

# Chemistry (CHEM)

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## Courses

### CHEM 1A General Chemistry 3 Units

Terms offered: Fall 2025, Summer 2025 8 Week Session, Spring 2025  
Stoichiometry of chemical reactions, quantum mechanical description of atoms, the elements and periodic table, chemical bonding, real and ideal gases, thermochemistry, introduction to thermodynamics and equilibrium, acid-base and solubility equilibria, introduction to oxidation-reduction reactions, introduction to chemical kinetics.

#### Rules & Requirements

**Prerequisites:** High school chemistry recommended

**Credit Restrictions:** Students will receive no credit for CHEM 1A after completing CHEM 1AD or CHEM 4A. A deficient grade in CHEM 1A may be removed by taking CHEM 1AD.

#### Hours & Format

**Fall and/or spring:** 15 weeks - 3-3 hours of lecture, 1-1 hours of discussion, and 0-2 hours of voluntary per week

**Summer:** 8 weeks - 6-6 hours of lecture, 2-2 hours of discussion, and 0-2 hours of voluntary per week

#### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

### CHEM 1AD General Chemistry (Digital) 3 Units

Terms offered: Spring 2016

An interactive general chemistry course that uses modern digital technology, offered in a smaller classroom setting to facilitate student participation and foster an engaging learning environment. Topics cover the Chemistry 1A curriculum, ranging from quantum mechanics and interactions of atoms and molecules to properties and equilibria of bulk materials. The course involves a blend of classroom lectures and peer learning with substantial web-based assignments and resources including web access to lecture videos. Lecture time is also devoted to ChemQuiz peer discussions and live demos of chemical properties and processes, which students generally find to be illuminating and valuable learning experiences.

#### Rules & Requirements

**Prerequisites:** High school chemistry recommended

**Credit Restrictions:** Students will receive no credit for Chemistry 1AD after completing Chemistry 1A or 4A. A deficient grade in Chemistry 1A may be removed by taking Chemistry 1AD.

#### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

**Summer:** 8 weeks - 6 hours of lecture and 2 hours of discussion per week

#### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructors:** Pines, Slack

## CHEM 1AL General Chemistry Laboratory 2 Units

Terms offered: Fall 2025, Summer 2025 8 Week Session, Spring 2025  
An experimental approach to chemical sciences with emphasis on developing fundamental, reproducible laboratory technique and a goal of understanding and achieving precision and accuracy in laboratory experiments. Proper use of laboratory equipment and standard wet chemical methods are practiced. Areas of investigations include chemical equilibria, spectroscopy, nanotechnology, green chemistry, and thermochemistry. Completion of, or concurrent enrollment in 1A is required.

### Rules & Requirements

**Prerequisites:** CHEM 1A, with min grade of C-; or co-enrollment in CHEM 1A; or AP CHEM with min score of 4; or CHEM HL IB with min score of 5; or GCE A-Level CHEM with min grade of C

**Credit Restrictions:** Students will receive no credit for 1AL after taking 4A.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture, 3 hours of laboratory, and 0 hours of voluntary per week

**Summer:** 8 weeks - 2 hours of lecture, 6 hours of laboratory, and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

## CHEM 1B General Chemistry 4 Units

Terms offered: Spring 2025, Spring 2023, Spring 2022  
Introduction to chemical kinetics, electrochemistry, properties of the states of matter, binary mixtures, thermodynamic efficiency and the direction of chemical change, quantum mechanical description of bonding introduction to spectroscopy. Special topics: Research topics in modern chemistry and biochemistry, chemical engineering.

### Rules & Requirements

**Prerequisites:** CHEM 1A and CHEM 1AL with min grades of C-; or CHEM 4A with min grade of C-; or AP CHEM with min score of 4; or CHEM HL IB with min score of 5; or GCE A-Level CHEM with min grade of C

**Credit Restrictions:** Students will receive no credit for Chemistry 1B after completing Chemistry 4B.

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture, 4 hours of laboratory, and 0 hours of voluntary per week

**Summer:** 8 weeks - 6 hours of lecture, 8 hours of laboratory, and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM W1A General Chemistry 3 Units

Terms offered: Summer 2013 10 Week Session, Summer 2013 8 Week Session, Summer 2012 8 Week Session

Stoichiometry of chemical reactions, quantum mechanical description of atoms, the elements and periodic table, chemical bonding, real and ideal gases, thermochemistry, introduction to thermodynamics and equilibrium, acid-base and solubility equilibria, introduction to oxidation-reduction reactions, introduction to chemical kinetics. This course is web-based.

### Rules & Requirements

**Prerequisites:** High school chemistry is recommended

**Credit Restrictions:** Students will receive no credit for CHEM W1A after passing CHEM 1A or CHEM 4A. A deficiency in CHEM 1A may be removed by taking CHEM W1A.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of web-based lecture and 1 hour of web-based discussion per week

**Summer:** 8 weeks - 6 hours of web-based lecture and 2 hours of web-based discussion per week

**Online:** This is an online course.

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 3A Chemical Structure and Reactivity 4 Units

Terms offered: Fall 2025, Summer 2025 8 Week Session, Spring 2025  
Introduction to organic chemical structures, bonding, and chemical reactivity. The organic chemistry of alkanes, alkyl halides, alcohols, alkenes, alkynes, and organometallics.

### Rules & Requirements

**Prerequisites:** CHEM 1A with min grade of C-; or AP Chem with min score of 4; or Chem HL IB with min score of 5; or GCE A-Level Chem with min grade of C

**Credit Restrictions:** Students will receive no credit for CHEM 3A after completing CHEM 12A; a deficient grade in CHEM 12A may be removed by taking CHEM 3A- will restrict credit if completed before Chemistry 3A.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture, 1 hour of discussion, and 0 hours of voluntary per week

**Summer:** 8 weeks - 6 hours of lecture, 2 hours of discussion, and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 3AL Organic Chemistry Laboratory 2 Units

Terms offered: Fall 2025, Summer 2025 8 Week Session, Spring 2025  
Introduction to the theory and practice of methods used in the organic chemistry laboratory. An emphasis is placed on the separation and purification of organic compounds. Techniques covered will include extraction, distillation, sublimation, recrystallization, and chromatography. Detailed discussions and applications of infrared and nuclear magnetic resonance spectroscopy will be included.

### Rules & Requirements

**Prerequisites:** CHEM 1A and CHEM 1AL with min grades of C-; or CHEM 4A with min grade of C-; or AP CHEM with min score of 4; or CHEM HL IB with min score of 5; or GCE A-Level CHEM with min grade of C. Corequisite: CHEM 3A with min grade of C- or coenrollment in CHEM 3A

**Credit Restrictions:** Students will receive no credit for CHEM 3AL after taking CHEM 12A.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture and 4 hours of laboratory per week

**Summer:** 8 weeks - 2 hours of lecture and 8 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

## CHEM 3B Chemical Structure and Reactivity 4 Units

Terms offered: Fall 2025, Summer 2025 8 Week Session, Spring 2025  
Conjugation, aromatic chemistry, carbonyl compounds, carbohydrates, amines, carboxylic acids, amino acids, peptides, proteins, and nucleic acid chemistry. Ultraviolet spectroscopy and mass spectrometry will be introduced.

### Rules & Requirements

**Prerequisites:** CHEM 3A with min grade of C-

**Credit Restrictions:** Students will receive no credit for 3B after taking 12B.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture, 1 hour of discussion, and 0 hours of voluntary per week

**Summer:** 8 weeks - 6 hours of lecture, 2 hours of discussion, and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 3BL Organic Chemistry Laboratory 2 Units

Terms offered: Fall 2025, Summer 2025 8 Week Session, Spring 2025  
The synthesis and purification of organic compounds will be explored. Natural product chemistry will be introduced. Advanced spectroscopic methods including infrared, ultraviolet, and nuclear magnetic resonance spectroscopy and mass spectrometry will be used to analyze products prepared and/or isolated. Qualitative analysis of organic compounds will be covered.

### Rules & Requirements

**Prerequisites:** CHEM 3AL with min grade of C-. Co-requisite: CHEM 3B with min grade of C- or co-enrollment in CHEM 3B

**Credit Restrictions:** Students will receive no credit for CHEM 3BL after taking CHEM 12B.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture and 4 hours of laboratory per week

**Summer:** 8 weeks - 2 hours of lecture and 8 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

## CHEM N3AL Organic Chemistry Laboratory 2 Units

Terms offered: Summer 2018 8 Week Session, Summer 2017 8 Week Session, Summer 2015 8 Week Session  
Introduction to the theory and practice of methods used in the organic chemistry laboratory. An emphasis is placed on the separation and purification of organic compounds. Techniques covered will include extraction, distillation, sublimation, recrystallization, and chromatography. Detailed discussions and applications of infrared and nuclear magnetic resonance spectroscopy will be included.

### Rules & Requirements

**Prerequisites:** CHEM 1A and CHEM 1AL with min grades of C-; or CHEM 4A with min grade of C-; or AP CHEM with min score of 4; or CHEM HL IB with min score of 5; or GCE A-Level CHEM with min grade of C. Co-requisite: CHEM 3A with min grade of C- or co-enrollment in CHEM 3A. CHEM 4A with approval of instructor

**Credit Restrictions:** Students will receive no credit for CHEM N3AL after taking CHEM 12A.

### Hours & Format

**Summer:** 8 weeks - 2 hours of web-based lecture and 8 hours of laboratory per week

**Online:** This is an online course.

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

**Instructor:** Pedersen

## CHEM 4A General Chemistry and Quantitative Analysis 5 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

Series is intended for majors in physical, biological sciences, and engineering. It presents the foundation principles of chemistry, including stoichiometry, ideal and real gases, acid-base and solubility equilibria, oxidation-reduction reactions, thermochemistry, entropy, nuclear chemistry and radioactivity, the atoms and elements, the periodic table, quantum theory, chemical bonding, molecular structure, chemical kinetics, and descriptive chemistry. Examples and applications will be drawn from diverse areas of interest such as atmospheric, environmental, materials, polymer and computational chemistry, and biochemistry. Laboratory emphasizes quantitative work. Equivalent to 1A-1B plus 15 as prerequisite for further courses in chemistry.

### Rules & Requirements

**Prerequisites:** High school chemistry; calculus (may be taken concurrently); high school physics is recommended

**Credit Restrictions:** Students will receive no credit for 4A after taking 1A. Deficiency in 4A may be removed by successfully completing 1A and 1AL together in the same semester.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture, 4 hours of laboratory, and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 4B General Chemistry and Quantitative Analysis 5 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

Series is intended for majors in physical, biological sciences, and engineering. It presents the foundation principles of chemistry, including stoichiometry, ideal and real gases, acid-base and solubility equilibria, oxidation-reduction reactions, thermochemistry, entropy, nuclear chemistry and radioactivity, the atoms and elements, the periodic table, quantum theory, chemical bonding, molecular structure, chemical kinetics, and descriptive chemistry. Examples and applications will be drawn from diverse areas of interest such as atmospheric, environmental, materials, polymer and computational chemistry, and biochemistry. Laboratory emphasizes quantitative work. Equivalent to 1A-1B plus 15 as prerequisite for further courses in chemistry.

