Chemistry
UNIVERSITY OF TORONTO

# CHM 217H: Introduction to Analytical Chemistry

**Summer 2025 Course Syllabus**

## I COURSE & LABORATORY INSTRUCTOR

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Student hours: By appointment: See the course Quercus for the detail

**Note:** Always start with "CHM217- S25" in the subject line of your email. I do my best to get back to you within 24 hours. If you haven't received a reply, please send me a reminder.

## II COURSE OVERVIEW

**COURSE DESCRIPTION:**

CHM217H1, Introduction to Analytical Chemistry, is the first in a series of courses designed to introduce students to the topic of chemical detection and measurement. Analytical chemistry, a diverse and fascinating discipline, plays an essential role in many other important subjects such as biochemistry, clinical chemistry, environmental science, food and nutrition, forensic science, organic chemistry and spectroscopy, medicinal and pharmaceutical chemistry, pharmacology, and toxicology. Whether performing blood tests, verifying the safety of our food and drinking water, determining the cause of a fire, or identifying genetic disease markers, analytical chemistry touches every aspect of our daily lives.

This course introduces the fundamental principles of chemical measurement used in medical diagnosis, quality assurance and control, and research studies. It will teach students how to correctly handle and interpret experimental measurements, compare results and procedures, and calibrate analytical instrumentation. Students will also learn how to perform many analytical techniques, including volumetric analysis, potentiometry, UV/visible and infrared spectrophotometry, flame atomic spectrometry, and chromatography.

**STUDENT LEARNING OUTCOMES:**

By the end of the course, students will be expected to demonstrate the following core competencies:

- To identify different types and sources of error, perform relevant statistical analyses of experimental data, and draw appropriate conclusions from the results.
- To analyze, interpret, and communicate data and findings in a scientifically valid and effective manner.
- To be familiar with and implement standard operating procedures to accurately and precisely prepare standard solutions, calibrate instrumentation, and competently perform common methods of quantitative chemical analysis.
- To work both individually and collaboratively as part of a small group to accomplish an experimental goal, such as characterizing a method of analysis or completing a specific chemical determination.
- To access, understand, and apply information from Material Safety Data Sheets to safely conduct chemical experiments and appropriately deal with any generated waste products.
- To develop the practice of accurate and timely data recording, following the principles of Good Laboratory Practice (GLP).
- To apply knowledge of the operating principles of specific analytical methods and instrumentation to the identification and remediation of potential interferences from sample composition in chemical analyses.

**PREREQUISITE COURSES:**

This course assumes you have a basic understanding of the material covered in high school chemistry and the prerequisite courses CHM151Y or CHM135H+CHM136H (or equivalent). This includes the following topics:

- Significant figures, decimal places, and rounding in calculations
- Fundamental SI units and common unit prefixes; unit conversion
- Common chemical units and their conversion to/from SI units
- Interpretation of simple chemical names and formulae
- Calculation of molecular and formula masses
- Concentration calculations (molar, molal, mass, mole fraction, density)
- Balancing equations; stoichiometry & limiting reagent calculations
- Identification and balancing of acid-base, precipitation and redox reactions
- Formal oxidation numbers; identification of oxidant and reductant
- Definition of the equilibrium constant; relations between $K$, $Q$, and $\Delta G$
- Basic principles of equilibrium calculations; combination of equilibria
- Acids and bases (Arrhenius, Brønsted-Lowry, and Lewis); acid & base strength
- Calculation of pH, $K_a$, $K_b$, and equivalence point in acid-base titrations
- Identification of buffers, calculation of buffer composition & pH
- Solubility, precipitation, $K_{sp}$, and solubility calculations
- Standard reduction potentials, electrodes and cells; the Nernst equation

- Chemical bonds (covalent, ionic, coordinate); atomic & molecular orbitals
- Naming, identity, structure, and properties of common functional groups (alkane, alkene, alkyne, alkyl halide, alcohol, aldehyde, ketone, carboxylic acid, ester, ether, phenyl, *etc*.)
- Molecular orbital description of σ and π bonds
- Definition & origin of bonding, non-bonding & anti-bonding MOs
- Delocalization and aromaticity (phenyl group, conjugated alkenes, and enones)

