

UNIVERSITY OF CALGARY
DEPARTMENT OF CHEMISTRY
COURSE SYLLABUS
FALL 2019

COURSE: CHEM 311, ANALYTICAL CHEMISTRY: QUANTITATIVE ANALYSIS

CONTACT INFORMATION

LEC	DAY & TIME	ROOM	INSTRUCTOR	OFFICE	EMAIL	OFFICE HOURS
L01	Tue & Thu 12:30-13:45	ENG 60	Dr. Amanda Musgrove	SA 144F	amanda.musgrove@ucalgary.ca	See D2L

Drop-in office hours will be posted on D2L; appointments may also be requested by email or online via

<https://amandamusgrove.youcanbook.me>

You can also ask and answer questions on the class Piazza site: <https://piazza.com/ucalgary.ca/fall2019/chem311>

To help me reply faster, please put "**CHEM 311**" in the subject line of any email correspondence.

Departmental Office: Room SA 229, Tel: (403) 220-5341, e-mail: uginfo@chem.ucalgary.ca

COURSE DESCRIPTION

Lectures: Principles and practice of precision measurement in chemistry. Statistical treatment of data. Acid-base and oxidation-reduction equilibria. Complexometric analysis. Laboratory: Quantitative analysis of organic and inorganic materials.

TEXTBOOK

Using **EITHER** of the following texts are recommended for study in CHEM 311. **Older editions are acceptable**; however, it is the students' sole responsibility to ensure that s/he can identify the appropriate chapter readings and practice problems in alternate texts.

Quantitative Chemical Analysis, 9th Ed.; Daniel C. Harris, 2016, W.H Freeman and Company.

A copy of this text is made available on reserve in the library:

http://sirsi1.lib.ucalgary.ca/uhtbin/cgiisirs/x/0/0/57/5/3?searchdata1=4216033{CKEY}&searchfield1=GENERAL^SU BJECT^GENERAL^^&user_id=WEBSERVER An 8th and a 9th edition of Harris are available in SA 144 for use in-room.

Supplemental resource: *Analytical Chemistry 2.1*: David Harvey, 2016, published online:

http://dpquadweb.depauw.edu/harvey_web/eTextProject/version_2.1.html

Students will need to supplement readings from Analytical Chem 2.1 with material from Harris (above) for some course topics – see notes packages for detailed course readings.

TOPICS INCLUDED AND SUGGESTED TEXTBOOK READINGS

Chapter references are from the Harris 9th ed. textbook.

TOPIC 1: INTRODUCTION TO ANALYTICAL CHEMISTRY

Chapter 0: The Analytical Process

Chapter 1: Measurements

Chapter 2: Tools of the Trade

AFTER STUDYING THIS TOPIC, YOU SHOULD BE ABLE TO:

- Explain the general principles of quantitative analysis
- Identify common analytical methods and equipment, and describe their correct usage

TOPIC 2: UNCERTAINTY AND ERROR ANALYSIS

Chapter 3: Experimental Error

Chapter 4: Statistics (4.1-4.6)

AFTER STUDYING THIS TOPIC, YOU SHOULD BE ABLE TO:

- Identify sources of uncertainty in chemical measurements
- Use appropriate statistical techniques to describe and quantify the uncertainty in chemical measurements

TOPIC 3: QUANTITATIVE ANALYSIS: EQUILIBRIUM AND TITRATIONS

Chapter 6: Chemical Equilibrium

Chapter 7: Let the Titrations Begin

Chapter 8: Activity and the Systematic Treatment of Equilibrium

Chapter 9: Monoprotic Acid-base Equilibria

Chapter 10: Polyprotic Acid-base Equilibria

Chapter 11: Acid-base Titrations

Chapter 12: EDTA Titrations

Chapter 15: Electrodes and Potentiometry

AFTER STUDYING THIS TOPIC, YOU SHOULD BE ABLE TO:

- Use equilibrium principles to quantitatively describe the composition of solutions:
 - Monoprotic and polyprotic acids and bases
 - Metal ions with chelating reagents
 - Sparingly soluble compounds
- Describe (qualitatively and quantitatively) the changes that occur in these solutions during a titration
- Explain and apply important titration techniques, including: endpoint detection, back titration, masking interferants
- Describe the effect of analyte concentration on electrochemical potential and how potentiometry is used in endpoint detection

Students are responsible for all material included in lectures and laboratories. Some examinable course material may not be addressed directly in lecture, but will be discussed in laboratory or in the assigned readings and homework.

LABORATORY EXPERIMENTS (3 + 7, 10 WEEKS)

② "TRAINING CAMP"

3 weeks of hands-on skill development.

② ANALYSIS FOR SODIUM CARBONATE

Skills: Standardization, primary standards, acid-base titrations.

② ANALYSIS OF AN ACID MIXTURE

Skills: Potentiometric (pH) titrations, acid-base titrations, correcting for non-removable impurities.

② DETERMINATION OF SOLUBLE CHLORIDE

Skills: Volhard titration, Back titration, precipitation, filtration, argentometric titration.