### Rules & Requirements

**Prerequisites:** High school chemistry; calculus (may be taken concurrently); high school physics is recommended

**Credit Restrictions:** Deficiency in 4B may be removed by successfully completing 15.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3-3 hours of lecture, 4-4 hours of laboratory, and 0-2 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 12A Organic Chemistry 5 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

A study of all aspects of fundamental organic chemistry, including nomenclature, chemical and physical properties, reactions and syntheses of the major classes of organic compounds. The study includes theoretical aspects, reaction mechanisms, multistep syntheses, and the chemistry of polycyclic and heterocyclic compounds. This course is more extensive and intensive than 3A-3B and includes a greater emphasis on reaction mechanisms and multistep syntheses. 12A (F); 12B (SP)

### Rules & Requirements

**Prerequisites:** 12A: 1B or 4B with grade of C- or higher; 12B: 12A with grade of C- or higher. For students majoring in chemistry or a closely related field such as chemical engineering or molecular and cell biology

**Credit Restrictions:** Students will receive no credit for 12A after taking both 3A and 3AL. Deficiency in 12A may be removed by successfully completing 3A and 3AL in the same semester. Students will receive no credit for 12A after taking 112A. Chem 12A is formerly known as Chem 112A.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3-3 hours of lecture, 1-1 hours of discussion, 5-5 hours of laboratory, and 0-2 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** Chemistry 112A

## CHEM 12B Organic Chemistry 5 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

A study of all aspects of fundamental organic chemistry, including nomenclature, chemical and physical properties, reactions and syntheses of the major classes of organic compounds. The study includes theoretical aspects, reaction mechanisms, multistep syntheses, and the chemistry of polycyclic and heterocyclic compounds. This course is more extensive and intensive than 3A-3B and includes a greater emphasis on reaction mechanisms and multistep syntheses. 12A (F); 12B (SP)

### Rules & Requirements

**Prerequisites:** 12A: 1B or 4B with grade of C- or higher. 12B: 12A with grade of C- or higher. For students majoring in chemistry or a closely related field such as chemical engineering or molecular and cell biology

**Credit Restrictions:** Students will receive no credit for 12B after taking both 3B and 3BL. Deficiency in 12B may be removed by successfully completing 3B and 3BL in the same semester. Students will receive no credit for 12B after taking 112B. Chem 12B is formerly known as Chem 112B.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture, 1 hour of discussion, 5 hours of laboratory, and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** Chemistry 112B

## CHEM 15 Analytical and Bioanalytical Chemistry 3 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016

An introduction to analytical and bioanalytical chemistry including background in statistical analysis of data, acid-base equilibria, electrochemical, spectrometric, and chromatographic methods of analysis and some advanced topics in bioanalytical chemistry such as microfluidics, bioassay techniques, and enzymatic biosensors.

### Rules & Requirements

**Prerequisites:** 1A and 1AL or equivalent

**Credit Restrictions:** Deficiency in 15 may be removed by successfully completing 4B.

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 4 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 24 Freshman Seminar 1 Unit

Terms offered: Fall 2024, Spring 2024, Fall 2023

The Freshman Seminar Program has been designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small seminar setting. Freshman seminars are offered in all campus departments, and topics may vary from department to department and semester to semester. Enrollment limited to 15 freshmen.

### Rules & Requirements

**Repeat rules:** Course may be repeated for credit when topic changes.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of seminar per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** The grading option will be decided by the instructor when the class is offered. Final Exam To be decided by the instructor when the class is offered.

## CHEM 32 Preparation for General Chemistry 2 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

Foundation and preparation for General Chemistry. Topics and concepts include elements, atoms, molecules, chemical reactions, chemical calculations, properties of gases and gas laws; thermodynamics, acid/base chemical equilibrium, and periodic trends. In addition, by practicing learning as a process, students will cultivate the habits, strategies, and mindset necessary to succeed in the sciences. Through rigorous practice and guided reflection, students will grow in their ability to master the subject matter and hone their disposition toward scientific learning.

### Rules & Requirements

**Credit Restrictions:** Students will receive no credit for CHEM 32 after taking and passing any other Chemistry course.

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 1 hour of discussion per week

### Summer:

6 weeks - 5 hours of lecture and 2 hours of discussion per week  
10 weeks - 3 hours of lecture and 3 hours of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam required, with common exam group.

## CHEM 32L Preparation for General Chemistry Laboratory 1 Unit

Terms offered: Prior to 2007

An introduction to the experimental nature of chemistry. An emphasis is placed on gaining familiarity with equipment and experience with the rigorous approaches used in Chemistry laboratory courses. Areas of investigation include scientific calculations and statistical analysis, analytical measurements, acid-base chemistry, titration, equilibrium, solubility, and green chemistry.

### Rules & Requirements

**Prerequisites:** Must be concurrently enrolled in Chem 32

**Credit Restrictions:** Students will receive no credit for CHEM 32L after completing CHEM 1AL. A deficient grade in CHEM 32L may be removed by taking CHEM 1AL.

### Hours & Format

**Summer:** 6 weeks - 6 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

## CHEM 34 Preparation for General Chemistry for CoC Majors 4 Units

Terms offered: Summer 2022 Second 6 Week Session

This course is designed to help develop fundamental laboratory techniques, study habits, chemical vocabulary, and knowledge of chemistry concepts needed to succeed in CHEM 4A. Students in the course will also come to know and belong to the larger College of Chemistry community, through panel discussions with CoC faculty, students, and staff, and immersion in current research via weekly lab tours and research talks from professors and graduate students. After completing the course, you will understand essential chemistry concepts relevant to CHEM 4A, including chemical calculations, statistics, quantitative analysis, models of atoms, the periodic table, molecules and chemical bonds, acid-base chemistry, thermochemistry, and equilibrium.

### Rules & Requirements

**Prerequisites:** Students must be enrolled in a College of Chemistry major (Chemistry, Chemical Biology, or Chemical Engineering) to take CHEM 34. Nonmajors should enroll in CHEM 32

### Hours & Format

**Summer:** 6 weeks - 8 hours of lecture and 3 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

## CHEM 49 Supplementary Work in Lower Division Chemistry 1 - 4 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

Students with partial credit in lower division chemistry courses may, with consent of instructor, complete the credit under this heading.

### Rules & Requirements

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-4 hours of independent study per week

### Summer:

6 weeks - 1-6 hours of independent study per week

8 weeks - 1-4 hours of independent study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

## CHEM 96 Introduction to Research and Study in the College of Chemistry 1 Unit

Terms offered: Fall 2025, Fall 2024, Fall 2023

Introduces sophomores and new transfer students to research activities and programs of study in the College of Chemistry. Includes lectures by faculty, an introduction to college library and computer facilities, the opportunity to meet alumni and advanced undergraduates in an informal atmosphere, and discussion of college and campus resources.

### Rules & Requirements

**Prerequisites:** Sophomore or junior standing in the College of Chemistry, or consent of instructor

**Credit Restrictions:** Students will receive no credit for CHEM 96 after completing CHEM C96.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of seminar per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam required.

## CHEM 98 Supervised Group Study 1 - 4 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

Group study of selected topics.

### Rules & Requirements

**Prerequisites:** Consent of instructor

**Credit Restrictions:** Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-4 hours of directed group study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

## CHEM 98W Directed Group Study 1 Unit

Terms offered: Fall 2020, Fall 2019, Fall 2018

Topics vary with instructor. Enrollment restrictions apply.

### Rules & Requirements

**Credit Restrictions:** Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of directed group study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.



## CHEM 100 Communicating Chemistry 2 Units

Terms offered: Spring 2011, Spring 2010, Spring 2009

For undergraduate and graduate students interested in improving their ability to communicate their scientific knowledge by teaching chemistry in elementary schools. The course will combine instruction in inquiry-based chemistry teaching methods and learning pedagogy with 10 weeks of supervised teaching experience in a local school classroom. Thus, students will practice communicating scientific knowledge and receive mentoring on how to improve their presentations. Approximately three hours per week, including time spent in school classrooms.

### Rules & Requirements

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 1 hour of fieldwork per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** 20

## CHEM 101 Greener Solutions: A Safer Design Partnership 3 Units

Terms offered: Prior to 2007

Green chemistry seeks to promote the design and adoption of safer chemicals and materials. Their development and adoption depends on solving a number of design and selection challenges. The Greener Solutions course guides interdisciplinary teams undergraduate students to solve these challenges in a specific application

### Objectives & Outcomes

- Course Objectives:**
1. Understand the principles of green chemistry and bio-inspired design and be able to apply them in developing safer alternatives to a hazardous chemical or material in a specific application;
  2. Understand principles of chemical exposure, hazard and risk and be able to apply them in the process of evaluating alternatives to a chemical of concern;
  3. Effectively access information and use tools to evaluate and compare the hazard profiles of chemicals and materials;
  4. Frame research questions and propose solutions, working in the applied setting of a partner company's challenge; and
  5. Communicate complex technical ideas clearly and effectively in written and oral form.

This 4-unit interdisciplinary, project-based course is intended for undergraduate students in public health, chemical engineering, chemistry, environmental studies, and engineering. The course draws on students' disciplinary expertise and teaches new skills to identify safer alternatives to hazardous chemicals currently used in a product or manufacturing process

**Student Learning Outcomes:** Student teams complete interim assignments during the six-week, session-long research project, which culminates in a final report and presentation. While class lectures, discussion and assignments support the technical aspects of the project, significant emphasis is also placed on developing the requisite processoriented skills: gathering information, working in teams, and communicating effectively in both written and oral forms.

### Rules & Requirements

**Prerequisites:** Advanced undergraduate; general chemistry or equivalent knowledge. Recommended: General Chemistry (CHEM 1A, 1B, 4A, 4B)

**Repeat rules:** Course may be repeated for credit with instructor consent.

### Hours & Format

**Summer:** 6 weeks - 3 hours of lecture, 3 hours of demonstration, and 3 hours of directed group study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.



## CHEM 102 Foundations of Discovery Learning for College of Chemistry Transfer Students 1 Unit

Terms offered: Fall 2025, Fall 2024, Fall 2023

This course is offered to incoming junior transfer students majoring in chemistry, chemical biology, or chemical and biomolecular engineering within the College of Chemistry (CoC) at UC Berkeley. The course is designed to assist transfer students with their transition into the CoC through: 1) discussions around best learning practices, stress management, CoC coursework, and careers, 2) interactions with the CoC community, including personalized mentorship from graduate students and faculty, and 3) rigorous preparation for creating and participating in discovery learning experiences, such as research or industrial internships. Students in the course will complete assignments relating to professional development and discovery learning.

### Rules & Requirements

**Prerequisites:** Students must be junior transfers enrolled in a College of Chemistry major (Chemistry, Chemical Biology, or Chemical Engineering)

### Hours & Format

**Fall and/or spring:** 15 weeks - 1.5 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

## CHEM 103 Inorganic Chemistry in Living Systems 3 Units

Terms offered: Fall 2025, Spring 2025, Fall 2023

The basic principles of metal ions and coordination chemistry applied to the study of biological systems.