**RELATED COURSES AND FOCUS ON PRACTICAL CHEMICAL ANALYSIS:**

This course is a prerequisite for the following course(s): CHM 317H1, CHM 410H1, CHM 414H1, and CHM 416H1. In addition, it is a core component of the optional Focus on Practical Chemical Analysis, which students may apply to have added to their transcript. For further information on this focus, please see: https://www.chemistry.utoronto.ca/programs-studies/new-focus-practical-chemical-analysis

**READINGS:**

Students may use any of the following as the required textbook. Choose the one that best fits your learning style:

- Harris and Lucy, "Quantitative Chemical Analysis", 9th or 10th edition, Macmillan Learning
- Skoog *et al*, "Fundamentals of Analytical Chemistry", 9th or 10th edition, Brooks-Cole/Cengage Learning
- Harvey, "Analytical Chemistry 2.1", LibreTexts™

**A tentative schedule of lecture topics with reading assignments** will be posted on the course website accessible through Quercus. I strongly recommend "pre-reading" the text *before* the associated class periods. This will help us make better use of class time and enable deeper discussion of topics.

The course will use some **supplemental online materials**, some of which you are expected to watch and take notes on. Other materials will be provided as quick 'refresher' modules that can be viewed at your discretion. You will also be provided with links to additional online resources that will assist you in completing tutorial exercises and lab activities.

**A few important dates**:

- ***First Class:*** Monday, May 5th, 9:10-10:00 am, SS2125
- By Monday, May 12: Complete Lab Safety & Procedure Quiz
- **First Tutorial**: May 9, 10:10-11 am (see ACORN for the location)
- ***First Lab:*** May 13, 9 am- 1 pm, LM6 (review the lab manual & lab schedule)
- **Term Test 1**: Monday, June 2, 9:10-10:00 am (be in the class by 9:00 am, location TBD)
- **Term Test 2**: Monday, July 14, 9:10-10:00 am (be in the class by 9:00 am, location TBD)
- ***Last Lab:*** Poster Presentation, Tuesday, August 5, 9:00 am- 1:00 pm
- ***Last Class:*** Friday, August 8, 9:10-10:00 am
- ***Last Tutorial:*** Friday, August 8, 10:10-11:00 am

**Note:** There will be **no** class, lab, or tutorial on the following dates:

- Friday, May 16 (Presidential Day)
- Monday, May 19 (Victoria Day)
- Thursday, May 29
- June 16- June 23 (Exam week)
- Monday, June 30 (Presidential Day)
- Tuesday, July 1 (Canada Day)
- Friday, August 1 (Presidential Day)
- Monday, August 3 (Civic Holiday)

## III COURSE ORGANIZATION

This course is organized by units, each lasting approximately 1-3 weeks. Classes ("lectures"), labs ("practical"), and tutorials will all be held in person unless changes are required due to university public health directives.

Please **note** that lecture recordings may not be provided. Attendance at lectures is highly encouraged. Additionally, access to any videos posted on Quercus will require a U of T login to access the Library's MyMedia service.

The **mandatory laboratory** will occupy 11 weeks over a 13-week period within the semester. Students will be assigned to demo groups, within which they will work individually, in pairs, and in small teams, depending on the assigned experiment. Experiments are performed in blocks on rotation, so each demo group will be performing a different experiment each week, except dry lab and Experiment 1.

There will be 10 **tutorials** over the semester on Fridays. Please refer to the tentative schedule posted on Quercus for the specific dates.

**Slides for class** ("lecture") will be posted to the course Quercus Shell, generally before the corresponding class. Many students have found that they *learn best* by taking notes.

