Chemistry 220 University of San Diego
Analytical Chemistry Fall 2020

Class: Thurs 9:15 – 10:35 am in SCST 133 or remote; Credit 3 units

Lab: Monday or Wednesday 1:25 pm-5:25pm in SCST 494 or remote

Contact Information: Dr. David De Haan, Office Phone: x6882, Email: ddehaan@sandiego.edu
Personal Zoom meeting room: https://sandiego.zoom.us/j/6420471749
Office Hours: M 10:30 – 11:30, T 10:45 am – noon, Th 2:30 – 3:30 pm, F 11:45-1:30 pm, and by appointment.

Description and Overview of the Course:
Welcome! Analytical Chemistry is the science of chemical measurement. It addresses questions such as, "How do you know if you have had COVID-19?" and "Is there a better way to measure copper in drinking water?" Our society relies on our ability to get answers to questions like these. Analytical chemistry itself rests on a foundation of statistics, standards and strategies that allow us to determine the *quality* of our results.

Class sessions (Thursdays 9:15-10:35am) are organized around what you *need to know* to perform the lab activities. Class activities include lectures, discussions, demonstrations, problem-solving practice, group activities, calculations to perform, an oral presentation, and two exams. Lab activities include not only making chemical measurements and recording data in your electronic lab notebooks ("the lab"), but also coding in Python to automate measurements and data processing, and using any time this frees up for data analysis, error evaluation, and report writing. This course has 2 exams, neither of which is comprehensive.

Come to class on time, prepared and ready to participate! Before class, you are expected to have completed any reading / video assignments and quizzes due. This course material quickly builds on knowledge from previous classes, so it is important to keep up. Please take advantage of office hours. I also encourage e-mail questions, which I will respond to on the course discussion board on Blackboard so that everyone has access to the information. However, please allow up to 24 hours for a response. You will find a calendar for the course on Blackboard, along with laboratory handouts, homework and Python assignments, as well as writing resources.

General Course Goals
Upon completion of this course, you will be able to:
1. summarize and interpret lab results using statistical functions,
2. work skillfully with others in any type of laboratory,
3. evaluate the quality of a measurement,
4. use the scientific method, and
5. communicate the results of your work in person and in writing.

Course learning outcomes
Upon completion of this course, students will be able to:

1. **Implement a range of chemical quantitative methodologies while minimizing experimental error.**

Examples:
- perform titrations
- create reliable standards for chemical analysis
- prepare buffer solutions at target concentration and pH values
- make quantitative measurements using the techniques of spectroscopy, chromatography, electrochemistry, and kinetics
- build and fully utilize calibration curves
- automate repetitive tasks/calculations

2. **Quantitatively assess the quality of your data and draw appropriate conclusions from your results.**

Examples:
- quantify the level of random error in any measurement or laboratory result
- assess the significance of differences between datasets using appropriate statistics
- develop and optimize a sampling plan or measurement method

Required Materials:

- **Textbook**: *Quantitative Chemical Analysis, 9th or 10th Ed.,* Harris (W.H. Freeman, 2016 / 2020)
- **Calculator** capable of scientific notation, exponential and logarithmic calculations, and standard deviations
- **A laptop or tablet device is required**

Electronic Lab Notebook (ELN) $15 – We will set up your online lab notebook on the first day of lab. You will have three weeks to use the service before paying for it. (After three weeks you will be locked out of your notebook until payment.) Access it using this sign-up link: https://mynotebook.labarchives.com/login.

- **Safety glasses** (when working with certain household chemicals)

Grading System:

Assignment:	Points	
Exam 1	100	A: 90% or above
Exam 2	100	B: 80 to 90%
Lab Work: Prelab, Data/Observation, Results/Analysis, PythonLabs	360	C: 68 to 80%
HW Assignments	60	D: 58 to 68%
Quizzes and Participation	70	F: less than 58%
Project Lab Presentation	60	
Total Points	750 pts total	

Explanation of Assignments

Reading and/or **video + quiz assignments** are given to help you get ready for each class session. While you read or watch, **take notes** on important definitions and concepts. Try the simple problem examples in the text. All quizzes are open book / open note, and must be completed before class begins.

