

Advanced Analytical Chemistry
CHEM 3220 (CRN 2120)
Fall Quarter, 2020

Instructor: Dr. J. Alex Huffman
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Class Zoom Room: <https://udenver.zoom.us/j/94052065959>

Class Time: Mon/Wed, 10:00 – 10:50 AM via Zoom (live, synchronous)
Class Time: Fri, 10:00 – 10:50 AM in Boettcher Aud. Room 102 (& via Zoom)
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). Fall 2020 course will also incorporate aspects of data collection and analysis related to the deployment of CO₂ sensors in the DU Lamont School of Music. These data will be used for indoor air quality/ventilation monitoring for the purposes of COVID transmission monitoring.

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. 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
- 4) Gas-phase indoor air monitoring

Not all skill scan 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
- 5) Data analysis

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

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. Please schedule a time to meet on Zoom.

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 Canvas site. You are not required to read all material listed. Please skim all readings and read more thoroughly the sections that are closest to what we discussed in class. Readings are also provided as a resource for assignments, and in this respect lecture material will NOT always discuss all material that you will examine within assignments.

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. All assignments must be submitted electronically (whether scanned or typed). 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 (~14% 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, but notice will be provided (no pop quizzes). 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	40%
Exams	34%
Group Presentation	10%
Journal Presentations	10%
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, or contact Science Reference Librarian Naomi Bishop (303-871-4499, 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 ACCOMODATIONS

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 ACCOMODATIONS

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 4th 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

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 14	M	Syllabus Introduction + Quarter-long assignments									1
2		Sep 16	W	Analytical Process					Skoog (PIA), Chapter 1				2
3		Sep 18	F	Effective Sci. Prez (my 3-min)					Schultz, Chapters 25 & 26				3
4	2	Sep 21	M	CO ₂ sensor design					-	1		Topics em.	4
5		Sep 23	W	Sensor calibration & experiment considerations						2			5
6		Sep 25	F	CO ₂ mixing ratio: source + sink calcs	PS#1				-	3			6
7	3	Sep 28	M	Quantitative Reasoning	PS#2				Helfand (web), Chapters 1 & 2	4			7
8		Sep 30	W	Guest Lecture: Meg Eastwood (Lit. Searching)	PS#3	PS #1 Due	#1: CO ₂ sensors			5			8
9		Oct 02	F	Igor tutorial	PS#4					6			9
10	4	Oct 05	M	Chromatography - Theory I		PS #2 Due	#2: quant. Reasoning		Braithewaite, Chapters 1 - 2	7			10
11		Oct 07	W	Chromatography - Theory II					-	8			11
12		Oct 09	F	Chromatography - van Deemter equation I		PS #3 Due	#3: lit. research		-	9			12
13	5	Oct 12	M	Chromatography - van Deemter equation II	PS#5	PS #4 Due	#4: Igor			10			13
14		Oct 14	W	Chromatography - Gas & Liquid Chromatography				4 Ideas Due		11			14
15		Oct 16	F	Classroom CO ₂ data						12			15
16	6	Oct 19	M	Mass spectrometry: intro and history		PS #5 Due	#5: Chromatography		de Hoffmann, Introduction	1			16
17		Oct 21	W	MS ion sources - EI					de Hoffmann, Chapter 1	2			17
18		Oct 23	F	MS ion sources - EI	PS#6				-	3			18
19	7	Oct 26	M	MS ion sources - CI		Mid-term EXAM Due			-	4			19
20		Oct 28	W	MS ion sources - CI, ESI					-	5			20
21		Oct 30	F	MS mass analyzers - sector	PS#7				de Hoffmann, Chapter 2.5	6			21
22	8	Nov 02	M	MS mass analyzers - TOF		PS #6 Due	#6: MS-1 ionization		de Hoffmann, Chapter 2.4	7			22
23		Nov 04	W	MS mass analyzers - TOF + Quad					de Hoffmann, Chapter 2.1	8			23
24		Nov 06	F	MS mass analyzers - Quad	PS#8				-	9			24
25	9	Nov 09	M	Presentations		PS #7 Due	#7: classroom data		-			1,2	25
26		Nov 11	W	Presentations					-			3,4	26
27		Nov 13	F	Presentations					-			5,6	27
28	10	Nov 16	M	MS mass analyzers - Trap MS					de Hoffmann, Chapter 2.2,2.3,2.6	10			28
29		Nov 18	W	MS Interpretation	PS#9	PS #8 Due	#8: MS-2 analyzers	13 Ideas Due	de Hoffmann, Ch. 4.1	11			29
30		Nov 20	F	MS Interpretation					de Hoffmann, Chapter 6.1-6.5	12			30
		Dec 02	Th			PS #9 Due	#9: MS-3 interp						
31	-	Dec 03	F	FINAL EXAM - 10:00 - 11:50 AM									31

CHEM 3220 - Adv. Analytical Chem.
Dr. Huffman

Preliminary Schedule - Fall 2020

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