**TUTORIAL OBJECTIVES:**

There will be 10 tutorials scheduled throughout the semester, starting on May 9 at 10:10 AM. These tutorials are designed to supplement the lecture and lab material by providing opportunities to engage with typical analytical problems and calculations, focusing on problem-solving strategies. In-class activities and follow-up assignments will be drawn from both assigned problems and prior years' term tests and final exams. Three of the tutorials will provide practice problems in advance of the two term tests and the final exam.

**LABORATORY OBJECTIVES:**

Analytical chemistry is a highly practical subject. The mandatory laboratory sessions reflect the topics addressed in lectures and provide an opportunity to see and use a variety of common analytical procedures and instruments. This will allow students to develop the technical skills necessary to perform a variety of common chemical methods of analysis. Labs also provide ample opportunities for students to develop their collaboration and communication skills through frequent group work.

## IV EVALUATION/GRADING SCHEME

**OVERVIEW:**

- Assignments: 10%
- Laboratory (see lab manual for grades breakdown): 35%
- Two Term Tests (Monday, June 2 & Monday, July 14): 20%
- Online and in-class activities (each activity has 1 or more points): 5%
- Final Exam (cumulative): 30%

**NOTE 1:** For students missing one term test for a valid reason, the missed test grade will be calculated based on performance on the other term tests and the class average of the other two tests.

**NOTE 2:** There are no makeup lab sessions available, as there is only one lab session per week.

**NOTE 3:** Students who miss a lab session for a valid reason are required to write the lab report based on the data obtained by other students. Their practical performance mark will be calculated based on the average of their previous performance. However, if a student misses the lab due to an invalid reason, they are still required to write the lab report, but their mark will be deducted by 50%. Additionally, their practical performance mark will be considered zero in this case.

**NOTE 4:** Term tests will be held in person during class on two Mondays (June 2nd and July 14th) during regularly scheduled class time. The location will be posted on the course Quercus shell.

**NOTE 5:** The final exam will be in-person during the scheduled August examination period (August 16-25). The date and time will be set by the Faculty of Arts & Science and released sometime in August. Students are advised not to plan travel during this period until after the exam timetable is published.

**NOTE 6:** The practical skills acquired in CHM 217H are an extremely important aspect of this course. **To pass the course, you must attend and submit a complete lab report for at least seven (7) of the nine (9) in-person experimental sessions where hands-on lab work is performed.** Students who fail to attend enough practical sessions, even if justified with documentation, will not receive credit for CHM 217H since they will not have acquired the practical skills expected of a student who has completed this course.

## V COURSE POLICIES

- Communication with course/lab instructor
  - If you have a science question, please consider asking your question during class or lab sessions, during student hours, or posting on the lab discussion, if available, where your classmates can benefit from the question and answer(s).
  - Students may contact the lecture instructor via email (soha.ahmadi@mail.utoronto.ca) and may address her as "Soha" or Dr. Ahmadi if you feel more comfortable with that. Please include your full information, including your full name, student number, laboratory section, and demo group in any emails with the subject that start with **CHM217-S25**.

- Each member of this course is expected to maintain a:

(i) professional and respectful attitude during all course activities, including classes, laboratories, tutorials, and online activities.
(ii) personal calendar/schedule/organizer to ensure that all course activities are completed, and due dates are met.
(iii) collection of notes recorded independently based on concepts covered in course activities (students registered with Accessibility Services requiring a class note-taker will have access to this accommodation)
(iv) familiarity with the university policy on Academic Integrity (overleaf)

- The University of Toronto is committed to equity, human rights, and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. As a Course Instructor, I will neither condone nor tolerate behaviour that undermines the dignity or self-esteem of any

individual in this course and wish to be alerted to any attempt to create an intimidating or hostile environment. It is our collective responsibility to create a space that is inclusive and welcomes discussion. Discrimination, harassment and hate speech will not be tolerated. If you have any questions, comments, or concerns, we encourage you to reach out to the staff in our Equity Offices.

- Privacy language and appropriate use of course materials: For additional information, see the syllabus "Copyright" section.

