

# Chemistry

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The Chemistry PhD program is designed towards developing the ability to do creative scientific research. Accordingly, the single most important facet of the curriculum for an individual is his or her own research project. In keeping with the goal of fostering an atmosphere of scholarly, independent study, formal course requirements are minimal and vary among disciplines. Advisers tailor course requirements to best prepare the student for the chosen research field.

The doctoral program includes the following concentrations, each of which has specific degree requirements:

1. **Physical Chemistry:** In general, the Physical Chemistry Graduate Program encompasses experimental physical, analytical, nuclear, biophysical, and theoretical chemistry.
2. **Synthetic Chemistry:** The Synthetic Chemistry Graduate Program includes emphases in preparation of organic or inorganic compounds, development of methods for their synthesis, and their characterization and use.
3. **Chemical Biology:** The Chemical Biology Graduate Program covers research areas at the interface of chemistry and biology, ranging from the synthesis of bioactive materials to the characterization of living systems.

## Admission to the University

### Minimum Requirements for Admission

The following minimum requirements apply to all graduate programs and will be verified by the Graduate Division:

1. A bachelor's degree or recognized equivalent from an accredited institution;
2. A grade point average of B or better (3.0);
3. If the applicant has completed a basic degree from a country or political entity (e.g., Quebec) where English is not the official language, adequate proficiency in English to do graduate work, as evidenced by a TOEFL score of at least 90 on the iBT test, 570 on the paper-and-pencil test, or an IELTS Band score of at least 7 on a 9-point scale (note that individual programs may set higher levels for any of these); and
4. Sufficient undergraduate training to do graduate work in the given field.

### Applicants Who Already Hold a Graduate Degree

The Graduate Council views academic degrees not as vocational training certificates, but as evidence of broad training in research methods, independent study, and articulation of learning. Therefore, applicants who already have academic graduate degrees should be able to pursue new subject matter at an advanced level without the need to enroll in a related or similar graduate program.

Programs may consider students for an additional academic master's or professional master's degree only if the additional degree is in a distinctly different field.

Applicants admitted to a doctoral program that requires a master's degree to be earned at Berkeley as a prerequisite (even though the applicant already has a master's degree from another institution in the same or

a closely allied field of study) will be permitted to undertake the second master's degree, despite the overlap in field.

The Graduate Division will admit students for a second doctoral degree only if they meet the following guidelines:

1. Applicants with doctoral degrees may be admitted for an additional doctoral degree only if that degree program is in a general area of knowledge distinctly different from the field in which they earned their original degree. For example, a physics PhD could be admitted to a doctoral degree program in music or history; however, a student with a doctoral degree in mathematics would not be permitted to add a PhD in statistics.
2. Applicants who hold the PhD degree may be admitted to a professional doctorate or professional master's degree program if there is no duplication of training involved.

Applicants may apply only to one single degree program or one concurrent degree program per admission cycle.

### Required Documents for Applications

1. **Transcripts:** Applicants may upload *unofficial* transcripts with your application for the departmental initial review. Unofficial transcripts must contain specific information including the name of the applicant, name of the school, all courses, grades, units, & degree conferral (if applicable).
2. **Letters of recommendation:** Applicants may request online letters of recommendation through the online application system. Hard copies of recommendation letters must be sent directly to the program, by the recommender, not the Graduate Admissions.
3. **Evidence of English language proficiency:** All applicants who have completed a basic degree from a country or political entity in which the official language is not English are required to submit official evidence of English language proficiency. This applies to institutions from Bangladesh, Burma, Nepal, India, Pakistan, Latin America, the Middle East, the People's Republic of China, Taiwan, Japan, Korea, Southeast Asia, most European countries, and Quebec (Canada). However, applicants who, at the time of application, have already completed at least one year of full-time academic course work with grades of B or better at a US university may submit an official transcript from the US university to fulfill this requirement. The following courses will not fulfill this requirement:
  - courses in English as a Second Language,
  - courses conducted in a language other than English,
  - courses that will be completed after the application is submitted, and
  - courses of a non-academic nature.

