Department of Chemistry

Chair

- Viresh Rawal

Professors

- Paul Alivisatos
- Aaron Dinner
- Guangbin Dong
- Gregory Engel
- Laura Gagliardi
- Giulia Galli, Molecular Engineering - Associate Appointment
- Philippe M. Guyot Sionnest
- Chuan He
- Michael D. Hopkins
- Yamuna Krishnan
- Ka Yee Christina Lee
- Wenbin Lin
- David Mazziotti
- Jiwoong Park
- Joseph Piccirilli, Biochemistry & Molecular Biology
- Viresh Rawal
- Benoit Roux, Biochemistry & Molecular Biology
- Stuart Rowan, Molecular Engineering - Associate Appointment
- Norbert F. Scherer
- Elena Shevchenko, Professor Part-Time
- Steven J. Sibener
- Scott Snyder
- Jack Szostak, as of 9/1/2022
- Dmitri Talapin
- Bozhi Tian
- Andrei Tokmakoff
- Gregory Voth
- Luping Yu

Associate Professors

- John Anderson
- Bryan Dickinson
- Raymond Moellering
- Surinarayanan Vaikuntanathan

Assistant Professors

- Sarah King
- Mark Levin
- Weixin Tang
- Anna Wuttig

Senior Instructional Professors

- Vera Dragisich
- Valerie Keller
- Britni Ratliff
- Meishan Zhao

Assistant Instructional Professor

- Shaunna McLeod
- Hannah Lant

Emeritus Faculty

- Laurie Jeanne Butler
- Philip E. Eaton
- Karl Freed
- Robert Haselkorn, MGCB
- Richard F. Jordan
- Stephen Kent, Biochemistry & Molecular Biology
- Donald H. Levy
- James R. Norris, Jr.
- Takeshi Oka
- Stuart A. Rice
- James Skinner, Molecular Engineering - Associate Appointment
- Hisashi Yamamoto

The Ph.D. program in the Department of Chemistry offers wide opportunity and unusual flexibility for advanced study and research, and is designed to encourage individuality, independence, and excellence in students. Most students select their research advisor by winter quarter of their first year and are engaged in research by the spring quarter. The department has neither a system of cumulative examinations nor a written major examination. There are relatively few course requirements and great flexibility as to which courses may be taken.

In the Division of the Physical Sciences barriers between departments are low. Students in the Department of Chemistry often take courses in other departments and can even earn the degree in chemistry for research that has been done under the supervision of a member of another department. Students are encouraged to fashion special programs of study under the guidance of the faculty.

Application

A completed application will include undergraduate transcripts, three letters of recommendation, and the results of the GRE examination (the advanced test in chemistry is recommended). Foreign applicants must also submit the results of the TOEFL or IELTS.

Students are normally admitted beginning with the autumn quarter of each year. The sequential nature of some of our courses makes this the best time to begin graduate studies. Although applications may be considered at any time at the discretion of the admissions committee, students are strongly encouraged to complete their applications by December 1st. The department has no admissions quota and in recent years the entering class has numbered between 38 and 55.

A well defined Master of Science (S.M.) program of appropriate rigor is maintained, but the Department of Chemistry does not offer financial support to students whose degree goal is the master's degree. This degree is neither a prerequisite for, nor a forerunner of, the Ph.D. degree, although it may be acquired along the way if a student so desires.

The Department of Chemistry participates actively in the Medical Scientist Training Program (MSTP) administered by the Pritzker School of Medicine at the University of Chicago. MSTP is a structured six year program leading to both the M.D. degree and the Ph.D. in chemistry. Full tuition and a stipend are awarded for the six year period. MSTP is funded by the National Institute of General Medical Sciences and is open only to U.S. citizens.

Financial Support

All students admitted to the Ph.D. program are offered financial support. Generally this takes the form of a first year teaching assistantship which provides a complete merit tuition scholarship and pays a competitive monthly stipend. Teaching assistants are usually assigned to one of the undergraduate laboratory courses. Duties involve supervising one class section (13-18 students) for one afternoon per week, holding a discussion session and office hours, and assisting with grading. The total time required is about fifteen hours per week.

By the end of the third quarter students have usually selected their research supervisor. An appointment as a research assistant (stipend plus tuition) normally continues throughout the period of research.

There are several special supplemental fellowships and scholarships offered by the department and the University. All students seeking admission are automatically considered in the competition for these awards. No separate application is required. Students are urged to compete for the many national and other external fellowships available.

Advanced Degrees

The department administers basic examinations in the fields of inorganic, organic, and physical chemistry in the autumn, winter, and spring quarters. Graduate students are expected to take these examinations upon entering the department. Deficiencies evidenced by these examinations must be remedied and the examinations passed prior to the end of the third quarter of residence (not counting summer quarter).