### Rules & Requirements

**Prerequisites:** Chemistry 3A or 112A. Chemistry majors can only count 2 of the 3 units towards their Allied Subject requirement

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 104A Advanced Inorganic Chemistry 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

The chemistry of metals and nonmetals including the application of physical chemical principles.

### Rules & Requirements

**Prerequisites:** 1B, 4B, or 3A; 104A is prerequisite to 104B

**Credit Restrictions:** 104A: No restrictions; 104B: Chemical Biology majors can only count 2 of the 3 units towards their Allied Subject requirement for 104B after taking 103.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 0 hours of voluntary per week

**Summer:** 8 weeks - 6 hours of lecture and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 104B Advanced Inorganic Chemistry 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

The chemistry of metals and nonmetals including the application of physical chemical principles.

### Rules & Requirements

**Prerequisites:** 104A or consent of instructor. Chemical Biology majors can only count 2 of the 3 units towards their Allied Subject requirement for 104B after taking 103

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

**Summer:** 8 weeks - 6 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 105 Instrumental Methods in Analytical Chemistry 4 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

Principles, instrumentation and analytical applications of atomic spectroscopies, mass spectrometry, separations, electrochemistry and micro-characterization. Discussion of instrument design and capabilities as well as real-world problem solving with an emphasis on bioanalytical, environmental, and forensic applications. Hands-on laboratory work using modern instrumentation, emphasizing independent projects involving real-life samples and problem solving.

### Rules & Requirements

**Prerequisites:** 4B; or 1B and 15; or 1B and a UC GPA of 3.3 or higher

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 8 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 108 Inorganic Synthesis and Reactions 4 Units

Terms offered: Spring 2025, Fall 2022, Spring 2022

The preparation of inorganic compounds/materials using vacuum line, air-and moisture-exclusion, electrochemical, high-pressure, colloidal, solid state and other synthetic techniques. Kinetic and mechanistic studies of inorganic compounds/materials.

### Rules & Requirements

**Prerequisites:** 4B or 15; 104B with grade of C- or higher, or 103; Chem C150 recommended

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 8 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM C110L General Biochemistry and Molecular Biology Laboratory 4 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

Experimental techniques of biochemistry and molecular biology, designed to accompany the lectures in Molecular and Cell Biology 100B and 110.

### Rules & Requirements

**Prerequisites:** 110 (may be taken concurrently)

### Hours & Format

**Fall and/or spring:** 15 weeks - 2-2 hours of lecture and 6-8 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

**Also listed as:** MCELLBI C110L

## CHEM 113 Advanced Mechanistic Organic Chemistry 3 Units

Terms offered: Spring 2025, Fall 2022, Fall 2020

Advanced topics in mechanistic and physical organic chemistry typically including kinetics, reactive intermediates, substitution reactions, linear free energy relationships, orbital interactions and orbital symmetry control of reactions, isotope effects, and photochemistry.

### Rules & Requirements

**Prerequisites:** 3B or 112B with a minimum grade of B- or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 114 Advanced Synthetic Organic Chemistry 3 Units

Terms offered: Spring 2024, Spring 2022, Spring 2020

Advanced topics in synthetic organic chemistry with a focus on selectivity. Topics include reductions, oxidations, enolate chemistry and the aldol reaction, reactions of non-stabilized anions, olefination reactions, pericyclic reactions and application to the synthesis of complex structures.

### Rules & Requirements

**Prerequisites:** 3B or 112B with a minimum grade of B- or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 115 Organic Chemistry--Advanced Laboratory Methods 4 Units

Terms offered: Fall 2025, Summer 2025 Second 6 Week Session, Spring 2025

Advanced synthetic methods, chemical and spectroscopic structural methods, designed as a preparation for experimental research.

### Rules & Requirements

**Prerequisites:** Chem 12B with a grade of C- or higher. Chem 3B and 3BL may be considered with a grade of C- or higher along with instructor consent

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture and 11 hours of laboratory per week

### Summer:

6 weeks - 2.5 hours of lecture and 27.5 hours of laboratory per week  
8 weeks - 2 hours of lecture and 20.5 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

## CHEM 120A Physical Chemistry 3 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

Kinetic, potential, and total energy of particles and forces between them; principles of quantum theory, including one-electron and many-electron atoms and its applications to chemical bonding, intermolecular interactions, and elementary spectroscopy.

### Rules & Requirements

**Prerequisites:** 4B or equivalent; Physics 7B or 8B; Mathematics 53; Mathematics 54 or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 120B Physical Chemistry 3 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

Statistical mechanics, thermodynamics, equilibrium and applications to chemical systems: states of matter, solutions and solvation, chemical kinetics, molecular dynamics, and molecular transport.

### Rules & Requirements

**Prerequisites:** 120A (or may be taken concurrently); 4B or equivalent; Mathematics 53; Mathematics 54 (may be taken concurrently); Physics 7B or 8B

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 121 Introduction to Computational Chemistry 3 Units

Terms offered: Spring 2025, Spring 2023, Fall 2021

This course demonstrates how computers are used to solve modern problems in physical chemistry. It focuses first on methods of electronic structure theory that reveal details of molecular structure and energetics, and secondly on simulation methods that explore fluctuations and dynamics of complex systems comprising many molecules. Students will use MATLAB to implement these numerical approaches for illustrative problems. No prior programming experience is required.

### Rules & Requirements

**Prerequisites:** Chem 120A and Chem 120B are very strongly recommended as prerequisites, or co-requisites

### Hours & Format

**Fall and/or spring:** 15 weeks - 3-3 hours of lecture and 1-2 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

## CHEM 122 Quantum Mechanics and Spectroscopy 3 Units

Terms offered: Fall 2025, Fall 2023, Fall 2022

Postulates and methods of quantum mechanics and group theory applied to molecular structure and spectra.

### Rules & Requirements

**Prerequisites:** 120A

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 125 Physical Chemistry Laboratory 3 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

Experiments in thermodynamics, kinetics, molecular structure, and general physical chemistry.

### Rules & Requirements

**Prerequisites:** Two of the following: 120A, 120B, C130, or 130B with grades of C- or higher (one of which may be taken concurrently)

**Credit Restrictions:** Deficiency in 125 may be removed by successfully completing C182. Consent of instructor is required to enroll in 125 after completing C182 or EPS C182.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture and 5 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 130B Biophysical Chemistry 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

The weekly one-hour discussion is for problem solving and the application of calculus in physical chemistry. Molecular structure, intermolecular forces and interactions, biomolecular spectroscopy, high-resolution structure determinations.

### Rules & Requirements

**Prerequisites:** Chemistry C130 or Molecular and Cell Biology C100A, or consent of instructor. Chemistry and Chemical Biology majors can only count 2 of the 3 units towards their Allied Subject requirement

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM C130 Biophysical Chemistry: Physical Principles and the Molecules of Life 4 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

Thermodynamic and kinetic concepts applied to understanding the chemistry and structure of biomolecules (proteins, DNA, and RNA). Molecular distributions, reaction kinetics, enzyme kinetics. Bioenergetics, energy transduction, and motor proteins. Electrochemical potential, membranes, and ion channels.

### Rules & Requirements

**Prerequisites:** CHEM 3A or CHEM 112A, MATH 51, BIOLOGY 1A, and BIOLOGY 1AL; CHEM 3B or CHEM 112B recommended

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

**Summer:** 8 weeks - 5.5 hours of lecture and 2 hours of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Also listed as:** MCELLBI C100A

## CHEM 135 Chemical Biology 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

One-semester introduction to biochemistry, aimed toward chemistry and chemical biology majors.

### Rules & Requirements

**Prerequisites:** 3B or 12B; Biology 1A; or consent of instructor

**Credit Restrictions:** Students will receive no credit for 135 after taking Molecular and Cell Biology 100B or 102.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 136 Bioorganic Chemistry and Advanced Chemical Biology 3 Units

Terms offered: Not yet offered

Chem 136 is intended for advanced undergraduate students majoring in Chemistry, Chemical Biology, Chemical and Biomolecular Engineering, Molecular and Cell Biology, and related majors. The course will review, reinforce, and build upon organic and biophysical chemistry skills needed for research in Chemical Biology. This will include a review of reaction mechanisms and arrow pushing skills, the chemical reactions of biomolecules, a survey of biochemical structural features, and a discussion of reaction energetics. A strong background in organic chemistry will be expected. Following this, contemporary areas of ChemBio research will be surveyed, including drug design, immunotherapy techniques, CRISPR/Cas9 strategies, drug delivery, and more.

### Rules & Requirements

**Prerequisites:** Chem 12A/B or Chem 3A/3B (or equivalent at prior institution) required Chem 135 or MCB 102A (or equivalent at prior institution) required. Concurrent enrollment OK Waiver of prerequisites required consent of course instructor

**Repeat rules:** Course may be repeated for credit with instructor consent.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

## CHEM C138 The Berkeley Lectures on Energy: Energy from Biomass 3 Units

Terms offered: Fall 2015, Fall 2014, Fall 2013

After an introduction to the different aspects of our global energy consumption, the course will focus on the role of biomass. The course will illustrate how the global scale of energy guides the biomass research. Emphasis will be placed on the integration of the biological aspects (crop selection, harvesting, storage and distribution, and chemical composition of biomass) with the chemical aspects to convert biomass to energy. The course aims to engage students in state-of-the-art research.

### Rules & Requirements

**Prerequisites:** Chemistry 1B or Chemistry 4B, Mathematics 1B, Biology 1A

**Repeat rules:** Course may be repeated for credit under special circumstances: Repeatable when topic changes with consent of instructor.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructors:** Bell, Blanch, Clark, Smit, C. Somerville

**Also listed as:** BIO ENG C181/CHM ENG C195A/PLANTBI C124

## CHEM C142 Machine Learning, Statistical Models, and Optimization for Molecular Problems 4 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

An introduction to mathematical optimization, statistical models, and advances in machine learning for the physical sciences. Machine learning prerequisites are introduced including local and global optimization, various statistical and clustering models, and early meta-heuristic methods such as genetic algorithms and artificial neural networks. Building on this foundation, current machine learning techniques are covered including deep learning artificial neural networks, Convolutional neural networks, Recurrent and long short term memory (LSTM) networks, graph neural networks, decision trees.

### Objectives & Outcomes

**Course Objectives:** To build on optimization and statistical modeling to the field of machine learning techniques

To introduce the basics of optimization and statistical modeling techniques relevant to chemistry students

To utilize these concepts on problems relevant to the chemical sciences.

**Student Learning Outcomes:** Students will be able to understand the landscape and connections between numerical optimization, stand-alone statistical models, and machine learning techniques, and its relevance for chemical problems

### Rules & Requirements

**Prerequisites:** MATH 53 and MATH 54; CHEM 120A or CHEM 120B or BIO ENG 103

**Credit Restrictions:** Students will receive no credit for BIO ENG C142 after completing BIO ENG 142. A deficient grade in BIO ENG C142 may be removed by taking BIO ENG 142.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternate method of final assessment during regularly scheduled final exam group (e.g., presentation, final project, etc.).