② ANALYSIS FOR COPPER IN BRASS

Skills: Iodometric titration, sample preparation, alternation of analyses.

② DETERMINATION OF ETHYLENE GLYCOL BY FUNCTIONAL-GROUP ANALYSIS

Skills: Redox titration, primary standards.

② DETERMINATION OF NTA IN DETERGENT BY POTENTIOMETRIC TITRATION

Skills: Potentiometric titration, ion-selective electrodes, Gran plots, surfactant analysis.

② ANALYSIS OF CALCIUM IN LIMESTONE BY COMPLEXIMETRIC TITRATION

Skills: EDTA titration, complexation reactions.

WHILE COMPLETING THE LABORATORY COMPONENT, YOU WILL:

- Develop hands-on lab skills and the ability to perform chemical manipulations with high precision and accuracy.
- Determine the most relevant sources of uncertainty/error in analytical techniques.
- Demonstrate appropriate record-keeping by keeping a lab notebook that conforms to professional and ethical standards.

LABORATORY GRADING AND OUT OF SPEC (OOS) REPORTS

Full details are given in the Chem 311 lab manual (available on D2L).

For the 7 graded labs, you will hand in a numerical **report of analysis**, which will be graded /5 based on accuracy. If you receive a grade of 1.9 or lower, you should complete an *Out of Spec (OOS) Report* (form available on D2L). You are encouraged to meet with your TA to discuss your performance while completing the form. Your TA will 'sign off' on completion of the form.

For your laboratory grade calculation, if your lowest grade is 1.9 or lower, it is only 'droppable' if you have completed an OOS report. You only *need* to complete a report for your lowest grade (if it is below 1.9), but you are free to do more.

ASSIGNMENTS

There are 5 **assignments** in this course. They will be posted to D2L approximately one week before the due date (typically the Thursday of the week noted): check D2L for details, as the due dates may be adjusted based on course progress.

All assignments are "hybrid" assignments, where you will submit some answers via D2L, and some written work on paper for grading. Written work should be submitted to the blue dropboxes outside SA 204 (organized by lab section) before 5 PM on the due date. *Instructions and due dates for these assignments are available on the course D2L site.* Each assignment will have questions reflecting approximately the previous two weeks of course content. All 5 assignment grades will be averaged together to comprise your "assignment" grade for the course.

The **in-class Top Hat** practice questions will be graded based on a combination of participation and correctness. If you choose to participate, your average Top Hat score for the semester can **replace your lowest non-zero assignment score** if doing so benefits your grade overall. This will be done automatically for all students who have participated in Top Hat – make sure your UCID and @ucalgary.ca email are updated in your Top Hat account profile so your grades can be linked.

*All Top Hat grades will be pro-rated to allow for 3-4 classes "free/excused" – if you are ill, unable to attend, or have a tech failure for a couple days, these be covered in the "free" days and balanced out at the end of term. **No need to send in sick notes or notify your instructor for a day or two of TopHat missed during term.** If you are unable to participate for longer, contact your instructor to make alternate arrangements.*

(in other words, if we did 100 Top Hat questions in 20 classes (~5 per class) and you scored 75/100, with 3 "free" classes, at the end of term your score would be adjusted to be 75/85. This would be done automatically and posted to D2L after the end of classes).

TENTATIVE LECTURE & LABORATORY SCHEDULE

WEEK STARTING:	SCHEDULE FOR LECTURE TOPICS (SUBJECT TO CHANGE)	LAB SCHEDULE
September 5 (<i>Thursday</i>)	Introduction The Analytical Process	No labs
September 9	Theory of Titrations I Uncertainty in Measurements	Check-in Training Camp 1
September 16	Uncertainty in Measurements Statistics Ass't 1 Due	Training Camp 2
September 23	Statistics Hypothesis Testing	Training Camp 3
September 30	Solubility Equilibria Activity Ass't 2 Due	Carbonate
October 7	Systems of Equilibria Potentiometry	Acid Mix
October 14 <i>Thanksgiving: Oct. 14</i>	Potentiometry Theory of Titrations II Midterm: Wed Oct 16, 7-9PM, ICT 102	No labs
October 21	Solubility Titrations	Volhard
October 28	Acid-base Equilibria Polyprotic Acids and Bases Ass't 3 Due	Brass
November 4	Acid-Base Titrations	Glycol
November 11 <i>Fall Break: Nov 11-15</i>	No Classes	No labs
November 18	Acid-Base Titrations EDTA Titrations Ass't 4 Due	NTA
November 25	EDTA Titrations	Limestone
December 2	Redox Titrations Ass't 5 Due	Check-out
<i>Assignments 1-5 (both online and written parts, if applicable) are due <u>before 5 PM on the announced due date.</u> (see D2L)</i>		
<i>Classes End: Dec 6</i>		<i>Final Exam Period: Dec. 9-19</i>

Department Approval

Electronically Approved

Date

August 29, 2019