Homework assignments. There are four individual homework assignments (on DataCamp) and four group homework assignments so that you can practice using course concepts. On the group assignments, it is important to actively participate as your group works through the problems to maximize your understanding of experiment goals, methods and calculations. When you run into a homework problem that your group can't solve, don't give up – get help! Drop into an office hour, contact another group, post a question on the discussion board, or email a question. Group homework assignments must be turned in as a group (never individually) through Blackboard by 11:59 pm on Friday the week they are assigned on the course calendar, unless otherwise noted.

There will be two **exams**. They are written assuming that you have mastered the basics, and seek to probe cumulative knowledge in the course to date and to evaluate how well you can apply your knowledge to different situations. You may be asked to evaluate the quality of a measurement, solve a problem, or suggest a method of analysis for a certain chemical or system.

Dates for the exams are as follows:

Thursday Oct 1st 9:15 am – 10:35 am: Midterm exam #1
Thursday Nov 4th 9:15 am – 10:35 am: Midterm exam #2

Make-up exams/make-up labs will **not** be possible unless your absence has been approved *in advance*, and you provide *documentation* of the reason for your absence (serious illness, conference travel, etc).

Experiments. The goals of each experiment may vary, but many experiments allow you to organize information, construct hypotheses, design a measurement strategy, and carry it out (while troubleshooting). Data analysis and evaluation are integral parts of each experiment – in fact, it is often impossible to know if you have taken enough data before doing at least some preliminary analysis. Plan to stay in the lab session for the full 4 hours each week so that you can maximize efficient "synchronous time" with your lab partners and instructor, and minimize the work you must finish later. When you finish data collection, work on data analysis and writing conclusions.

Lab experiments will usually consist of the following:

a) Prelab assignment
b) Collect data/observations in lab
c) Complete a Results and Analysis (RA) section

Module	Prelab	Data and Observations (D/O)	Results and Analysis (R/A)	Total
1		10 pts	20 pts	30 pts
2	20 pts	20	20	50
Python1	10		20	30
3	10	20	20	50
Python2	10		20	30
4 ASV	10	10	20	40
5 Chrom	10	20	20	50
6 Project	10 pt proposal	30	30	80
			Presentation 60	60

a) **Prelab assignment:** Before each lab, you will be asked to do some preparatory work. Typically this involves reading through the experiment, setting up your D/O section in 2-column format, and doing some type of preparatory calculations. Every prelab should include:
   1. A brief goal/purpose statement for the experiment,
   2. A list of needed reagents and equipment,
   3. A summary of any chemical hazards and how they will be addressed,
   4. The procedure summarized in your own words (in D/O left column),
   5. Space set up in D/O right column for data and observations, including at least one data table ready to be filled in, and
   6. Prelab calculations (if any).

   Pre-lab assignments must be submitted in your electronic lab notebook (ELN) by 11:59 pm the day before your lab. Late prelabs turned in after this deadline but before lab begins are worth up to 50%. Prelab assignments must be complete before you start the lab activities.

b) **Data and Observations (D/O) section**: All laboratory work is to be recorded in the D/O section during the lab session: both what you do *and* why you do it. This includes experimental procedures, on-the-fly changes, raw data with units, and observations. Submit the D/O section at the end of each lab period. (Any part of the D/O section edited after the lab session ends will not be graded.)

c) **Results and Analysis (R/A) section:** Each experiment will require follow-up calculations and analysis that will also be submitted via the ELN. Each R/A section should include the following parts:
   1. Sample calculations and equations – if you prefer working with pen and paper, just compile pictures of this work in proper order into a single Word document, and upload this document to the ELN,
   2. Quantitative error analysis,
   3. Completed Python code in an uploaded Jupyter notebook that includes your name in the filename,
   4. All summary tables, figures, and uploaded files must have captions and associated explanatory narrative (a "guided tour" pointing out important features and the quality of the results), and
   5. A 3-4 sentence conclusion summarizing the main outcomes of the lab and evaluating whether goals were achieved.

   R/A sections are typically due at 11:59 PM on a Friday one week after the lab is completed. Late "Results and Analysis" will lose 20% for every day that it is late and will receive no credit after 5 days. See the course calendar for specific due dates.