**Absences and Makeup Work:**

- Process for signaling course absences and requesting make-up tests or exams: Students are responsible for notifying the course instructor of any known absences or timetable conflicts in a timely manner. In the event of illness, students should notify the course instructor as soon as practically possible, especially if the absence coincides with a scheduled lab class.
- If you are absent from your studies due to illness or other reasons and unable to complete course work (e.g., a term test or an assignment) then a piece of written documentation is required. The following four items are the recognized forms of documentation:
  1. Absence Declaration via ACORN (please note the circumstances under which an absence declaration can and cannot be submitted)
  2. U of T Verification of Illness or Injury Form
  3. College Registrar's letter
  4. Letter of Academic Accommodation from Accessibility Services

- Students who complete the ACORN Absence Declaration form must additionally contact me at soha.ahmadi@mail.utoronto.ca (subject email: CHM217- Absence) to discuss their situation within five business days of the missed piece of work. This is an essential action for any consideration to be granted.
- Please note that assignments in this course are group assignments completed with your classmates. Your absence may impact the entire group. It is your responsibility to discuss the situation with your groupmates and ensure clear communication to minimize any disruptions to the group's work.
- For extended absences and for absences due to non-medical reasons, make sure to contact your College Registrar's Office. They can help you decide between a request for an extension or other types of academic consideration.
- If you suspect or know that you have a disability that is affecting your studies, learn about the services and supports available through Accessibility Services. A disability can be physical disability, sensory disability, a learning disability, mental health disorder or a short-term disability like an injury. If you are not sure whether you have a disability, you can confidentially contact Accessibility Services with your questions.

- Policy for late report/assignment submissions: a penalty of 5% of the total mark for the assignment will be applied per day (including weekends and holidays). Exceptions:
    - An extension had been agreed to by the instructor before the deadline
    - An emergency arose, and any notification/documentation was completed in accordance with the Rules and Regulations as posted in the Faculty of Arts & Science Calendar
- Missed academic work: Students will either be given an opportunity to make up the missed work or offered a reweighting scheme commensurate with the nature of the missed work and closeness to the end of the term. This may include shifting the marks to a different item of work, or assigning a grade based on comparable term work relative to the class average.
- Please note that since there is only one lab session, we cannot offer a makeup lab. For further information on the procedure regarding missing lab sessions, please refer to the lab manual.
- Submission methods: students are responsible for checking the time, date, and submission process for each item of term work. Generally, submissions will be made through Quercus or Markus.
- Process for requesting re-grading of course work: Students are responsible for submitting requests for re-grading before deadlines established by the Faculty of Arts & Science (see https://artsci.calendar.utoronto.ca/petitions-and-appeals ) . Generally, requests should be made by email within one week of receiving the graded term work.

**In the laboratory:**

- Every student is expected to always observe proper safety procedures. This includes the wearing of personal protective equipment, following correct procedures when handling and disposing of chemicals, dealing with and reporting any spills or accidents promptly, and maintaining awareness of those around them.
- For collaborative experiments, every student is expected to contribute equally to the work, and to perform their share of both the experiment and clean-up. Further expectations around communication, data processing, and timely sharing of information are set out in the lab manual.
- The use of **ChatGPT and/or other generative AI tools** is permitted in writing your lab report or assignments, within the limitations of reviewing your own written work for additional suggestions of grammar, punctuation, etc. However, please note that you may only use the free version of these tools. For more details, see lab manual section 4.5 on using generative Artificial Intelligence (AI) tools in the writing of laboratory reports.

## VI TECHNOLOGY REQUIREMENTS

- Specific guidance from the U of T Vice-Provost, Students regarding student technology requirements is available here: https://www.viceprovoststudents.utoronto.ca/student-policies-guidelines/tech-requirements-online-learning/

- Advice for students writing online assessments (quizzes etc.): https://studentlife.utoronto.ca/task/online-exams-and-tests/

- This course requires the use of computers, and technical issues are possible. When working on a piece of academic work, students are responsible for scheduling enough time to allow for reasonable delays due to technical difficulties to be overcome, so such issues will not be acceptable grounds for deadline extension. Particularly, maintaining an up-to-date independent backup copy of your work is strongly recommended to guard against hard-drive failures, corrupted files, lost computers, etc.

