (Factor/Cluster)					-				30
31	-	Nov 20	M	FINAL EXAM - 10:00 - 11:50 AM		PS #8 Due	#8: Multi. Analysis		-				31

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Dr. Huffman will be out of town Oct. 16 (imm. after class) through Oct. 20

**Textbook Key:**

Braithewaite = Chromatographic Methods

de Hoffmann = Mass Spectrometry: Principles and Applications

Helfand = Frontiers in Science: Scientific Habits of Mind\*

\* <http://ccnmtl.columbia.edu/projects/mmt/frontiers/web/index.html>

Schultz = Eloquent Science

Skoog (PIA) = Principles of Instrumental Analysis

^ = entire section(s) not required