

## CHEM 251 - Fall 2023

### CHEM 251 - ANALYTICAL CHEMISTRY - Fall 2023

**Lectures:** P-144 Mon., Wed. & Fri. 1:00 - 1:50 pm

**Labs:** CLS 424 Tue. or Thurs. 8:00 - 12:40 or 1:00 - 5:40

**Instructor:** Prof. Christopher R. Harrison

email: [charrison@sdsu.edu](mailto:charrison@sdsu.edu)

Office hours: By appointment - <https://harrison-sdsu.youcanbook.me>

Zoom meeting room: <http://sdsu.zoom.us/my/charrison>

**Textbook:** "Analytical Chemistry 2.1" David Harvey (**FREE**)

Downloadable at: <http://bit.ly/2kQioMo> or as print on demand from the bookstore.

**Lab Manual:** Free electronic lab manual and notebook through Google Docs - details provided in class & lab.

**Course Objective:** This course will allow you to develop the foundational knowledge to understand modern analytical chemistry tools and techniques. This is done by learning how fundamental equilibria, and chemical reactions, alter the quantitative composition of a chemical system. In particular this course focuses on the quantitative aspects of chemistry, and the mathematical treatment of chemical equilibria.

#### **Expected Student Learning Outcomes:**

##### **In the lecture:**

- Students will evaluate and interpret the error and uncertainty in measurements.
- Students will apply statistical tools, such as Student T's, F, and Grubbs tests to the comparison of data from chemical analyses in order to identify different and/or equivalent results.
- Students will be introduced to a range of sampling techniques/methods and their advantages and limitations.
- Students will apply their knowledge of acid/base equilibria for the preparation and evaluation of buffers to meet specific requirements.
- Students will calculate chemical equilibria using both chemical concentrations and chemical activities, thus identifying the limitations in the use of chemical concentrations in calculations.

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- Students will explore a range of titrimetric analysis techniques and use their knowledge of the related chemical equilibria to predict the chemical changes through the process of the titrations.
- Students will be introduced to the techniques related to gravimetric chemical analysis.
- Students will apply their knowledge of redox chemistry to the calculation and evaluation of electrochemical analytical methods.
- Students will quantify chemical concentrations based on spectroscopic data, relating chemical interactions with light to the quantity of chemical present in solution.
- Students will be introduced to the fundamental equilibria which govern chromatographic chemical separations.
- Students will gain perspective on the diversity of scientists working to advance analytical chemistry.

### **In the labs:**

- Students will master classical and fundamental analytical techniques for chemical measurement and analysis.
- Students will evaluate the robustness and validity of quantitative chemical measurements.
- Students will use modern chemical analysis tools to quantify the composition of unknown substances.
- Students will learn safe chemical handling and disposal practices.
- Students will learn to maintain a detailed and accurate digital laboratory notebook.
- Students will develop independent time management skills for complex and detailed laboratory procedures.
- Students will become familiar with reading and interpreting standard operating procedures.

**Lecture format:** As this is a flipped classroom the lectures have been prerecorded and are available through Canvas. The lectures are to be watched as “homework” prior to coming to class. The class time will be used to work on problems in groups and master the topics covered in the lectures.

### **Course Materials:**

All course materials will be made available through Canvas.

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### Homework:

There will be weekly homework assignments. The homework is more challenging than typical exam questions. The homework is designed to be done in groups. With only one result submitted and graded by the group. Group size and policy will be discussed and finalized in class.

There will be periodic mandatory, online, **self and peer evaluations** throughout the semester. The evaluation is for you to provide feedback to your group mates, on their performance towards completing the homework. Each student will be evaluated on their contributions in a number of metrics, the average of the scores **may** be used to as a modifier to your homework scores from the previous two weeks.

If your peers acknowledge that you are putting in more work than them, you may get a bonus on the prior weeks homework.

On the other hand, if your peers indicate that you were doing less work than everyone else, your homework score may be reduced slightly for that period.

If you are a student who is making an average contribution to the group your homework score will not be modified.

