

**Colorado State University  
Fall Session 2019**

**CHEM 334  
Quantitative Analysis Laboratory  
Course Syllabus**

**Laboratory Location:** Yates 503

**Instructor:** Dr. Joseph DiVerdi  
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**Office Location:** Yates 504A  
**Office Phone:** 970.980.5868  
**Office Hours:** MTWRF 11:00 AM – 12:00 PM  
**Office Hour Location:** Yates 501, 502, 503 or 504

**Graduate Teaching Assistant:** Julie Holder  
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**Office Hours:** M 1:00 PM – 3:00 PM  
**Office Hour Location:** Yates 503

**Section #:** L01: T: 9:00 AM-12:00 PM  
**Section #:** L02: T: 12:00 PM -3:00 PM

**Graduate Teaching Assistant:** Collin Perry  
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**Office Hours:** MW 3:00 PM – 4:00 PM  
**Office Hour Location:** Yates 503

**Section #:** L03: R: 9:00 AM-12:00 PM  
**Section #:** L04: R: 12:00 PM -3:00 PM

**Course Purpose:** The purposes of this laboratory course are: (1) To introduce the techniques and methods of analytical chemistry to the student. (2) To develop more sophisticated laboratory skills in the student. (3) To increase the student's ability to communicate effectively and professionally both in writing and orally. (4) To develop the student's ability to read, interpret and understand modern professional chemical literature. (5) To foster, encourage and develop critical thinking and higher-order creative thinking in the student.

**Course Topics:** Tools, instruments, equipment and methods used in the analytic chemistry laboratory; the experimental quantitative measurement of chemical species; the application of analytical methods to chemical problems; the development of quantitative analytical methods and the application of advanced mathematics to problems in analytical chemistry.

**Prerequisites:** Previous enrollment in CHEM 114 - General Chemistry Laboratory 2 and either previous or concurrent enrollment in CHEM 335 - Introduction to Analytic Chemistry.

**Textbook:** No textbook is required. Textbooks that should be on the bookshelves of professional chemists at this stage in their development: (1) *Quantitative Chemical Analysis*, Daniel Harris, ISBN 9780716770411; (2) *An Introduction to Error Analysis*, John Taylor, ISBN 9780935702750.

**Academic Policies & Integrity:** The University's policies on Students' Responsibilities and Rights including Personal Integrity, Academic Integrity and related areas are presented at <http://catalog.colostate.edu/>, especially as described in Section 1.6 on "Policies and Guiding Principles". These policies will be followed in this course. The short of it is compactly contained in the Honor Pledge:

*"I will not give, receive or use any unauthorized assistance."*

Assistance from colleagues, experts and other sources is authorized but a threshold exists above which the assistance must be cited. This will be discussed (at some length) in the laboratory sessions.

Additional information on University policies on course registration, add/drop, withdraw and incomplete grades can be found at <http://www.catalog.colostate.edu/>, especially as described in Section 1.7 on "Advising and Registration". These policies will be followed in this course also.

**Web-based Course Tools:** <http://canvas.colostate.edu/>. As a registrant of this course, the student can access its site and must do so to view announcements, receive grades and submit laboratory report and presentation files. Experimental descriptions are available at <http://www.chem.colostate.edu/diverdi/>.

**Course Plan & Organization:** This laboratory course will be conducted as a "local" course in contrast to a "distance" course. As such, the student is expected to attend each laboratory session from beginning to end of each session, not arrive late and not plan to leave early. Each student is required to submit Laboratory Reports individually although the experimental data used in the creation of these may be collected as a group.

**Laboratory Notebook:** Each student will create and maintain a Laboratory Notebook throughout this Laboratory course and is required to obtain a bound **not a spiral book** for this purpose. It is best used as both a journal (or laboratory diary, if you will) and a workbook. This Laboratory Notebook will be reviewed and a grade applied to it based on the customary requirements for a laboratory notebook.

**Laboratory Experiments:** There will be eleven distinct Laboratory Experiments performed by the student in this course. Each Laboratory Experiment will occupy one week of laboratory time and a Laboratory Report will be submitted individually by each student and for each experiment.

