

Chemistry

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 comes 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. *If the applicant is admitted*, then *official* transcripts of all college-level work will be required. Official transcripts must be in sealed envelopes as issued by the school(s) attended. If you have attended Berkeley, upload your unofficial transcript with your application for the departmental initial review. *If you are admitted*, an official transcript with evidence of degree conferral *will not* be required.
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, not the Graduate Division.
3. **Evidence of English language proficiency:** All applicants from countries or political entities in which the official language is not English are required to submit official evidence of English language proficiency. This applies to applicants 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.

If applicants have previously been denied admission to Berkeley on the basis of their English language proficiency, they must submit new test scores that meet the current minimum 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. Official IELTS score reports must be mailed directly to our office from the British Council. TOEFL and IELTS score reports are only valid for two years.

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 three semesters of graduate student instructor service is required, usually 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 2020, Fall 2019, Fall 2018

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 2020, Fall 2019, Fall 2018

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 2020, Spring 2019, Spring 2017

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 2020, Spring 2018, Spring 2015

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 2020, Fall 2019, Fall 2018

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 2019, Spring 2017, Spring 2016

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 2020, Fall 2019, Fall 2018

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 2020, Spring 2019, Spring 2018
 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 2020, Spring 2019, Spring 2018
 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 CO₂ 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 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 2020, Fall 2019, Fall 2018

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 2020, Fall 2019, Fall 2018

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 2020, Fall 2019, Fall 2018

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: Fall 2019, Fall 2018, Fall 2017

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: Fall 2019, Fall 2018, Fall 2017

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: Fall 2019, Fall 2018, Fall 2017

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 2020, Fall 2019, Fall 2018

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 2020, Fall 2019, Fall 2018

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 2020, Fall 2019, Fall 2018

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 2020, Spring 2019, Spring 2018

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 2020, Spring 2019, Spring 2018

This course will describe the application of modern reactions to the total synthesis of complex target molecules. Natural products, such as alkaloids, terpenes, or polypropionates, as well as theoretically interesting "non-natural" molecules will be covered.

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

Rules & Requirements

Prerequisites: 262 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.

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

CHEM 263B Synthetic Design II 1 Unit

Terms offered: Spring 2020, Spring 2019, Spring 2018

The principles of retrosynthetic analysis will be laid down and the chemistry of protecting groups will be discussed. Special attention will be given to the automated synthesis of biopolymers such as carbohydrates, peptides, and proteins, as well as nucleic acids.

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

Rules & Requirements

Prerequisites: 263A 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.

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

CHEM 265 Nuclear Magnetic Resonance Theory and Application 1 Unit

Terms offered: Fall 2020, Fall 2019, Fall 2018

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 2019, Spring 2018, Spring 2017

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 2019, Spring 2018, Spring 2016

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 2019, Spring 2018, Spring 2016

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 2020, Spring 2019, Spring 2018

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 2020, Spring 2019, Spring 2018

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 2020, Spring 2019, Spring 2018

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

Terms offered: 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 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: Not yet offered

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: 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.

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

CHEM 278 Ethical Topics for Professional Software Engineering 1 Unit

Terms offered: Not yet offered

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 295 Special Topics 1 - 3 Units

Terms offered: Fall 2020, Spring 2020, Fall 2019

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: Fall 2020, Spring 2020, Fall 2019

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: Fall 2020, Spring 2020, Fall 2019

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: Fall 2020, Spring 2020, Fall 2019

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: Fall 2020, Spring 2020, Fall 2019

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: Prior to 2007

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 2020, Spring 2019, Fall 2017

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](#) [-]