**Instructor:** Teresa Head-Gordon

**Formerly known as:** Bioengineering C142/Chemistry C142

**Also listed as:** BIO ENG C142

## CHEM 143 Nuclear Chemistry 2 Units

Terms offered: Fall 2019, Fall 2018, Fall 2017

Radioactivity, fission, nuclear models and reactions, nuclear processes in nature. Computer methods will be introduced.

### Rules & Requirements

**Prerequisites:** Physics 7B or equivalent

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM C146 Radiochemical Methods in Nuclear Technology and Forensics 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

Experimental illustrations of the interrelation between chemical and nuclear science and technology and nuclear forensics; radioactive decay and counting techniques; nuclear spectroscopy; fundamental radiochemical techniques; radiochemical separations techniques; tracers; activation analysis; forensic applications of radiochemistry; fusion, fission and nuclear reactors.

### Objectives & Outcomes

**Course Objectives:** Familiarize students with principles of nuclear and radiochemistry and its many important applications in our daily lives; provide hands-on training.

**Student Learning Outcomes:** A solid understanding of nuclear and radiochemistry; proficiency in safe handling of radioactive materials in the laboratory, and appreciation for the wide application of radiochemical techniques in chemistry, nuclear technology, and nuclear forensics.

### Rules & Requirements

**Prerequisites:** CHEM 4B or CHEM 15; and CHEM 143 is recommended

**Credit Restrictions:** Students will receive no credit for CHEM 146 after completing CHEM 144, or CHEM C144.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1.5 hours of lecture and 4.5 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** Chemistry 146

**Also listed as:** NUC ENG C146

## CHEM 149 Supplementary Work in Upper Division Chemistry 1 - 4 Units

Terms offered: Spring 2016, Spring 2015, Spring 2014

Students with partial credit in upper division chemistry courses may, with consent of instructor, complete the credit under this heading.

### Rules & Requirements

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-4 hours of independent study per week

### Summer:

6 weeks - 2.5-10 hours of independent study per week

8 weeks - 1.5-7.5 hours of independent study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM C150 Introduction to Materials Chemistry 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

The application of basic chemical principles to problems in materials discovery, design, and characterization will be discussed. Topics covered will include inorganic solids, nanoscale materials, polymers, and biological materials, with specific focus on the ways in which atomic-level interactions dictate the bulk properties of matter.

### Rules & Requirements

**Prerequisites:** CHEM 104A. CHEM 104B recommended

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Also listed as:** MAT SCI C150



## CHEM 159 Polymer Organic Chemistry 3 Units

Terms offered: Spring 2025

This course will introduce concepts pertaining to the synthesis of modern polymers. We will focus on the major polymerization methods including step-growth, radical, anionic, cationic, ring-opening, and organometallic polymerizations with emphasis given to the mechanisms, kinetics, and thermodynamics of each polymerization method. More specialized topics such as "living" and "controlled" polymerizations, stereochemistry, and polymer sustainability will also be discussed in detail. Throughout the course we will emphasize the historical developments and people behind the advancements in the field of polymer science.

### Rules & Requirements

**Prerequisites:** Required: 1st semester organic chemistry (Chem 3A or 12A) + concurrent enrollment in 2nd semester organic chemistry (Chem 3B or 12B). Strongly Preferred: 2 semesters of organic chemistry (3A/B + 12A/B) completed

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required, with common exam group.

## CHEM C170L Biochemical Engineering Laboratory 3 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024, Fall 2018, Spring 2014, Spring 2013

Laboratory techniques for the cultivation of microorganisms in batch and continuous reactions. Enzymatic conversion processes. Recovery of biological products.

### Rules & Requirements

**Prerequisites:** Chemical Engineering 170A (may be taken concurrently) or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 7 hours of laboratory and 1 hour of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Also listed as:** CHM ENG C170L

## CHEM 171H Berkeley Changemaker: The Green Materials Innovation Challenge 3 Units

Terms offered: Spring 2024, Spring 2023

Project-based course partnering students with companies, government, and non-profits interested in adopting safer green chemistry for their products. Students will learn the principles of green chemistry by identifying solutions to a real-world green chemistry challenge provided by the external partner. After completing the course students will understand essential concepts related to green chemistry, hazard assessment, bio-inspired design, and life cycle analysis, and how to apply these concepts to evaluate alternatives to a hazardous chemical. Students will know how to read and think critically about a scientific article, collaborate effectively, and hone their communication skills.

### Rules & Requirements

**Prerequisites:** 1 semester of Chemistry 1A or Biology 1A

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

## CHEM C178 Polymer Science and Technology 3 Units

Terms offered: Fall 2025, Spring 2025, Spring 2023, Fall 2016, Spring 2016, Spring 2015

An interdisciplinary course on the synthesis, characterization, and properties of polymer materials. Emphasis on the molecular origin of properties of polymeric materials and technological applications. Topics include single molecule properties, polymer mixtures and solutions, melts, glasses, elastomers, and crystals. Experiments in polymer synthesis, characterization, and physical properties.

### Rules & Requirements

**Prerequisites:** Junior standing

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Also listed as:** CHM ENG C178

## CHEM 179 Numerical Algorithms applied to Computational Quantum Chemistry 3 Units

Terms offered: Fall 2025, Spring 2025, Spring 2024

Introduction to numerical algorithms, their application to computational quantum chemistry, and best practices for software implementation and reuse. This course covers a toolbox of useful algorithms from applied mathematics that are used in physical simulations. Illustrated via computer implementation of density functional theory for modeling chemical reaction mechanisms from quantum mechanics. Topics covered include local optimization, numerical derivatives and integration, dense linear algebra the symmetric eigenvalue problem, the singular value decomposition, and the fast Fourier transform. Students are guided through principles of procedural and object-oriented programming C++ and usage of efficient numerical libraries.

### Rules & Requirements

**Prerequisites:** (1) Computing: Either (a) both CHEM 274A and CHEM 274B OR (b) CS 61A or CS/DATA C88C AND CS 9F; (2) Math: MATH 53 and MATH 54 or equivalent; (3) Familiarity with UNIX/Linux command line, and (4) An undergraduate physical chemistry course or permission of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 3 hours of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

## CHEM C182 Atmospheric Chemistry and Physics Laboratory 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

Fluid dynamics, radiative transfer, and the kinetics, spectroscopy, and measurement of atmospherically relevant species are explored through laboratory experiments, numerical simulations, and field observations.

### Rules & Requirements

**Prerequisites:** Earth and Planetary Science 50 and 102 with grades of C- or higher (one of which may be taken concurrently) or two of the following: Chemistry 120A, 120B, C130, or 130B with grades of C- or higher (one of which may be taken concurrently)

**Credit Restrictions:** Deficiency in C182 may be removed by successfully completing 125. Consent of instructor is required to enroll in C182 after completing 125.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1.5 hours of lecture and 5 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** Chemistry C182/Earth and Planetary Science C182

**Also listed as:** EPS C182

## CHEM C191 Introduction to Quantum Computing 4 Units

Terms offered: Spring 2025, Spring 2024, Fall 2023

This multidisciplinary course provides an introduction to fundamental conceptual aspects of quantum mechanics from a computational and informational theoretic perspective, as well as physical implementations and technological applications of quantum information science. Basic sections of quantum algorithms, complexity, and cryptography, will be touched upon, as well as pertinent physical realizations from nanoscale science and engineering.

### Rules & Requirements

**Prerequisites:** Linear Algebra (EECS 16A or PHYSICS 89 or MATH 54) AND either discrete mathematics (COMPSCI 70 or MATH 55), or quantum mechanics (PHYSICS 7C or PHYSICS 137A or CHEM 120A)

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

**Also listed as:** COMPSCI C191/PHYSICS C191

## CHEM C191A Introduction to Quantum Computing I 4 Units

Terms offered: Fall 2025

This is the first semester of a multidisciplinary two-semester sequence in Quantum Computing. This semester provides an introduction to fundamental conceptual aspects of quantum mechanics in the language of qubits and quantum gates, and a first introduction to quantum computation. Topics in part one include basic concepts and results in quantum information, quantum algorithms, and an introduction to quantum error correction.

### Rules & Requirements

**Prerequisites:** Linear Algebra: Either EECS 16A, Physics 89, Math 54, or equivalent. Some background in either quantum mechanics (Physics 137A, Chemistry 120A, or equivalent) or discrete mathematics (CS 70, Math 55, or equivalent) is expected

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

**Also listed as:** EECS C191A/PHYSICS C191A

## CHEM C191B Introduction to Quantum Computing II 4 Units

Terms offered: Not yet offered

This is the second semester of a multidisciplinary two-semester sequence in Quantum Computing. This second semester covers fundamentals of control of qubits, methods of quantum error mitigation, quantum benchmarking, quantum supremacy and tests of quantumness, advanced quantum error correction including fault-tolerant quantum computing and error thresholds, theory/practice of near-term fault fault tolerance, discussions of different physical platforms for quantum computing, and alternative paradigms for quantum computing.

### Rules & Requirements

**Prerequisites:** C191A or equivalent (with permission of instructor)

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

**Also listed as:** EECS C191B/PHYSICS C191B

## CHEM 192 Individual Study for Advanced Undergraduates 1 - 3 Units

Terms offered: Spring 2016, Fall 2015, Spring 2015

All properly qualified students who wish to pursue a problem of their own choice, through reading or nonlaboratory study, may do so if their proposed project is acceptable to the member of the staff with whom they wish to work.

### Rules & Requirements

**Prerequisites:** Consent of instructor and adviser

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 0 hours of independent study per week

### Summer:

6 weeks - 1-5 hours of independent study per week

8 weeks - 1-4 hours of independent study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

## CHEM H193 Senior Honors Thesis 3 Units

Terms offered: Spring 2016, Fall 2015, Spring 2015

A senior honors thesis is written in consultation with the student's faculty research advisor. This is a required course for students wishing to graduate with honors in Chemistry or Chemical Biology.

### Rules & Requirements

**Prerequisites:** Senior standing, approval of faculty research advisor, overall GPA of 3.4 or higher at Berkeley

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 9-0 hours of independent study per week

**Summer:** 8 weeks - 16.5 hours of independent study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

## CHEM H194 Research for Advanced Undergraduates 2 - 6 Units

Terms offered: Spring 2023, Fall 2022, Summer 2022 Second 6 Week Session

Students may pursue original research under the direction of one of the members of the staff.

### Rules & Requirements

**Prerequisites:** Minimum GPA of 3.4 overall at Berkeley and consent of instructor and adviser

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 0-6 hours of independent study and 0-6 hours of laboratory per week

### Summer:

6 weeks - 0-15 hours of independent study and 0-15 hours of laboratory per week

8 weeks - 0-11.5 hours of independent study and 0-11.5 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

## CHEM 195 Special Topics 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

Special topics will be offered from time to time. Examples are: photochemical air pollution, computers in chemistry.

### Rules & Requirements

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

**Summer:** 10 weeks - 4.5 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

## CHEM 196 Special Laboratory Study 2 - 6 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

Special laboratory work for advanced undergraduates.