**Experimental Protocol & Description:** This document describes a particular experiment with a succinct background explanation, experimental procedure and a description of the analysis of the resulting data. An instance of this document exists for every experiment that will be performed in this course. All of these documents will be available in electronic form on RamCT. The student is expected to obtain and study each one of these documents prior to arriving at the laboratory for the corresponding experiment and to strive to understand the theoretical chemistry that will be applied. The use of a personal library or various web-based resources is advised (beware of bogus sources - seek out reputable sources and don't accept everything that is "published"). The laboratory printer is not to be used for creating hardcopy of these documents.

**Laboratory Report:** A Laboratory Report is the final product of a Laboratory Experiment. Laboratory Reports will follow the standard Introduction, Materials and Methods, Results, Discussion, Acknowledgements and References format found in professional journals. (Look up the journal [\*Analytical Chemistry\*](#) if you're not already familiar with it.) Each Report will be no more than two (2) pages in length and either single or double column format. The Laboratory Report will be submitted both (1) in hardcopy form and (2) coincidentally as a single PDF file (no other format is acceptable and **a zero grade will be issued if either is not submitted**) at the beginning of the laboratory period one week after the corresponding experiment commenced. No late submissions will be accepted. No "re-grades" will be performed. Plan your work accordingly. Make requests for help to the GTAs and Laboratory Instructor in a timely manner. Print your hardcopy version from the PDF version so that they are identical.

A professional style for the names of files submitted is required. Use lower case exclusively. Use the following format for Laboratory Reports and for Oral Presentations submitted in this course, respectively:

"334\_last\_name\_report\_#1.pdf"  
"334\_last\_name\_oral\_presentation.pdf"

**Oral Presentation/Examination:** Each student will make a formal oral presentation of one of the Laboratory Experiments and Laboratory Reports. The choice of the Experiment to be used in the Oral Presentation will be made by the student in consultation with and with the approval of the Laboratory Instructor. A projector and companion computer will set up in a classroom for presentations and a laser pointer will be provided. Students will bring their presentations on their own USB disks in **PDF format only** (no other format will be accepted). Students will make a presentation in their regularly scheduled

section. Each student will be allocated fifteen (15) minutes in which to make a presentation. All students are expected to be present for all presentations. Students will be expected to make a serious oral presentation at an upper division university level on a topic of chemistry and to answer serious questions from the audience.

**Laboratory Grades:** Each student's final course grade will be based on (1) the scores earned on the eleven Laboratory Reports (each worth 100 points), (2) the score earned on the Oral Presentation (worth 100 points) and (3) the score earned on the Laboratory Notebook (worth 100 points). The final course grade will be based on the number of points earned out of a possible 1300 points. The final letter grade issued will be based on breakpoints set by the Laboratory Instructor in the final earned point distribution.

The Oral Presentation must be made and the slides must be submitted (as a PDF file) coincident with the delivery of the presentation. Failure to complete both of these tasks at the appointed time will result in a failing course grade, that is, "F."

If a student fails to submit one of the eleven Laboratory Reports (for any reason), the Oral Presentation score will be substituted for the missing Laboratory Report score as well as being counted as the Oral Presentation score.

If a student submits all eleven Laboratory Reports and the Oral Presentation score is higher than the lowest of the eleven Laboratory Report scores, the Oral Presentation score will be substituted for the lowest of the Laboratory Report scores as well as being counted as the Oral Presentation score.

No extra credit or alternate grading schemes will be offered or issued.

Final course grades will be issued from the following list: A, B, C, D or F. No "plus" or "minus" values for the final course grade will be issued.

There are no written examinations, including a final examination, in this laboratory course.

**Laboratory Topic Schedule:**

| Laboratory Schedule |  |  |
|---------------------|--|--|
| Week Beginning      | Topic  | Notes  |
| 26 Aug              | Course Introduction,<br>Laboratory Check-In  |  |
| 2 Sep               | Experiment #1  |  |
| 9 Sep               | Experiment #2  | Experiment #1 Report Due                               |
| 16 Sep              | Experiment #3  | Experiment #2 Report Due                               |
| 23 Sep              | Experiment #4  | Experiment #3 Report Due                               |
| 30 Sep              | Experiment #5  | Experiment #4 Report Due                               |
| 7 Oct               | Experiment #6  | Experiment #5 Report Due                               |
| 14 Oct              | Experiment #7  | Experiment #6 Report Due                               |
| 21 Oct              | Experiment #8  | Experiment #7 Report Due                               |
| 28 Oct              | Experiment #9  | Experiment #8 Report Due                               |
| 4 Nov               | Experiment #10   | Experiment #9 Report Due                               |
| 11 Nov              | Experiment #11   | Experiment #10 Report Due                              |
| 18 Nov              | Presentation on Presentations  | Experiment #11 Report Due                              |
| 25 Nov              | University Holiday   |  |
| 2 Dec               | Laboratory Check-Out<br>Laboratory Notebook Evaluation<br>Draft Oral Presentation Review | Draft Oral Presentation Slides Due<br>(hardcopy only)  |
| 9 Dec               | Oral Presentation/Examination  | Oral Presentation Slides File Due<br>(electronic only) |
| 16 Dec              | Final Examination Week   | No final examination                                   |