*Please note that I do not know if I can make Canvas perform these kinds of calculations, so I will be doing them in a separate spreadsheet. I will communicate clearly with any students getting bonuses or reductions in their homework scores.*

### Lab Results:

All lab results will be submitted via through a Google form. Lab results will need to be submitted periodically, as indicated in the course calendar. **For each lab that is late to be submitted at a deadline a 1 point deduction to your total lab grade will be incurred.** Late lab deductions are calculated at each grading period, so a missed lab can incur more than one deduction.

### Lab Notebook:

Digital lab notebooks, will be used in this class. Details on how the lab notebooks work will be reviewed in class. The week following each lab result submission deadline the lab notebooks will be reviewed by your TA and graded for proper data recording, as indicated in the lab manual.

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### Exams:

All mid-semester exams (4) will take place in the regular class time in the designated classroom. The exam questions will include calculations and theory, from both the lectures and labs. The final exam is scheduled by the university and will be two hours long, the final exam is a cumulative exam.

**Exam wrappers** will be required with each mid-semester exam, as a means of self-assessing your progress and adjusting your study strategies accordingly to ensure that you are developing into the most effective learner you can be.

### Grading Plan:

As with any course, the grade that you receive is based upon your demonstrated knowledge of the course material. With this in mind, each graded element of this course will be used to evaluate your mastery of the material. In the table below you will find the point values for each course component.

Component	Quantity	Each	Total	% of Total
Lab Notebook	3	5	15	3%
Homework	14	5	70	16%
Lab Results	Best 7 of 8	10	70	16%
Analytical Literature	2	10	20	5%
Mid-semester Exams	4	50	200	46%
Final Exam (cumulative)	1	60	60	14%
<b>Total</b>			<b>435</b>	

Letter	Cutoff
A	93%
A-	90%
B+	87%
B	84%
B-	80%
C+	77%
C	74%
C-	70%
D	60%
F	< 60%

- Your final letter grade will be determined based upon the total number of points you have earned throughout the course. A tentative grade distribution (in percentages) is tabulated above. Note particularly high or low class averages may shift the grade distribution.
- Note: The grading scale is only an example. You are NOT guaranteed the corresponding letter grade for achieving a given percentage grade. Your final letter grade will be influenced by the overall class grade distribution to reflect your rank in comparison with your classmates.

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## Course Schedule

Week	Dates	Topics	Chap.	Videos	Problem Sets
1	Aug. 21 - 25	Overview, calculations	1	1-3	1
2	Aug. 29 - Sept. 1	Measuring Tools & Measurements	2A-E & 4A	4-7	2
3	Sept. 6 - 8	Distributions & Statistical Analysis	4B-F	8-15	3-5
4	Sept. 11 - 15	Sampling & Equilibrium	7A-C & 6A-F	16-19	6,7
-	Mon. Sept. 18	<b>Exam 1 - Videos 1-19</b>			
5	Sept. 18 - 22	Acid-Base Equilibrium	6G	20-22	8
6	Sept. 26 - 24	Buffers	6H	23-25	9
7	Oct. 2 - 6	Activity coefficients & Equilibria	6I	26-27	10
-	Mon. Oct. 9	<b>Exam 2 - Videos 20-27</b>			
8	Oct. 9 - 13	Titrimetric Analyses - acid-base	9A-B	28-31	11,12
9	Oct. 16 - 20	Titrimetric Analyses - redox	9C-D	34-37	13-15
10	Oct. 23 - 27	Titrimetric Analyses - complexation & precipitations	9E	32, 33, 38, 39	16
-	Mon. Oct. 30	<b>Exam 3 - Videos 28-39</b>			
11	Oct. 30 - Nov. 3	Standardization & Calibration	5A,B,C,E	40-43	17
12	Nov. 6 - 9	Electrochemical Analyses	11A-B	44-47	18
-	Nov. 10	<i>Veterans Day - No Class</i>			
13	Nov. 13 - 17	Spectroscopic Analyses	10A,B,D-G	48-52	19
-	Mon. Nov. 20	<b>Exam 4 - Videos 40-52</b>			
-	Nov. 22 - 24	<i>Thanksgiving - No classes</i>			
14	Nov. 27 - Dec. 1	Chromatography & Electrophoresis	12	53-56	N/A
15	Dec. 4 - 8	<b>Review</b>			
-	Fri. Dec. 15	<b>Final Exam 1:00 - 3:00 pm</b>		<b>Cumulative</b>	