Participation Grade: There will be regular opportunities to earn points based on effort, attendance and participation during activities in class.

USD's Academic Integrity Policy is followed in this course:

- *Exams:* By signing an exam, you are stating that you have neither given nor received help on it, and have used only allowed sources (if any).
- It is considered a violation of the Academic Integrity Policy to possess or otherwise use *course materials* (i.e., lab reports, homework or homework keys, exams) from previous semesters.
- *R/A sections*: All ideas that are not your own must be properly referenced. Direct quotes must be set off by quotation marks and referenced. Follow these guidelines to avoid plagiarism.

Attendance Policy

Lab attendance is mandatory since working together is a vital part of this course. Your group needs you! Labs will begin promptly at 1:25 pm. The only reasons for missing a lab that could allow admission to a make-up lab session are:

1) Serious illness with proper documentation (i.e. doctor's note) or
2) Required attendance at an official University, graduate school, or military event (documentation also needed).

However, if you have a "category 2" conflict with a scheduled lab day, you need to notify and get approval from the instructor for your absence as far in advance as possible. If your absence does not have prior approval, it is unexcused and your grade on that experiment will be prorated downward.

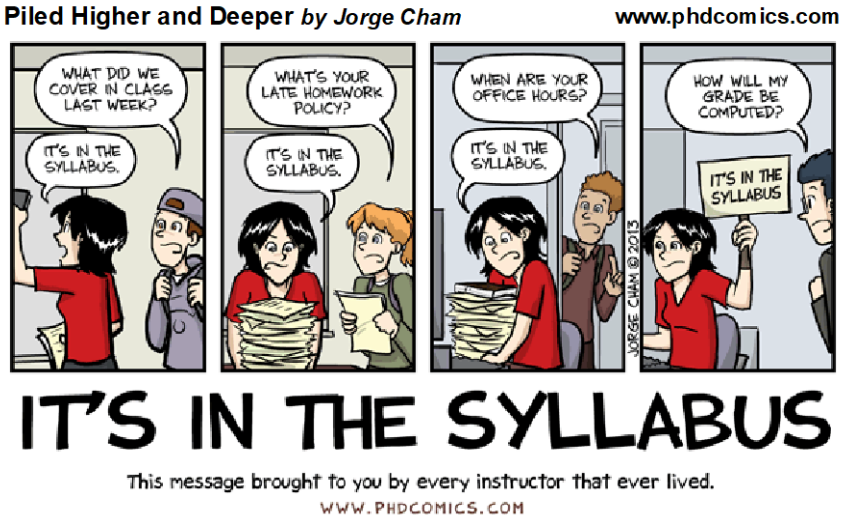
Unexcused absences cannot be made up. If you miss more than one lab in the semester with an unexcused absence, you will fail the course.

Accomodations for Learning Disabilities

Students with any sort of learning disability who believe that they may require accommodations for this class are encouraged to contact Disability and Learning Difference Resource Center in Serra 300 (disabilityservices@sandiego.edu) within the first three weeks of the semester.

IMPORTANT NOTES:

- Allow up to 1 week for the return of assignments.
- Joining class late can be disruptive. Please be on time.
- You are expected to maintain a respectful attitude toward *everyone* in the class.
- Parts of the course are subject to change, to meet the needs of the students.