**University Activity Conflicts:** Any student having a conflict with the Schedule described in this syllabus as the result of scheduled University Activities must to inform the Instructor via e-mail during the first week of the semester. The options will be reviewed at that time and accommodations will be made, both as

provided for by University Policy. Otherwise, students are expected to be executing according to the Schedule presented in this Syllabus.

**Laboratory Experiments:** The following is a list of titles of experiments that will be performed in this laboratory course. The order in which these experiments are performed may vary depending upon the needs of the course. The exact schedule will be clearly communicated during the semester.

1. Creation of a publication-quality manuscript figure and figure legend.
2. Gravimetric calibration of volumetric glassware.
3. Spectrophotometric determination of a single analyte and calibration by the methods of internal standard and standard additions.
4. Spectrophotometric determination of iron (single analyte).
5. Spectrophotometric determination of copper and nickel (multiple analytes).
6. Standardization of an aqueous base with a primary standard and determination of an acid by volumetric titration with a colorimetric end-point.
7. Determination of acids by volumetric titration with a pH end-point.
8. Determination of calcium by volumetric titration of a complexometric reagent with a colorimetric end-point.
9. Determination of calcium by Atomic Absorption Spectroscopy.
10. Determination of fluoride using potentiometry and an Ion Selective Electrode (ISE).
11. Determination of chloride by volumetric titration with a potentiometric end-point.

**Laboratory Safety:** The physical safety in the laboratory of all personnel including students, GTAs and faculty is of paramount importance. Proper laboratory dress and conduct are required at all times. Students are required to secure and use their own approved (!) protective eyewear. There are no "loaners" available in the laboratory. Additionally, students are required to be suitably attired in the laboratory according to the clearly and previously identified in the lower division laboratory courses at all times. Lastly, professional and courteous conduct is required at all time. Students failing to abide by any of these requirements will be summarily ejected from the laboratory without provision for making up any experimental work missed and without any special consideration in the evaluation and grading of the corresponding submitted materials.

**Topics of Great Importance:** The following items represent various methods and techniques that are central to the ways of Quantitative Analytical Chemistry.

1. Ways to prevent the contamination of reagents, solid, liquid, wash bottles, pipette tips, *etc.*
2. How to use volumetric glassware to prepare solutions, when the use of volumetric glassware is warranted and when Erlenmeyer glassware is sufficient and related issues.
3. The benefits and perils of using Descriptive Statistics for the analysis of experimental data and how well (or poorly) Excel does the job of analyzing and visualizing scientific data.
4. How and when to dry a solid to constant weight.
5. Strategies for dispensing a known weight of a solid.
6. The methods of the triple wash and the quantitative transfer.
7. How to retain an analyte when manipulating it in various ways, for example, filtering a solution with a suspended solid in it and quantitatively retaining the solid and solution.
8. The Propagation of Uncertainty method of error analysis.
9. Concentration units including molarity, percent by weight or volume and parts per million (ppm).
10. How to read analog and digital instruments.
11. How to create a high-quality graph and how to embed it in a document.
12. How to create a high-quality laboratory report modeled on professional writing.
13. How to create robust and portable documents and presentations.

**Homework:** There is no specifically assigned or named "homework" for this upper-division university course. Your responsibilities outside of the laboratory are: (1) to prepare for each particular experiment by obtaining the appropriate Laboratory Description prior to the time when you will begin the actual experimental work and (2) to create an upper-division university Laboratory Report. Within these short descriptions you are responsible for seeking out the information necessary for completing these tasks. As in other upper-division university courses it is considered customary to spend a serious three times the actual contact time on these "homework" activities. Three hours of scheduled laboratory time each week translates into nine hours of out of laboratory work.