### Rules & Requirements

**Prerequisites:** Consent of instructor and adviser

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-4 hours of independent study and 0-1 hours of laboratory per week

### Summer:

6 weeks - 2.5-10 hours of independent study and 0-2.5 hours of laboratory per week

8 weeks - 2-7.5 hours of independent study and 0-2 hours of laboratory per week

10 weeks - 1.5-6 hours of independent study and 0-1.5 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

## CHEM 197 Field Study in Chemistry 1 - 4 Units

Terms offered: Spring 2021, Spring 2020, Summer 2016 8 Week Session

Supervised experience in off-campus organizations relevant to specific aspects and applications of chemistry. Written report required at the end of the term. Course does not satisfy unit or residence requirements for the bachelor's degree.

### Rules & Requirements

**Prerequisites:** Upper division standing and consent of instructor

**Credit Restrictions:** Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of fieldwork per week

**Summer:** 8 weeks - 6 hours of fieldwork per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

## CHEM 198 Directed Group Study 1 - 4 Units

Terms offered: Fall 2022, Spring 2022, Fall 2021

Group study of selected topics.

### Rules & Requirements

**Prerequisites:** Completion of 60 units of undergraduate study and in good standing

**Credit Restrictions:** Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-4 hours of directed group study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

## CHEM 199 Supervised Independent Study and Research 1 - 4 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

Enrollment is restricted by regulations listed in the .

### Rules & Requirements

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 0 hours of independent study per week

### Summer:

6 weeks - 1-5 hours of independent study per week

8 weeks - 1-4 hours of independent study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

## CHEM 200 Chemistry Fundamentals 1 Unit

Terms offered: Fall 2025, Fall 2024, Fall 2023

Review of bonding, structure, stereochemistry, conformation, thermodynamics and kinetics, and arrow-pushing formalisms.

### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor

### Hours & Format

**Fall and/or spring:** 6 weeks - 3 hours of lecture and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 201 Fundamentals of Inorganic Chemistry 1 Unit

Terms offered: Fall 2025, Fall 2024, Fall 2023

Review of bonding, structure, MO theory, thermodynamics, and kinetics.

### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor

### Hours & Format

**Fall and/or spring:** 6 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 208 Structure Analysis by X-Ray Diffraction 4 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

The theory and practice of modern, single-crystal X-ray diffraction. Groups of four students determine the crystal and molecular structure of newly synthesized materials from the College of Chemistry. The laboratory work involves the mounting of crystals and initial evaluation by X-ray diffraction film techniques, the collection of intensity data by automated diffractometer procedures, and structure analysis and refinement.

### Rules & Requirements

**Prerequisites:** Consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 8 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 214 Heterocyclic Chemistry 3 Units

Terms offered: Spring 2024, Spring 2022, Spring 2020

Advanced topics in organic chemistry with a focus on the reactivity and synthesis of aromatic heterocycles. Classic and modern methods for the synthesis of indoles, pyridines, furans, pyrroles, and quinolines will be covered, as well as complex, multi-heteroatom ring systems. Applications to medicinal and bioorganic chemistry will be included where appropriate.

### Rules & Requirements

**Prerequisites:** Graduate student standing or consent of instructor. A year of organic chemistry with a grade of B- or better is required for undergraduate enrollment

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

**Instructor:** Maimone

## CHEM 220A Thermodynamics and Statistical Mechanics 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

A rigorous presentation of classical thermodynamics followed by an introduction to statistical mechanics with the application to real systems.

### Rules & Requirements

**Prerequisites:** 120B

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 220B Statistical Mechanics 3 Units

Terms offered: Spring 2025, Spring 2023, Spring 2022

Principles of statistical mechanics and applications to complex systems.

### Rules & Requirements

**Prerequisites:** 220A

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 221A Advanced Quantum Mechanics 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

Basic principles/postulates of quantum mechanics, Hilbert space and representation theory, quantum theory of measurements, advanced descriptions of harmonic oscillator and theory of angular momentum, time independent and time dependent approximation methods, applications to quantum mechanics of atoms and molecules.

### Rules & Requirements

**Prerequisites:** Chem120A or Physics137A, Chem120B and Chem122, or equivalents

### Hours & Format

**Fall and/or spring:** 15 weeks - 3-3 hours of lecture and 0-2 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 221B Advanced Quantum Mechanics 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

Time dependence, interaction of matter with radiation, scattering theory. Molecular and many-body quantum mechanics.

### Rules & Requirements

**Prerequisites:** 221A

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 222 Spectroscopy 3 Units

Terms offered: Fall 2017, Spring 2017, Spring 2015

This course presents a survey of experimental and theoretical methods of spectroscopy, and group theory as used in modern chemical research. The course topics include experimental methods, classical and quantum descriptions of the interaction of radiation and matter. Qualitative and quantitative aspects of the subject are illustrated with examples including application of linear and nonlinear spectroscopies to the study of molecular structure and dynamics and to quantitative analysis. This course is offered jointly with 122.

### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 223A Chemical Kinetics 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2022

Deduction of mechanisms of complex reactions. Collision and transition state theory. Potential energy surfaces. Unimolecular reaction rate theory. Molecular beam scattering studies.

### Rules & Requirements

**Prerequisites:** 220A (may be taken concurrently)

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.



## CHEM C230 Protein Chemistry, Enzymology, and Bio-organic Chemistry 2 Units

Terms offered: Spring 2020, Spring 2015, Spring 2014, Spring 2013

The topics covered will be chosen from the following: protein structure; protein-protein interactions; enzyme kinetics and mechanism; enzyme design. Intended for graduate students in chemistry, biochemistry, and molecular and cell biology.

### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor

### Hours & Format

#### Fall and/or spring:

10 weeks - 3 hours of lecture per week

15 weeks - 2 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

**Also listed as:** MCELLBI C214

## CHEM C234 Green Chemistry: An Interdisciplinary Approach to Sustainability 3 Units

Terms offered: Spring 2016, Spring 2015, Spring 2014, Spring 2013

Meeting the challenge of global sustainability will require interdisciplinary approaches to research and education, as well as the integration of this new knowledge into society, policymaking, and business. Green Chemistry is an intellectual framework created to meet these challenges and guide technological development. It encourages the design and production of safer and more sustainable chemicals and products.

### Rules & Requirements

**Prerequisites:** One year of chemistry, including a semester of organic chemistry, or consent of instructors based on previous experience

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

**Summer:** 6 weeks - 20 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

**Instructors:** Arnold, Bergman, Guth, Iles, Kokai, Mulvihill, Schwarzman, Wilson

**Also listed as:** ESPM C234/PB HLTH C234

## CHEM 236 Bioorganic Chemistry and Advanced Chemical Biology 3 Units

Terms offered: Fall 2025

Chem 236 is intended for Chemical Biology grad students who previously completed BS or BA degrees in Chemistry, Biochemistry, or Biology. Undergraduates are welcome to take the course if they have a solid command of the background material. The course will review, reinforce, and build upon organic and biophysical chemistry skills needed for ChemBio research. This will include a review of reaction mechanisms and arrow pushing skills, the chemical reactions of biomolecules, a survey of biochemical structural features, and a discussion of reaction energetics. Following this, contemporary areas of Chemical Biology will be surveyed, including drug design, immunotherapy techniques, CRISPR/Cas9 strategies, drug delivery, and more

### Rules & Requirements

**Prerequisites:** Chem 12A/B or Chem 3A/3B (or equivalent at prior institution) required Chem 135 or MCB 102 (or equivalent at prior institution) required. Concurrent enrollment OK Waiver of prerequisites required consent of course instructor

**Repeat rules:** Course may be repeated for credit with instructor consent.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM C236 Energy Solutions: Carbon Capture and Sequestration 3 Units

Terms offered: Fall 2018, Spring 2017, Spring 2015, Spring 2014, Spring 2013

After a brief overview of the chemistry of carbon dioxide in the land, ocean, and atmosphere, the course will survey the capture and sequestration of CO<sub>2</sub> from anthropogenic sources. Emphasis will be placed on the integration of materials synthesis and unit operation design, including the chemistry and engineering aspects of sequestration. The course primarily addresses scientific and engineering challenges and aims to engage students in state-of-the-art research in global energy challenges.

### Rules & Requirements

**Prerequisites:** Chemistry 4B or 1B, Mathematics 1B, and Physics 7B, or equivalents

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

**Instructors:** Bourg, DePaolo, Long, Reimer, Smit

**Also listed as:** CHM ENG C295Z/EPS C295Z



## CHEM C238 The Berkeley Lectures on Energy: Energy from Biomass 3 Units

Terms offered: Fall 2015, Fall 2014, Fall 2013

After an introduction to the different aspects of our global energy consumption, the course will focus on the role of biomass. The course will illustrate how the global scale of energy guides the biomass research. Emphasis will be placed on the integration of the biological aspects (crop selection, harvesting, storage, and distribution, and chemical composition of biomass) with the chemical aspects to convert biomass to energy. The course aims to engage students in state-of-art research.

### Rules & Requirements

**Prerequisites:** Biology 1A; Chemistry 1B or 4B, Mathematics 1B

**Repeat rules:** Course may be repeated for credit under special circumstances: Repeatable when topic changes with consent of instructor.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

**Instructors:** Bell, Blanch, Clark, Smit, C. Somerville

**Also listed as:** BIO ENG C281/CHM ENG C295A/PLANTBI C224

## CHEM C242 Machine Learning, Statistical Models, and Optimization for Molecular Problems 4 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

An introduction to mathematical optimization, statistical models, and advances in machine learning for the physical sciences. Machine learning prerequisites are introduced including local and global optimization, various statistical and clustering models, and early meta-heuristic methods such as genetic algorithms and artificial neural networks. Building on this foundation, current machine learning techniques are covered including deep learning artificial neural networks, Convolutional neural networks, Recurrent and long short term memory (LSTM) networks, graph neural networks, decision trees.

### Objectives & Outcomes

**Course Objectives:** To build on optimization and statistical modeling to the field of machine learning techniques

To introduce the basics of optimization and statistical modeling techniques relevant to chemistry students

To utilize these concepts on problems relevant to the chemical sciences.

**Student Learning Outcomes:** Students will be able to understand the landscape and connections between numerical optimization, stand-alone statistical models, and machine learning techniques, and its relevance for chemical problems.

### Rules & Requirements

**Prerequisites:** Math 53 and Math 54; Chem 120A or 120B or BioE 103; or consent of instructor

**Credit Restrictions:** Students will receive no credit for BIO ENG C242 after completing BIO ENG 242. A deficient grade in BIO ENG C242 may be removed by taking BIO ENG 242.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

**Instructor:** Teresa Head-Gordon

**Formerly known as:** Bioengineering C242/Chemistry C242

**Also listed as:** BIO ENG C242

## CHEM 243 Advanced Nuclear Structure and Reactions 3 Units

Terms offered: Spring 2013, Fall 2009, Fall 2008

Selected topics on nuclear structure and nuclear reactions.

### Rules & Requirements

**Prerequisites:** 143 or equivalent and introductory quantum mechanics

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 250A Introduction to Bonding Theory 1 Unit

Terms offered: Fall 2025, Fall 2024, Fall 2023

An introduction to group theory, symmetry, and representations as applied to chemical bonding.