Applicants who have previously applied to Berkeley must also submit new test scores that meet the current minimum requirement from one of the standardized tests. Official TOEFL score reports must be sent directly from Educational Test Services (ETS). The institution code for Berkeley is 4833 for Graduate Organizations. Official IELTS score reports must be sent electronically from the testing center to University of California, Berkeley, Graduate Division, Sproul Hall, Rm 318 MC 5900, Berkeley, CA 94720. TOEFL and IELTS score reports are only valid for two years prior to beginning the graduate program at UC Berkeley. Note: score reports can not expire before the month of June.

## Where to Apply

Visit the Berkeley Graduate Division application page (<http://grad.berkeley.edu/admissions/apply/>).

## The Requirements for a PhD Degree in Chemistry

- **Coursework:** There is no formal coursework requirement, however, the equivalent of four semester-long courses is normally taken. Courses you will take will depend on your background and research interests.
- **Graduate student instructor service:** A total of two semesters of graduate student instructor service is required with a third semester as optional. Graduate Student Instruction is usually fulfilled in the first semester and one semester in each of the next two years.
- **Research:**
  - First-year report (synthetic and chemical biology division): An original, journal-quality research proposal no more than 10 pages read by two chemistry faculty.
  - Second-year seminar (all divisions): A 25-minute presentation to the department on your research progress.
- **Qualifying examination (all divisions):** An oral examination with a committee of three chemistry faculty and one outside department faculty member on your research and defense of an original research proposal (synthetic) or critical analysis of a recent outside paper (non-synthetic).
- **Dissertation (all divisions):** Submission of your dissertation approved by a committee of your research adviser, a second chemistry faculty member, and one outside department faculty member. No dissertation defense.

## Chemistry

Expand all course descriptions [+] Collapse all course descriptions [-]

### CHEM 200 Chemistry Fundamentals 1 Unit

Terms offered: Fall 2022, Fall 2021, Fall 2020

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

Chemistry Fundamentals: Read More [+]

#### 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.

Chemistry Fundamentals: Read Less [-]

### CHEM 201 Fundamentals of Inorganic Chemistry 1 Unit

Terms offered: Fall 2022, Fall 2021, Fall 2020

Review of bonding, structure, MO theory, thermodynamics, and kinetics. Fundamentals of Inorganic Chemistry: Read More [+]

#### 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.

Fundamentals of Inorganic Chemistry: Read Less [-]

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

Terms offered: Spring 2023, Spring 2022, Spring 2020

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.

Structure Analysis by X-Ray Diffraction: Read More [+]

#### 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.

Structure Analysis by X-Ray Diffraction: Read Less [-]

## CHEM 214 Heterocyclic Chemistry 3 Units

Terms offered: Spring 2022, Spring 2020, Spring 2018

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.

Heterocyclic Chemistry: Read More [+]

### 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

Heterocyclic Chemistry: Read Less [-]

## CHEM 220A Thermodynamics and Statistical Mechanics 3 Units

Terms offered: Fall 2022, Fall 2021, Fall 2020

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

Thermodynamics and Statistical Mechanics: Read More [+]

### 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.

Thermodynamics and Statistical Mechanics: Read Less [-]

## CHEM 220B Statistical Mechanics 3 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021

Principles of statistical mechanics and applications to complex systems.

Statistical Mechanics: Read More [+]

### 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.

Statistical Mechanics: Read Less [-]

## CHEM 221A Advanced Quantum Mechanics 3 Units

Terms offered: Fall 2022, Fall 2021, Fall 2020

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.

Advanced Quantum Mechanics: Read More [+]

### 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.

Advanced Quantum Mechanics: Read Less [-]

## CHEM 221B Advanced Quantum Mechanics 3 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021  
 Time dependence, interaction of matter with radiation, scattering theory.  
 Molecular and many-body quantum mechanics.  
 Advanced Quantum Mechanics: Read More [+]

### 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.

Advanced Quantum Mechanics: Read Less [-]

## 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.

Spectroscopy: Read More [+]

### 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.

Spectroscopy: Read Less [-]