## VII INSTITUTIONAL POLICIES & SUPPORT

**ACADEMIC INTEGRITY**

Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see www.academicintegrity.utoronto.ca/)

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In **laboratory reports**:

1. Using someone else's ideas or words without appropriate acknowledgement.
2. Submitting your own work in more than one course without the permission of the instructor.
3. Making up sources or facts.
4. Obtaining or providing unauthorized assistance on any report. **Please note that the use of websites (such as Chegg.com) to share laboratory report material unless otherwise authorized or to post/access answers to questions is an academic offence under the University of Toronto's Code of Behaviour on Academic Matters. Alleged instances of this nature are forwarded to the Faculty of Arts & Science Student Academic Integrity office.**

On quizzes and term tests:

1. Using or possessing unauthorized aids. **Please note that the use of websites (such as Chegg.com or the course discussion board) to post quiz/term test questions or to post/access answers to questions is an academic offence under the University of Toronto's Code of Behaviour on Academic Matters. Alleged instances of this nature are forwarded to the Faculty of Arts & Science Student Academic Integrity office.**
2. Looking at someone else's answers or collaborating/discussing answers during a quiz or term test.
3. Misrepresenting your identity.

In general academic work:

1. Falsifying institutional documents or grades.
2. Falsifying or altering any documentation required by the University.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see www.academicintegrity.utoronto.ca/).

**Plagiarism Detection**

Normally, students will be required to submit their course essays to the University's plagiarism detection tool for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the tool's reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of this tool are described on the Centre for Teaching Support & Innovation web site (https://uoft.me/pdt-faq).

**COPYRIGHT**

If a student wishes to copy or reproduce class presentations, course notes or other similar materials provided by instructors, they must obtain the instructor's written consent beforehand. Otherwise, all such reproduction is an infringement of copyright and is absolutely prohibited.

**ACCESSIBILITY NEEDS**

Students with diverse learning styles and needs are extremely welcome in this course. The University of Toronto is committed to accessibility: if you require accommodations for a disability, or have any other accessibility concerns about the course, please contact Accessibility Services as soon as possible.

**ACCOMMODATIONS FOR RELIGIOUS OBSERVANCES**

Following the University's policies, reasonable accommodations will be made for students who observe religious holy days that coincide with the due date/time of an assignment, tutorial, class or laboratory session. Students must inform the instructor **before** the session/assignment date to arrange accommodations.

**ADDITIONAL SERVICES & SUPPORT**

The following are some important links to help you with academic and/or technical service and support:

- General student services and resources at Student Life
- Full library service through University of Toronto Libraries
- Resources on conducting online research through University Libraries Research
- Resources on academic support from the Academic Success Centre
- Learner support at the Writing Centre
- Information for Quercus Support

**ACKNOWLEDGEMENT OF TRADITIONAL LANDS**

We wish to acknowledge this land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca and, most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

- Two unique land acknowledgements given in the words of two indigenous community members. I encourage you to take a moment to read and reflect.

"As we engage in processes of reconciliation it is critical that land acknowledgements don't become a token gesture. They are not meant to be static, scripted statements that every person must recite in exactly the same way. They are expressions of relationship, acknowledging not just the territory someone is on, but that person's connection to that land based on knowledge that has been shared with them."
***Lindsay DuPré - Metis Nation***

"Getting to know people, creating a relationship to the place that you are from, the water that you drink...getting to know these things in an intimate way, is what essentially, will change peoples minds, change peoples hearts. Acknowledging the land and water that sustains us and life on Mother Earth is part of becoming a balanced and present human being. Its about honouring and protecting the land and water, honouring ourselves and our bodies."
***Nigit'stil Norbert, Gwich'ya Gwich'in***

Source: https://www.whose.land/en/whyacknowledge