### Rules & Requirements

**Prerequisites:** 200 or 201 or consent of instructor and background in the use of matrices and linear algebra

### Hours & Format

**Fall and/or spring:** 6 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 250B Inorganic Spectroscopy 1 Unit

Terms offered: Spring 2015, Spring 2014, Spring 2013

The theory of vibrational analysis and spectroscopy as applied to inorganic compounds.

### Rules & Requirements

**Prerequisites:** 250A or consent of instructor

### Hours & Format

**Fall and/or spring:**

6 weeks - 3 hours of lecture per week

15 weeks - 0 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 251A Coordination Chemistry I 1 Unit

Terms offered: Fall 2018, Fall 2017, Fall 2016

Structure and bonding, synthesis, and reactions of the d-transition metals and their compounds.

### Rules & Requirements

**Prerequisites:** 250A or consent of instructor

### Hours & Format

**Fall and/or spring:** 6 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 251B Coordination Chemistry II 1 Unit

Terms offered: Spring 2019, Spring 2018, Spring 2014

Synthesis, structure analysis, and reactivity patterns in terms of symmetry orbitals.

### Rules & Requirements

**Prerequisites:** 251A or consent of instructor

### Hours & Format

**Fall and/or spring:** 6 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 252A Organometallic Chemistry I 1 Unit

Terms offered: Fall 2025, Fall 2024, Fall 2022

An introduction to organometallics, focusing on structure, bonding, and reactivity.

### Rules & Requirements

**Prerequisites:** 200 or 201 or consent of instructor

### Hours & Format

**Fall and/or spring:** 6 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 252B Organometallic Chemistry II 1 Unit

Terms offered: Fall 2025, Fall 2024, Fall 2022

Applications of organometallic compounds in synthesis with an emphasis on catalysis.

### Rules & Requirements

**Prerequisites:** 252A or consent of instructor

### Hours & Format

**Fall and/or spring:** 6 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 253A Materials Chemistry I 1 Unit

Terms offered: Spring 2023, Spring 2022, Fall 2019

Introduction to the descriptive crystal chemistry and electronic band structures of extended solids.

### Rules & Requirements

**Prerequisites:** 200 or 201, and 250A, or consent of instructor

### Hours & Format

#### Fall and/or spring:

6 weeks - 3 hours of lecture per week

15 weeks - 0 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 253B Materials Chemistry II 1 Unit

Terms offered: Spring 2023, Spring 2022, Fall 2019

General solid state synthesis and characterization techniques as well as a survey of important physical phenomena including optical, electrical, and magnetic properties.

### Rules & Requirements

**Prerequisites:** 253A or consent of instructor

### Hours & Format

#### Fall and/or spring:

6 weeks - 3 hours of lecture per week

15 weeks - 0 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 253C Materials Chemistry III 1 Unit

Terms offered: Spring 2023, Spring 2022, Fall 2019

Introduction to surface catalysis, organic solids, and nanoscience.

Thermodynamics and kinetics of solid state diffusion and reaction will be covered.

### Rules & Requirements

**Prerequisites:** 253A or consent of instructor

### Hours & Format

**Fall and/or spring:** 5 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

**Instructors:** Somorjai, Yang

## CHEM 254 Bioinorganic Chemistry 1 Unit

Terms offered: Spring 2015, Spring 2014, Spring 2013

A survey of the roles of metals in biology, taught as a tutorial involving class presentations.

### Hours & Format

#### Fall and/or spring:

6 weeks - 3 hours of lecture per week

15 weeks - 0 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 259 Polymer Organic Chemistry 3 Units

Terms offered: Spring 2025

This course will introduce concepts pertaining to the synthesis of modern polymers. We will focus on the major polymerization methods including step-growth, radical, anionic, cationic, ring-opening, and organometallic polymerizations with emphasis given to the mechanisms, kinetics, and thermodynamics of each polymerization method. More specialized topics such as "living" and "controlled" polymerizations, stereochemistry, and polymer sustainability will also be discussed in detail. Throughout the course we will emphasize the historical developments and people behind the advancements in the field of polymer science.

### Rules & Requirements

**Prerequisites:** Required: 1st semester organic chemistry (Chem 3A or 12A) + concurrent enrollment in 2nd semester organic chemistry (Chem 3B or 12B). Strongly Preferred: 2 semesters of organic chemistry (3A/B + 12A/B) completed

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 260 Reaction Mechanisms 2 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

Advanced methods for studying organic reaction mechanisms. Topics include kinetic isotope effects, behavior of reactive intermediates, chain reactions, concerted reactions, molecular orbital theory and aromaticity, solvent and substituent effects, linear free energy relationships, photochemistry.

### Rules & Requirements

**Prerequisites:** 200 or consent of instructor

### Hours & Format

**Fall and/or spring:** 10 weeks - 3 hours of lecture and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

**Formerly known as:** 260A-260B

## CHEM 261A Organic Reactions I 1 Unit

Terms offered: Fall 2025, Fall 2024, Fall 2023

Features of the reactions that comprise the vocabulary of synthetic organic chemistry.

### Rules & Requirements

**Prerequisites:** 200 or 201 or consent of instructor

### Hours & Format

**Fall and/or spring:** 6 weeks - 3 hours of lecture and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 261B Organic Reaction II 1 Unit

Terms offered: Fall 2025, Fall 2024, Fall 2023

More reactions that are useful to the practice of synthetic organic chemistry.

### Rules & Requirements

**Prerequisites:** 261A or consent of instructor

### Hours & Format

**Fall and/or spring:** 6 weeks - 3 hours of lecture and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 261C Organic Reactions III 1 Unit

Terms offered: Fall 2013, Fall 2012, Fall 2011

This course will consider further reactions with an emphasis on pericyclic reactions such as cycloadditions, electrocyclizations, and sigmatropic rearrangements.

### Rules & Requirements

**Prerequisites:** 261B or consent of instructor

### Hours & Format

**Fall and/or spring:** 6 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 262 Metals in Organic Synthesis 1 Unit

Terms offered: Spring 2025, Spring 2024, Spring 2023

Transition metal-mediated reactions occupy a central role in asymmetric catalysis and the synthesis of complex molecules. This course will describe the general principles of transition metal reactivity, coordination chemistry, and stereoselection. This module will also emphasize useful methods for the analysis of these reactions.

### Rules & Requirements

**Prerequisites:** 261B or consent of instructor

### Hours & Format

**Fall and/or spring:**  
6 weeks - 3 hours of lecture per week  
15 weeks - 0 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 263A Synthetic Design I 1 Unit

Terms offered: Spring 2025, Spring 2024, Spring 2023

This course will provide an exposure to the range of catalytic reactions of organometallic systems, the identity of the catalysts for these reactions, and the scope and limitations of these reactions. Emphasis will be placed on understanding the mechanisms of homogeneous catalytic processes. Students will see the types of molecular fragments generated by catalytic organometallic chemistry and see the synthetic disconnections made possible by these reactions. The scope of transformations will encompass those forming commodity chemicals on large scale, pharmaceuticals on small scale, and both commodity and specialty polymers

### Rules & Requirements

**Prerequisites:** 262 or consent of instructor

### Hours & Format

**Fall and/or spring:** 5 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 263B Synthetic Design II 1 Unit

Terms offered: Spring 2025, Spring 2024, Spring 2023

This course will provide an exposure to the range of catalytic reactions of organometallic systems, the identity of the catalysts for these reactions, and the scope and limitations of these reactions. Emphasis will be placed on understanding the mechanisms of homogeneous catalytic processes. Students will see the types of molecular fragments generated by catalytic organometallic chemistry and see the synthetic disconnections made possible by these reactions. The scope of transformations will encompass those forming commodity chemicals on large scale, pharmaceuticals on small scale, and both commodity and specialty polymers.

### Rules & Requirements

**Prerequisites:** 263A or consent of instructor

### Hours & Format

**Fall and/or spring:** 5 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 265 Nuclear Magnetic Resonance Theory and Application 1 Unit

Terms offered: Spring 2025, Spring 2024, Spring 2023

The theory behind practical nuclear magnetic resonance spectroscopy and a survey of its applications to chemical research.

### Rules & Requirements

**Prerequisites:** 200 or 201 or consent of instructor

### Hours & Format

#### Fall and/or spring:

6 weeks - 3 hours of lecture per week

15 weeks - 0 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 268 Mass Spectrometry 2 Units

Terms offered: Spring 2025, Spring 2023, Spring 2022

Principles, instrumentation, and application in mass spectrometry, including ionization methods, mass analyzers, spectral interpretation, multidimensional methods (GC/MS, HPLC/MS, MS/MS), with emphasis on small organic molecules and bioanalytical applications (proteins, peptides, nucleic acids, carbohydrates, noncovalent complexes); this will include the opportunity to be trained and checked out on several open-access mass spectrometers.

### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor

### Hours & Format

**Fall and/or spring:** 10 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 270A Advanced Biophysical Chemistry I 1 Unit

Terms offered: Spring 2025, Spring 2024, Spring 2023

Underlying principles and applications of methods for biophysical analysis of biological macromolecules.

### Rules & Requirements

**Prerequisites:** 200 or consent of instructor

### Hours & Format

**Fall and/or spring:** 7.5 weeks - 2 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 270B Advanced Biophysical Chemistry II 1 Unit

Terms offered: Spring 2025, Spring 2024, Spring 2023

More applications of methods for biophysical analysis of biological macromolecules.

### Rules & Requirements

**Prerequisites:** 270A or consent of instructor

### Hours & Format

**Fall and/or spring:** 7.5 weeks - 2 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM C271A Chemical Biology I - Structure, Synthesis and Function of Biomolecules 1 Unit

Terms offered: Spring 2025, Spring 2024, Spring 2023

This course will present the structure of proteins, nucleic acids, and oligosaccharides from the perspective of organic chemistry. Modern methods for the synthesis and purification of these molecules will also be presented.

### Hours & Format

**Fall and/or spring:** 5 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

**Also listed as:** MCELLBI C212A

## CHEM C271B Chemical Biology II - Enzyme Reaction Mechanisms 1 Unit

Terms offered: Spring 2025, Spring 2024, Spring 2023

This course will focus on the principles of enzyme catalysis. The course will begin with an introduction of the general concepts of enzyme catalysis which will be followed by detailed examples that will examine the chemistry behind the reactions and the three-dimensional structures that carry out the transformations.

### Hours & Format

**Fall and/or spring:** 5 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

**Also listed as:** MCELLBI C212B

## CHEM C271C Chemical Biology III - Contemporary Topics in Chemical Biology 1 Unit

Terms offered: Spring 2025, Spring 2024, Spring 2023

This course will build on the principles discussed in Chemical Biology I and II. The focus will consist of case studies where rigorous chemical approaches have been brought to bear on biological questions. Potential subject areas will include signal transduction, photosynthesis, immunology, virology, and cancer. For each topic, the appropriate bioanalytical techniques will be emphasized.