## CHEM 223A Chemical Kinetics 3 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021  
 Deduction of mechanisms of complex reactions. Collision and transition state theory. Potential energy surfaces. Unimolecular reaction rate theory. Molecular beam scattering studies.  
 Chemical Kinetics: Read More [+]

### 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.

Chemical Kinetics: Read Less [-]

## 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.

Protein Chemistry, Enzymology, and Bio-organic Chemistry: Read More [+]

### 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

Protein Chemistry, Enzymology, and Bio-organic Chemistry: Read Less [-]

## 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. Green Chemistry: An Interdisciplinary Approach to Sustainability: Read More [+]

### 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

Green Chemistry: An Interdisciplinary Approach to Sustainability: Read Less [-]

## 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.

Energy Solutions: Carbon Capture and Sequestration: Read More [+]

### 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

Energy Solutions: Carbon Capture and Sequestration: Read Less [-]

## 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.

The Berkeley Lectures on Energy: Energy from Biomass: [Read More](#) [+]

### 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

The Berkeley Lectures on Energy: Energy from Biomass: [Read Less](#) [-]

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

Terms offered: 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.

Machine Learning, Statistical Models, and Optimization for Molecular Problems: [Read More](#) [+]

### 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

Machine Learning, Statistical Models, and Optimization for Molecular Problems: [Read Less](#) [-]

## 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.

Advanced Nuclear Structure and Reactions: Read More [+]

### 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.

Advanced Nuclear Structure and Reactions: Read Less [-]

## CHEM 250A Introduction to Bonding Theory 1 Unit

Terms offered: Fall 2022, Fall 2021, Fall 2020

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

Introduction to Bonding Theory: Read More [+]

### 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.

Introduction to Bonding Theory: Read Less [-]

## 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.

Inorganic Spectroscopy: Read More [+]

### 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.

Inorganic Spectroscopy: Read Less [-]

## 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.

Coordination Chemistry I: Read More [+]

### 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.

Coordination Chemistry I: Read Less [-]

## 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.

Coordination Chemistry II: Read More [+]

### 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.

Coordination Chemistry II: Read Less [-]

## CHEM 252A Organometallic Chemistry I 1 Unit

Terms offered: Fall 2022, Fall 2021, Fall 2020

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

Organometallic Chemistry I: Read More [+]

### 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.

Organometallic Chemistry I: Read Less [-]

## CHEM 252B Organometallic Chemistry II 1 Unit

Terms offered: Fall 2022, Fall 2021, Fall 2020

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

Organometallic Chemistry II: Read More [+]

### 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.

Organometallic Chemistry II: Read Less [-]

## 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.

Materials Chemistry I: Read More [+]

### 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.

Materials Chemistry I: Read Less [-]

## 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.

Materials Chemistry II: Read More [+]

### 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.

Materials Chemistry II: Read Less [-]

## 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.

Materials Chemistry III: Read More [+]

### 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

Materials Chemistry III: Read Less [-]

## 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.

Bioinorganic Chemistry: Read More [+]

### 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.

Bioinorganic Chemistry: Read Less [-]

## CHEM 260 Reaction Mechanisms 2 Units

Terms offered: Fall 2022, Fall 2021, Fall 2020

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.

Reaction Mechanisms: Read More [+]

### 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

Reaction Mechanisms: Read Less [-]

## CHEM 261A Organic Reactions I 1 Unit

Terms offered: Fall 2022, Fall 2021, Fall 2020

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

Organic Reactions I: Read More [+]

### 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.

Organic Reactions I: Read Less [-]

## CHEM 261B Organic Reaction II 1 Unit

Terms offered: Fall 2022, Fall 2021, Fall 2020

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

Organic Reaction II: Read More [+]

### 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.

Organic Reaction II: Read Less [-]

## 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.

Organic Reactions III: Read More [+]

### 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.

Organic Reactions III: Read Less [-]

## CHEM 262 Metals in Organic Synthesis 1 Unit

Terms offered: Spring 2023, Spring 2022, Spring 2021

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.