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### Lab Schedule:

- Labs begin on **August 29<sup>th</sup>**.
- The first two weeks of the lab are designated for lab check-in and equipment calibration - come to the labs prepared.
- There will be a set schedule for each student to do the analyses.
- The lab grades are based on your quantitative analysis results for each lab, those results are submitted through Blackboard, with the grade determined by the accuracy of the analysis.
- There are four designated lab submission deadlines (see Course Calendar) when a specific number of analyses must be submitted for grading.
- Labs can be graded upon request outside of the scheduled submission deadlines.
- Labs will only be graded ONCE. The grade received is FINAL.

### Lab Grade Review

- If the grade for an analysis is below 5 points the student can earn up to 2 points of credit. To do this the student must meet with Dr. Harrison and present a viable reason for why the analysis result was far from the true value. If a definitive cause for the error can be found, the student will get 2 points of credit added back to their score. If no clear source of error is found they will receive 1 point of credit.
- *This review of the lab grades must take place within one week of the lab having been graded.*

### Grading:

- The lab grades are determined by the accuracy of your analysis and are ranked out of 10 points. To obtain 10 points for a lab you must have a very accurate analysis. The lowest grade for any submitted lab will be 2 points.
- The Grade Center in Canvas is used to display all your individual grades, it is not used to calculate your final grade, due to the best X of Y nature of some of the grading components. Please use the Grade Center to verify that the correct grade has been entered for your assignments and midterms.

### On-Line Material:

- Please ensure that Canvas has your correct/active email address as the Canvas email feature will be frequently used to relay pertinent course information. It is your responsibility to ensure that you are receiving these communications.
- All course materials will be distributed and accessed through Canvas.

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- Some course components will be conducted through Google Drive, such as Google Forms for the submission of lab results. Links to these items will be provided through Canvas.

### **Absence & Deadline Policies:**

- All deadlines are firm and extensions will not be provided on an individual basis.
- Technology failures (e.g. webpages not loading, dog ate my computer, internet being down...) are likely to occur, do not leave the submission of homework or labs to the last minute. No extensions will be provided for such occurrences.
- Each student will be allowed one unexcused absence from a lab. For this absence the student will be allowed to make-up the missed lab period in one of the other lab sections. The student is not guaranteed to have access to any of the labs that require advanced sign-up when making-up a lab in a different lab section.
- Subsequent absences from lab may be allowed to be made-up provided that there was appropriate justification, as determined by the course instructor, for the missed lab.
- Unexcused absences for an exam will be treated as a zero. If an excused absence is allowed (e.g. medical reason, conference schedule conflict...) the points value for the exam will be redistributed over the other exams, or an estimate of the likely exam grade will be made based on all other exams taken in the course during the semester (comparing the student's performance to that of all their classmates as a benchmark).

### **Accommodations:**

Accommodations: If you are a student with a disability and are in need of accommodations for this class, please contact Student Disability Services at (619) 594-6473 as soon as possible. Please know accommodations are not retroactive, and Dr. Harrison cannot provide accommodations based upon disability until he has received an accommodation letter from Student Disability Services.

### **Preferred Names & Pronouns**

Any student who wishes to be addressed by a name other than what is presented in Canvas is encouraged to contact Dr. Harrison via email with the name you wish to use in this course. Similarly, if you have preferred pronouns that you wish to be addressed by please contact Dr. Harrison.

Dr. Harrison will communicate your desires to the TAs and all instructional staff will gladly honor your request.

### **Student Privacy and Intellectual Property**

The Family Educational Rights and Privacy Act (FERPA) mandates the protection of student information, including contact information, grades, and graded assignments. I

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will use Canvas to communicate with you, and I will not post grades or leave graded assignments in public places. Students will be notified at the time of an assignment if copies of student work will be retained beyond the end of the semester or used as examples for future students or the wider public. Students maintain intellectual property rights to work products they create as part of this course unless they are formally notified otherwise.

### **Religious observances**

According to the University Policy File, students should notify the instructors of affected courses of planned absences for religious observances by the end of the second week of classes.