### Hours & Format

**Fall and/or spring:** 5 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

**Also listed as:** MCELLBI C212C

## CHEM 272 Python for the Molecular Science 3 Units

Terms offered: Summer 2025

This course introduces programming concepts and techniques required for scientific computing using Python. Students will learn basic syntax, use cases, and ecosystems for Python programming in the molecular sciences. Students will become familiar with tools and practices commonly used in software development such as version control, documentation, and testing. The course will also provide a brief introduction to C++ and compare the functionalities of the two languages.

### Rules & Requirements

**Prerequisites:** Admission to the MSSE program

### Hours & Format

**Summer:** 13 weeks - 3 hours of lecture, 1 hour of discussion, and 1 hour of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 273 Numerical Methods for Computational Science 3 Units

Terms offered: Summer 2025

In computational molecular science, numerical methods are essential for solving mathematical problems that are too complex for analytical solutions. Using Python and its scientific libraries as a tool, this course covers the key numerical methods required for computational science from the following core mathematical areas: Linear Algebra, Calculus, Probability and Statistics, and Numerical Analysis.

### Rules & Requirements

**Prerequisites:** Admittance to the MSSE degree

### Hours & Format

**Summer:** 13 weeks - 3 hours of lecture, 1 hour of discussion, and 1 hour of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 274A Programming Languages for Molecular Sciences: Python and C++ 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

Course provides in-depth coverage of programming concepts and techniques required for scientific computing, data science, and high-performance computing using C++ and Python. Course will compare and contrast the functionalities of the two languages. Topics include classes, overloading, data abstraction, information hiding, encapsulation, file processing, exceptions, and low-level language features. Exercises based on molecular science problems will provide hands-on experience needed to learn these languages. Course serves as a prereq to later MSSE courses: Data Science, Machine Learning Algorithms, Software Engineering for Scientific Computing, Numerical Algorithms Applied to Computational Quantum Chemistry, and Applications Parallel Comp.

### Rules & Requirements

**Prerequisites:** Prior exposure to basic programming methodology or the consent of the instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3-3 hours of lecture, 2-2 hours of discussion, and 0-2 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 274B Software Engineering Fundamentals for Molecular Sciences 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

Course will advance students' understanding of fundamental knowledge and techniques for developing complex software. Students will gain an in-depth view of computer system architecture as well as abstraction techniques as means to manage program complexity. Students will collaboratively develop a software engineering package, gaining experience in all aspects of the software development process. Course serves as a prerequisite to later MSSE courses: Data Science, Machine Learning Algorithms, Software Engineering for Scientific Computing, Numerical Algorithms Applied to Computational Quantum Chemistry, and Applications of Parallel Computers

### Rules & Requirements

**Prerequisites:** Chem 274A - MSSE's Introduction to Programming Languages – C++ and Python -

### Hours & Format

**Fall and/or spring:** 15 weeks - 3-3 hours of lecture, 2-2 hours of discussion, and 0-2 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.



## CHEM 275A Introduction to Programming Languages C++ and Python 3 Units

Terms offered: Fall 2021, Fall 2020

This course provides in-depth coverage of programming concepts and techniques required for scientific computing, data science, and high-performance computing using C++ and Python. The course will compare and contrast the functionalities of the two languages. Topics include classes, overloading, data abstraction, information hiding, encapsulation, inheritance, polymorphism, file processing, templates, exceptions, container classes, and low-level language features. Numerous exercises based on molecular science problems will provide the hands-on experience needed to learn these languages

### Objectives & Outcomes

**Student Learning Outcomes:** Upon successfully completing this course, students will be able to

A.

Develop the necessary skills to effectively interact with machine learning environments.

B.

Acquire the skills needed to develop high-performance computing software.

### Rules & Requirements

**Prerequisites:** Prior exposure to basic programming methodology or the consent of the instructor

### Hours & Format

**Fall and/or spring:** 8 weeks - 5 hours of web-based lecture and 6 hours of web-based discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 275B Introduction to Software Engineering Best Practices 3 Units

Terms offered: Fall 2021, Fall 2020

This course will advance students' understanding of the different steps involved in software design. Students will acquire hands-on experience in practical problems such as specifying, designing, building, testing, and delivering reliable software systems for scientific computing. Students will collaboratively develop a software engineering package, thus gaining experience in all aspects of the software development process from the feasibility study to the final delivery of the product. This course is a prerequisite to MSSE courses in Software Engineering for Scientific Computing, Computational Chemistry and Materials Science, and Parallel Computing.

### Objectives & Outcomes

**Student Learning Outcomes:** Upon successfully completing this course, students will have the skills needed to develop high-performance computing software.

### Rules & Requirements

**Prerequisites:** Chem 275 - MSSE's Introduction to Programming Languages – C++ and Python

### Hours & Format

**Fall and/or spring:** 8 weeks - 5 hours of web-based lecture and 6 hours of web-based discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 277B Machine Learning Algorithms 3 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

An introduction to mathematical optimization and statistics and "non-algorithmic" computation using machine learning. Machine learning prerequisites are introduced including local and global optimization, various statistical and clustering models, and early meta-heuristic methods such as genetic algorithms and artificial neural networks. Building on this foundation, current machine learning techniques are covered including Deep Learning networks, Convolutional neural networks, Recurrent and long short term memory (LSTM) networks, and support vector machines and Gaussian ridge regression. Various case studies in applying optimization, statistical modeling, and machine learning methods as classification and regression task

### Objectives & Outcomes

#### Student Learning Outcomes: A.

To introduce the basics of optimization and statistical modeling techniques relevant to machine learning

B.

To build on optimization and statistical modeling to the recent field of machine learning techniques.

C.

To understand data and algorithms relevant to machine learning

### Rules & Requirements

**Prerequisites:** The students will have had MSSE courses (1) Chem 270 - Intro to Programming, (2) Chem 271 - Software Best Practices, and (3) DS100 courses

### Hours & Format

**Fall and/or spring:** 15 weeks - 4 hours of lecture and 2 hours of discussion per week

**Summer:** 8 weeks - 4.5 hours of lecture and 5.5 hours of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 278 Ethical Topics for Professional Software Engineering 1 Unit

Terms offered: Fall 2025, Fall 2024, Fall 2023

This course will expose students to applied ethics in professional ethics, information technology, intellectual property, and corporate ethics that are topic relevant to the MSSE degree.

### Rules & Requirements

**Prerequisites:** Acceptance into the MSSE program

### Hours & Format

**Fall and/or spring:** 5 weeks - 1 hour of web-based lecture and 1 hour of web-based discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 279 Numerical Algorithms applied to Computational Quantum Chemistry 3 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

Introduction to numerical algorithms, their application to computational quantum chemistry, and best practices for software implementation and reuse. This course covers a toolbox of useful algorithms from applied mathematics that are used in physical simulations. Illustrated via computer implementation of density functional theory for modeling chemical reaction mechanisms from quantum mechanics. Topics covered include local optimization, numerical derivatives and integration, dense linear algebra the symmetric eigenvalue problem, the singular value decomposition, and the fast Fourier transform. Students are guided through principles of procedural and object-oriented programming C++ and usage of efficient numerical libraries..

### Objectives & Outcomes

#### Course Objectives: 1.

To introduce computer-based physical simulation via computational quantum chemistry.

2.

To develop the core numerical algorithms needed to efficiently implement computational quantum chemistry methods, as well as other physical simulations.

3.

To reinforce programming skills directed to sustainable software as well as intelligent use of optimized libraries to implement numerical kernels.

### Rules & Requirements

**Prerequisites:** Students will have had MSSE courses (1) Chem 275A Intro to Programming, (2) Chem 275B Software Best Practices, and (3) Data Science 100 courses. In addition, undergraduate physical chemistry (Chem 120A or equivalent) or permission of instructor is required

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 3 hours of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 280 Foundations of Programming and Software Engineering for Molecular Sciences 2 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

This course provides an overview of topics relevant to programming and creating software projects. The course will be taught in collaboration with members of the Molecular Sciences Software Institute (MolSII). Students will learn basic syntax, use cases, and ecosystems for Python and C++. Students will become familiar with tools and practices commonly used in software development such as version control, documentation, and testing. Central to this course is a hands on molecular simulation project where students work in groups to create a software package using concepts taught in the course.

### Rules & Requirements

**Prerequisites:** Acceptance to MSSE program

### Hours & Format

**Fall and/or spring:** 2 weeks - 20 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 281 Software Engineering for Scientific Computing 3 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

The course covers computer architecture and software features that have the greatest impact on performance. It addresses debugging and performance tuning, detecting memory and stack overwrites, malloc corruption, hotspot, paging, cache misses. A toolbox with common algorithms: sorting, searching, hashing, trees, graph traversing, is followed by common patterns used in object-oriented design. It describes programming paradigms, dynamic libraries, distributed architectures, and services. Lectures on linear algebra and performance libraries are provided as background for future courses. HPC paradigms and GPU programming are introduced. Software packaging, extensibility, and interactivity is followed by team development, testing and hardening.

### Objectives & Outcomes

**Course Objectives:** The objective of this recurrent course is to equip students with the skills and tools every software engineer must master for a successful professional career.

### Rules & Requirements

**Prerequisites:** Students will have had MSSE courses (1) C275A Intro to Programming, (2) C275B Software Best Practices. Students are expected to be familiar with programming in C++ and have a basic understanding of LINUX. Additional materials will be provided for students to peruse as necessary

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture, 1 hour of discussion, and 1 hour of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 282 MSSE Leadership Bootcamp 2 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

This boot camp for the Master of Molecular Science and Software Engineering program is a two-week intensive course that introduces program participants to the leadership, management and entrepreneurial skills necessary in today's professional environment. Using the capstone project as a baseline, this course aims to provide program participants an understanding of the key aspects of management and leadership disciplines; team and organization dynamics; leading and participating in cross functional teams; engineering economic, finance and accounting concepts; effective communication skills and project management.

### Rules & Requirements

**Prerequisites:** Concurrent enrollment in Chem 283 Capstone Project Course

### Hours & Format

**Fall and/or spring:** 2 weeks - 17-17 hours of lecture and 25-25 hours of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 282A MSSE Leadership Bootcamp 1 Unit

Terms offered: Spring 2025

This is the first of the two one-unit courses that make up the Master of Molecular Science and Software Engineering (MSSE) program leadership course. Together, these two one-unit courses aim to introduce program participants to a number of key professional skills that will enhance their performance in today's business environment. Topics covered in this course include key aspects of management and leadership disciplines; engineering, economic, finance and accounting concepts; effective communication skills, and a technologist's role in marketing and business strategy formulation and execution.

### Hours & Format

**Fall and/or spring:** 2 weeks - 12.5 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 282B MSSE Leadership and Project Management 1 Unit

Terms offered: Spring 2025

MSSE Leadership and Project Management (CHEM 282B) will be taken concurrently with the capstone project (CHEM 283) course.

Tightly integrating with the Capstone Project Course, this course aims to reinforce the key aspects of leading and participating in cross functional teams and project management. Program participants will also be able to apply the project management and teamwork skills in completing their capstone team projects.