Metals in Organic Synthesis: [Read More](#) [+]

### 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.

Metals in Organic Synthesis: [Read Less](#) [-]

## CHEM 263A Synthetic Design I 1 Unit

Terms offered: Spring 2023, Spring 2022, Spring 2021

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

Synthetic Design I: [Read More](#) [+]

### 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.

Synthetic Design I: [Read Less](#) [-]

## CHEM 263B Synthetic Design II 1 Unit

Terms offered: Spring 2023, Spring 2022, Spring 2021

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.

Synthetic Design II: [Read More](#) [+]

### 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.

Synthetic Design II: [Read Less](#) [-]

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

Terms offered: Spring 2023, Spring 2022, Fall 2020

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

Nuclear Magnetic Resonance Theory and Application: [Read More](#) [+]

### 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.

Nuclear Magnetic Resonance Theory and Application: [Read Less](#) [-]

## CHEM 268 Mass Spectrometry 2 Units

Terms offered: Spring 2023, Spring 2022, Spring 2019

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.

Mass Spectrometry: Read More [\[+\]](#)

### 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.

Mass Spectrometry: Read Less [\[-\]](#)

## CHEM 270A Advanced Biophysical Chemistry I 1 Unit

Terms offered: Spring 2023, Spring 2022, Spring 2021

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

Advanced Biophysical Chemistry I: Read More [\[+\]](#)

### 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.

Advanced Biophysical Chemistry I: Read Less [\[-\]](#)

## CHEM 270B Advanced Biophysical Chemistry II 1 Unit

Terms offered: Spring 2023, Spring 2022, Spring 2021

More applications of methods for biophysical analysis of biological macromolecules.

Advanced Biophysical Chemistry II: Read More [\[+\]](#)

### 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.

Advanced Biophysical Chemistry II: Read Less [\[-\]](#)

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

Terms offered: Spring 2023, Spring 2022, Spring 2021

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.

Chemical Biology I - Structure, Synthesis and Function of Biomolecules: Read More [\[+\]](#)

### 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

Chemical Biology I - Structure, Synthesis and Function of Biomolecules: Read Less [\[-\]](#)

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

Terms offered: Spring 2023, Spring 2022, Spring 2021

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.

Chemical Biology II - Enzyme Reaction Mechanisms: [Read More](#) [+]

### 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

Chemical Biology II - Enzyme Reaction Mechanisms: [Read Less](#) [-]

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

Terms offered: Spring 2023, Spring 2022, Spring 2021

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.

Chemical Biology III - Contemporary Topics in Chemical Biology: [Read More](#) [+]

### 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

Chemical Biology III - Contemporary Topics in Chemical Biology: [Read Less](#) [-]

## CHEM 274A Introduction to Programming Languages C++ and Python 3 Units

Terms offered: Fall 2022, Fall 2021

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.

Introduction to Programming Languages C++ and Python: [Read More](#) [+]

### 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.

Introduction to Programming Languages C++ and Python: [Read Less](#) [-]

## CHEM 274B Introduction to Software Engineering 3 Units

Terms offered: Fall 2022

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

Introduction to Software Engineering: Read More [+]

### 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.

Introduction to Software Engineering: Read Less [-]

## 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

Introduction to Programming Languages C++ and Python: Read More [+]

### 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.

Introduction to Programming Languages C++ and Python: Read Less [-]

## 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.

Introduction to Software Engineering Best Practices: [Read More](#) [+]

### 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.

Introduction to Software Engineering Best Practices: [Read Less](#) [-]

## CHEM 277B Machine Learning Algorithms 3 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021

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

Machine Learning Algorithms: [Read More](#) [+]

### 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.

Machine Learning Algorithms: [Read Less](#) [-]

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

Terms offered: Fall 2022, Spring 2022, Spring 2021

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.

Ethical Topics for Professional Software Engineering: [Read More \[+\]](#)

### 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.

Ethical Topics for Professional Software Engineering: [Read Less \[-\]](#)

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

Terms offered: Fall 2022, Fall 2021

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..

Numerical Algorithms applied to Computational Quantum Chemistry: [Read More \[+\]](#)

### 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.

Numerical Algorithms applied to Computational Quantum Chemistry: [Read Less \[-\]](#)

## CHEM 280 Foundations of Programming and Software Engineering 2 Units

Terms offered: Fall 2022, Fall 2021, Fall 2020

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 (MoSSI). 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.