Chem 220 Fall 2020 Tentative Schedule

Week	Prelab Problems	Lab Experiment	Class Topic Th 9:15 – 10:35 am	Reading Assignment (10th Edition)	Assignments Due Friday by 11:59 pm (10th Edition)
Aug 17-20		Introduction to course (Blackboard, ELNs, CATME, Datacamp, Jupyter NBs), Module 1: Density of Solutions	❑ Protic Acids, Bases, Buffers *(6.5-6.7, 9.1-9.5)* ❑ Polyprotic Acids *(10.1-10.3)* ❑ Titrations *(7.1-7.2,11.4-11.7)*	*Review Chapters 1, 2.1-2.9, 3.1-3.3, 4.6, 6.5-6.7; Read Chapter 0.2, 9.1-5, 10.1-3, 11.4-7*	HW #1: complete DataCamp "Python Basics" and "Python Lists"
Aug 24-27	Prelab Exp#2 in ELN plus EOC probs 9-7, 9-8 in 9th ed. (9-7, 9-9 in 10th edition)	Module 2: Acids, Bases, and Buffers	❑ Basic statistics (4.1, 4.3) ❑ Comparing datasets: *F*-test and *t*-test *(4.2, 4.4)*	Read Chapters *4.1-4.4*	HW#2: complete DataCamp "Functions and Packages" and "Numpy"
Aug 31-Sep 3	Prelab: in ELN plus EOC probs 9-36 and 10-14 (9-33, 10-14 in 10th ed.)	Module 2: Acids, Bases and Buffers	❑ Ionic Strength and Activity *(8.1-8.3)* ❑ Calculating pH during titrations *(11.1-3)*	*Read Chapters 8.1-8.3, 11.1-3*	Results and Analysis Module 1
Sep 10-12 *(Monday lab meets on Saturday Sep 12)*	Prelab: in ELN (do EOC exercise 11-B)	PythonLab 1: Calculating pH	❑ Molecular Spectroscopy *(18.1-18.4, 18.6)* ❑ Kinetics and Enzyme Analysis (lecture slides)	Read Chapters *18.1-18.4, 18.6, p408-410 (416-420)*	Results and Analysis Module 2 *due Monday 14 Sep at 11:59 pm.*
Sep 14-17	Prelab in ELN	Module 3: Kinetics	❑ Propagation of Error (3.4-3.5) ❑ Quality Assurance (5.1-5.2)	Read chapters *3.4-3.5, 5.1-5.2*	groupHW#3: 4-4, 4-14, 9-4, 9-26, 11-6, 11-18 4-5, 4-14, 9-4, 9-23, 11-6, 11-18, in 10th Ed + PythonLab 1
Sep 21-24		Module 3: Kinetics	❑ Electrochemistry (Ch 17) ❑ Calibration Methods (5-3, 5-4)	Read chapters *4.7, 5.3 – 5.4, 15.1, 17.1 – 17.5*	groupHW#4: 3-16, 3-22, 8-10, 8-13 18-18 3-16, 3-21, 8-10, 8-13, 18-18 Project lab idea due
Sep 28-Oct 1	Prelab in ELN. Online lecture / quiz: Method of least squares (4.7)	PythonLab2: Linear Regression (Will finish most of Module 3 calculations here)	Test 1		PythonLab 2: Analysis of sample data and questions (due T/W Oct 6/7)
Oct 5-8	Prelab in ELN with EOC problems 17-34, 5-25 17-34, 5-28 in 10th Ed.	Module 4 Virtual Lab: Cu Analysis by Anodic Stripping Voltammetry	❑ Introduction to Chromatography and Separation Techniques (Ch 23)	Read Chapter *23*	groupHW#5: 5-3, 5-6, 5-18, 14-25 5-3, 5-7, 5-21, 14-25 + Results and Analysis Module 3
Oct 12-15	Prelab in ELN with EOC 23-C and 23-17 23-C and 23-18 in 10th Ed.	Module 5 Virtual Lab: Chromatography	❑ Liquid Chromatography (25) ❑ Gas Chromatography (24) ❑ Simplex optimization	Read chapter *25.2-3, ch* 24.1-3	Results and Analysis Module 4 Project proposal due
Oct 19-22	Prelab in ELN	Module 5 Virtual Lab: GC optimization	❑ Guest lecture by L. Perry: Building multivariate regression models with experimental data		groupHW#6: 17-33, 17-35, 23-28, 24-34a 25-12, 25-13ab, 25-18a-e, 17-36, 17-38 23-27, 24-37a, 25-12, 25-13ab, 25-19a-e

Oct 26-29	Prelab: prepare ELN	Module 6 Project	❑ Mass Spectrometry (22-1, 22-2)	Read chapter 22.1, 22.2	Results and Analysis Module 5
Nov 2-5		Module 6 Project	Test 2		
Nov 9-12		Module 6 Project Prepare draft presentations	Peer review of draft presentations		
Thursday Nov 19: 8 – 10 am: Project presentations					