### Rules & Requirements

**Prerequisites:** Must be taken in the same semester as CHEM 283

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 283 MSSE Capstone Project Course 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

This course provides students with a multifaceted experience managing a project involving the application and development of software for Computational Sciences. Students exercise leadership, team building, and critical thinking skills resulting in a Capstone project deliverables and final report. Capstone projects are an essential part of the MSSE program because students transfer skills learned in other MSSE courses to a real-world application in particular applying several software engineering, algorithmic and scientific concepts. This course is also designed to be tightly integrated with MSSE's Leadership Bootcamp. Capstone projects are developed with MSSE industrial and academic partners, individually or in cross-functional teams.

### Rules & Requirements

**Prerequisites:** All courses in the MSSE program curriculum are prerequisite of the Capstone Project course. Concurrent enrollment in Chem 282-MSSE Leadership Bootcamp and CS267-Applications of Parallel Computers is required

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-1 hours of lecture and 2-2 hours of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 284 High Performance Computing for the Molecular Sciences 3 Units

Terms offered: Not yet offered

This course introduces parallel programming concepts commonly encountered in computational molecular sciences codes, including distributed-memory parallelization, shared-memory parallelization, and GPU parallelization. Students will become familiar with MPI, OpenMP, and CUDA, while also learning specific strategies for addressing performance challenges associated with key computational chemistry algorithms. Special emphasis is placed on the execution of machine learning techniques within a high performance computing environment, as well as challenges arising from processing large amounts of data.

### Rules & Requirements

**Prerequisites:** Admission to the Master of Molecular Science and Software Engineering. CHEM 277B: Machine Learning Algorithms or instructor approval

**Credit Restrictions:** Students will receive no credit for CHEM 284 after completing COMPSCI 267.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture, 1 hour of discussion, and 1 hour of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 295 Special Topics 1 - 3 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

Lecture series on topics of current interest. Recently offered topics: Natural products synthesis, molecular dynamics, statistical mechanics, molecular spectroscopy, structural biophysics, organic polymers, electronic structure of molecules and bio-organic chemistry.

### Rules & Requirements

**Prerequisites:** Graduate standing or consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Offered for satisfactory/unsatisfactory grade only.

## CHEM 297 Field Study in Chemistry for Graduate Students 1 - 4 Units

Terms offered: Not yet offered

Supervised experience in off-campus organizations relevant to specific aspects and applications of chemistry as part of the student's progress towards a PhD degree. Written report required at the end of the term. Course does not satisfy unit or residence requirements for the bachelor's degree.

### Rules & Requirements

**Prerequisites:** Graduate student in good standing and consent of instructor; a written proposal for the internship, signed by the faculty sponsor must receive approval from the department chair

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3-3 hours of fieldwork per week

**Summer:** 8 weeks - 6-6 hours of fieldwork per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Offered for satisfactory/unsatisfactory grade only.

## CHEM 298 Seminars for Graduate Students 1 - 3 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

In addition to the weekly Graduate Research Conference and weekly seminars on topics of interest in biophysical, organic, physical, nuclear, and inorganic chemistry, there are group seminars on specific fields of research. Seminars will be announced at the beginning of each semester.

### Rules & Requirements

**Prerequisites:** Graduate standing

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-3 hours of colloquium per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Offered for satisfactory/unsatisfactory grade only.

## CHEM 299 Research for Graduate Students 1 - 9 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

Facilities are available to graduate students pursuing original investigations toward an advanced degree in Chemistry or related fields at the University of California, Berkeley. Investigations may include experiment, theory, data analysis, and dissemination of accomplishments or discoveries in the form of oral and written presentations or manuscripts submitted for peer-reviewed publication. Such work is done under the supervision and direction of a faculty member or their designee.

### Objectives & Outcomes

**Course Objectives:** Provide opportunities for graduate students to engage in original research under the direction, support, and mentorship of a faculty member in the chemistry department at UC Berkeley.

**Student Learning Outcomes:** Students will learn the skills and techniques necessary to complete a PhD in the field of Chemistry and ultimately become a world expert in their thesis research area. Students will show progress in the following areas related to their chosen field of study, including, but not limited to the following: Creativity, intellectual ownership, initiative, technical proficiency, resilience, communication both orally and in writing, ability to solve challenging problems, broad understanding of relevant disciplinary background (literature), the ability to initiate new research directions aimed toward solving important scientific challenges.

### Rules & Requirements

**Prerequisites:** Graduate standing. Consent of Instructor Required

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 0-0 hours of independent study per week

### Additional Details

**Subject/Course Level:** Chemistry/Graduate

**Grading:** Letter grade.

## CHEM 300 Professional Preparation: Supervised Teaching of Chemistry 2 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

Discussion, curriculum development, class observation, and practice teaching in chemistry.

### Rules & Requirements

**Prerequisites:** Graduate standing and appointment as a graduate student instructor

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of seminar per week

### Additional Details

**Subject/Course Level:** Chemistry/Professional course for teachers or prospective teachers

**Grading:** Letter grade.

## CHEM 301 Pre-High School Chemistry Classroom Immersion 1 Unit

Terms offered: Fall 2025, Fall 2024, Fall 2023

Provides training and opportunity for graduate students to make presentations in local public schools. Training ensures that presenters are aware of scientific information mandated by the State of California for particular grade levels, and that presentations are intellectually stimulating, relevant to the classroom students' interests, and age-appropriate. Time commitment an average of two to three hours/week, but actual time spent is concentrated during preparation and classroom delivery of presentations, which are coordinated between teachers' needs and volunteers' availability.

### Rules & Requirements

**Prerequisites:** Graduate standing

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Professional course for teachers or prospective teachers

**Grading:** Offered for satisfactory/unsatisfactory grade only.

**Instructor:** Bergman

## CHEM 301A Undergraduate Lab Instruction 2 Units

Terms offered: Fall 2017, Spring 2017, Fall 2016

Tutoring of students in 1AL and 1B laboratory. Students attend one hour of the regular GSI preparatory meeting and hold one office hour per week to answer questions about laboratory assignments.

### Rules & Requirements

**Prerequisites:** Junior standing or consent of instructor; 1A, 1AL, and 1B with grades of B- or higher

**Repeat rules:** Course may be repeated for credit up to a total of 4 units.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture and 4 hours of tutorial per week

### Additional Details

**Subject/Course Level:** Chemistry/Professional course for teachers or prospective teachers

**Grading:** Offered for pass/not pass grade only.

## CHEM 301B Undergraduate Chemistry Instruction 2 Units

Terms offered: Fall 2017, Spring 2017, Fall 2016

Tutoring of students in 1A-1B. Students attend a weekly meeting on tutoring methods at the Student Learning Center and attend 1A-1B lectures.

### Rules & Requirements

**Prerequisites:** Sophomore standing; 1A, 1AL, and 1B with grades of B- or higher

**Repeat rules:** Course may be repeated for credit up to a total of 4 units.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture and 5 hours of tutorial per week

### Additional Details

**Subject/Course Level:** Chemistry/Professional course for teachers or prospective teachers

**Grading:** Offered for pass/not pass grade only.

**Formerly known as:** 301



## CHEM 301C Chemistry Teacher Scholars 2 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024

The Chemistry Undergraduate Teacher Scholar Program places undergraduate students as apprentice instructors in lower division laboratory and discussion sections. In a weekly meeting with instructors, participants learn about teaching, review chemistry knowledge, and are coached to mentor students.

### Rules & Requirements

**Prerequisites:** Chemistry 1A or Chemistry 4A or equivalent. Consent of instructor required

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1.5-1.5 hours of lecture and 1-1 hours of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Professional course for teachers or prospective teachers

**Grading:** Offered for pass/not pass grade only.

## CHEM 301D Undergraduate Chemistry Course Instruction 1 - 2 Units

Terms offered: Fall 2017, Spring 2017, Fall 2016

Tutoring of students enrolled in an undergraduate chemistry course.

### Rules & Requirements

**Prerequisites:** Junior standing or consent of instructor; completion of tutored course with a grade of B- or better

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 2-4 hours of tutorial per week

### Additional Details

**Subject/Course Level:** Chemistry/Professional course for teachers or prospective teachers

**Grading:** Offered for pass/not pass grade only.

## CHEM 301T Undergraduate Preparation for Teaching or Instruction in Teaching 2 Units

Terms offered: Spring 2015, Spring 2014, Spring 2013

### Rules & Requirements

**Prerequisites:** Junior standing, overall GPA 3.1, and consent of instructor

**Repeat rules:** Course may be repeated for credit up to a total of 8 units.

### Hours & Format

**Fall and/or spring:** 15 weeks - 2-3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Professional course for teachers or prospective teachers

**Grading:** Letter grade.

## CHEM 301W Supervised Instruction of Chemistry Scholars 2 Units

Terms offered: Fall 2017, Spring 2017, Fall 2016

Tutoring of students in the College of Chemistry Scholars Program who are enrolled in general or organic chemistry. Students attend a weekly meeting with instructors.

### Rules & Requirements

**Prerequisites:** Sophomore standing and consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of independent study and 4-5 hours of tutorial per week

### Additional Details

**Subject/Course Level:** Chemistry/Professional course for teachers or prospective teachers

**Grading:** Offered for pass/not pass grade only.

## **CHEM 375 Professional Preparation: Supervised Teaching of Chemistry 2 Units**

Terms offered: Fall 2023, Fall 2021

Discussion, curriculum development, class observation, and practice teaching in chemistry.

### **Rules & Requirements**

**Prerequisites:** Graduate standing and appointment as a graduate student instructor

**Repeat rules:** Course may be repeated for credit without restriction.

### **Hours & Format**

**Fall and/or spring:** 15 weeks - 2 hours of seminar per week

### **Additional Details**

**Subject/Course Level:** Chemistry/Professional course for teachers or prospective teachers

**Grading:** Letter grade.

## **CHEM 602 Individual Study for Doctoral Students 1 - 8 Units**

Terms offered: Fall 2017, Spring 2017, Fall 2016

Individual study in consultation with the major field adviser, intended to provide an opportunity for qualified students to prepare themselves for the various examinations required of candidates for the Ph.D. degree. May not be used for unit or residence requirements for the doctoral degree.

### **Rules & Requirements**

**Repeat rules:** Course may be repeated for credit without restriction.

### **Hours & Format**

**Fall and/or spring:** 15 weeks - 1-8 hours of independent study per week

**Summer:** 8 weeks - 1.5-15 hours of independent study per week

### **Additional Details**

**Subject/Course Level:** Chemistry/Graduate examination preparation

**Grading:** Offered for satisfactory/unsatisfactory grade only.

## **CHEM 700 QB3 Colloquium for Graduate Students 0.0 Units**

Terms offered: Spring 2023, Spring 2022, Spring 2021

Weekly Graduate colloquium on topics of interest in QB3 research.

### **Rules & Requirements**

**Prerequisites:** Graduate standing

**Repeat rules:** Course may be repeated for credit without restriction.

### **Hours & Format**

**Fall and/or spring:** 15 weeks - 1-2 hours of colloquium per week

### **Additional Details**

**Subject/Course Level:** Chemistry/Graduate examination preparation

**Grading:** Offered for satisfactory/unsatisfactory grade only.

**Formerly known as:** Chemistry 999