Foundations of Programming and Software Engineering: Read More [+]

### 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.

Foundations of Programming and Software Engineering: Read Less [-]

## CHEM 281 Software Engineering for Scientific Computing 3 Units

Terms offered: Fall 2022

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.

Software Engineering for Scientific Computing: Read More [+]

### 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.

Software Engineering for Scientific Computing: Read Less [-]

## CHEM 282 MSSE Leadership Bootcamp 2 Units

Terms offered: 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.

MSSE Leadership Bootcamp: [Read More](#) [+]

### 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.

MSSE Leadership Bootcamp: [Read Less](#) [-]

## CHEM 283 MSSE Capstone Project Course 3 Units

Terms offered: Spring 2023, Spring 2022

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.

MSSE Capstone Project Course: [Read More](#) [+]

### 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.

MSSE Capstone Project Course: [Read Less](#) [-]

## CHEM 295 Special Topics 1 - 3 Units

Terms offered: Spring 2023, Fall 2022, Spring 2022

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.

Special Topics: [Read More](#) [+]

### 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.

Special Topics: [Read Less](#) [-]

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

Terms offered: Spring 2023, Fall 2022, Spring 2022

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. Seminars for Graduate Students: Read More [\[+\]](#)

### 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.

Seminars for Graduate Students: Read Less [\[-\]](#)

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

Terms offered: Spring 2023, Fall 2022, Spring 2022

The facilities of the laboratory are available at all times to graduate students pursuing original investigations toward an advanced degree at this University. Such work is ordinarily in collaboration with a member of the staff.

Research for Graduate Students: Read More [\[+\]](#)

### Rules & Requirements

**Prerequisites:** Graduate standing

**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

### Additional Details

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

**Grading:** Letter grade.

Research for Graduate Students: Read Less [\[-\]](#)

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

Terms offered: Spring 2023, Fall 2022, Spring 2022

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

Professional Preparation: Supervised Teaching of Chemistry: Read More [\[+\]](#)

### 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.

Professional Preparation: Supervised Teaching of Chemistry: Read Less [\[-\]](#)

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

Terms offered: Spring 2023, Fall 2022, Spring 2022

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.

Pre-High School Chemistry Classroom Immersion: Read More [\[+\]](#)

### 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

Pre-High School Chemistry Classroom Immersion: Read Less [\[-\]](#)

## 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.

Undergraduate Lab Instruction: [Read More](#) [+]

### 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.

Undergraduate Lab Instruction: [Read Less](#) [-]

## 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.

Undergraduate Chemistry Instruction: [Read More](#) [+]

### 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

Undergraduate Chemistry Instruction: [Read Less](#) [-]

## CHEM 301C Chemistry Teacher Scholars 2 Units

Terms offered: Spring 2020, Fall 2019, Spring 2019

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.

Chemistry Teacher Scholars: [Read More](#) [+]

### 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.

Chemistry Teacher Scholars: [Read Less](#) [-]

## 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.

Undergraduate Chemistry Course Instruction: [Read More](#) [+]

### 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.

Undergraduate Chemistry Course Instruction: [Read Less](#) [-]

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

Terms offered: Spring 2015, Spring 2014, Spring 2013

Undergraduate Preparation for Teaching or Instruction in Teaching: Read More [+]

### 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.

Undergraduate Preparation for Teaching or Instruction in Teaching: Read Less [-]

## 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.

Supervised Instruction of Chemistry Scholars: Read More [+]

### 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.

Supervised Instruction of Chemistry Scholars: Read Less [-]

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

Terms offered: Fall 2021

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

Professional Preparation: Supervised Teaching of Chemistry: Read More [+]

### 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.

Professional Preparation: Supervised Teaching of Chemistry: Read Less [-]

## 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.

Individual Study for Doctoral Students: Read More [+]

### 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.

Individual Study for Doctoral Students: Read Less [-]

## **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.

QB3 Colloquium for Graduate Students: [Read More \[+\]](#)

### **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

QB3 Colloquium for Graduate Students: [Read Less \[-\]](#)