In the first year, students must satisfactorily complete nine courses. At least six of these must be 30000 level courses from the offerings of the Department of Chemistry or of related departments in the Divisions of the Physical and the Biological Sciences, and the Pritzker School of Molecular Engineering. Grades of C or better are expected. The remaining three courses will consist of the Advanced Training for Teachers and Researchers in Chemistry, CHEM 5000x series. Other courses may include Chemistry 35000 and/or 40000 level chemistry research courses; however, one may not register for these courses during the autumn quarter. An advisor assists students in formulating programs of study that will best satisfy personal needs and departmental requirements. Courses taken outside the department to satisfy the first year requirements must be approved by the advisor.

Students who have completed all courses with grades of C or better (P in research courses) may be recommended for the S.M. degree; these students may, at the discretion of a faculty member, be required to submit a paper on their work in CHEM 35000 or a 40000 level research course.

At the end of the spring quarter in the first year, the faculty review the student's overall record. Course performance is a major part of this review; a B average or better in all 30000 level courses (excluding CHEM 35000) is expected. At this time the department will advise students whether they are qualified to continue studies and to prepare for the Ph.D. candidacy examination described below. A student seeking admission to Ph.D. candidacy must take the candidacy examination before the end of his or her fifth quarter in residence (normally October; for this purpose summer quarter is counted as a quarter in residence). This examination is based on the student's written research prospectus. The student presents the research prospectus to the committee, and must be prepared to discuss the relevant chemical literature, progress to date, plans for future work, and the relationship of the research to other chemical problems.

The faculty review the recommendations of the candidacy examining committee and, after consideration of the student's academic record, vote on whether or not to recommend that the student be admitted to candidacy. All candidates for the Ph.D. degree are required to participate in some form of teaching. Normally this involves serving as a teaching assistant for three quarters in the first year.

The Ph.D. degree is granted upon satisfactory completion of scholarly research work, presented in a written thesis, discussed in a public seminar, and defended orally before a faculty committee.

Students should especially note the following:

- It is the responsibility of the individual research sponsor to monitor the progress of a student's research. Unsatisfactory progress may result in termination of financial support and/or dismissal from the Ph.D. program.
- The department will recommend formal admission to candidacy as soon as the student has:
  - Satisfied the basic examination requirement
  - Satisfied the course requirements
  - Demonstrated satisfactory progress in research and teaching
  - Passed the candidacy examination
- Students should consider satisfying any or all course requirements by taking proficiency examinations. Application to take a proficiency examination should be made directly to the person who will be teaching the particular course. The examinations will be administered during the first week of the quarter in which the course is offered. No stigma is attached to failing a proficiency examination.

Chemistry Courses

CHEM 30100. Advanced Inorganic Chemistry. 100 Units.
Group theory and its applications in inorganic chemistry are developed. These concepts are used in surveying the chemistry of inorganic compounds from the standpoint of quantum chemistry, chemical bonding principles, and the relationship between structure and reactivity.
Instructor(s): W. Lin Terms Offered: Autumn
Prerequisite(s): CHEM 20100 and CHEM 26100

CHEM 30200. Synthesis and Physical Methods in Inorganic Chemistry. 100 Units.
This course covers theoretical and practical aspects of important physical methods for the characterization of inorganic molecules. Topics may include NMR, IR, RAMAN, EPR, and electronic and photoelectron spectroscopy; electrochemical methods; and single-crystal X-ray diffraction.
Instructor(s): W. Lin Terms Offered: Winter
Prerequisite(s): CHEM 30100

CHEM 30400. Organometallic Chemistry. 100 Units.
This course covers preparation and properties of organometallic compounds (notably those of the transition elements, their reactions, and the concepts of homogeneous catalysis).
Instructor(s): G. Dong Terms Offered: Spring
Prerequisite(s): CHEM 20100 and CHEM 26100
Equivalent Course(s): CHEM 20200

CHEM 30600. Chemistry Of The Elements and Materials. 100 Units.
This course surveys the descriptive chemistries of the main-group elements and the transition metals from a synthetic perspective, and reaction chemistry of inorganic molecules is systematically developed.
Instructor(s): J. Anderson Terms Offered: Winter
Prerequisite(s): CHEM 20100

CHEM 30900. Bioinorganic Chemistry. 100 Units.
This course covers various roles of metals in biology. Topics include coordination chemistry of bioinorganic units, substrate binding and activation, electron-transfer proteins, atom and group transfer chemistry, metal homeostasis, ion channels, metals in medicine, and model systems.
Instructor(s): C. He Terms Offered: Spring
Prerequisite(s): CHEM 20200 and 22200/23200

CHEM 31358. Simulation, Modeling, and Computation in Biophysics. 100 Units.
This course develops skills for modeling biomolecular systems. Fundamental knowledge covers basic statistical mechanics, free energy, and kinetic concepts. Tools include molecular dynamics and Monte Carlo simulations, random walk and diffusion equations, and methods to generate random Gaussian and Poisson distributors. A term project involves writing a small program that simulates a process. Familiarity with a programming language or Mathlab would be valuable.
Instructor(s): B. Roux Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, BIOS 20200 and BIOS 26210-26211, or consent from instructor
Note(s): CB
Equivalent Course(s): BCMB 31358, BIOS 21358, CPNS 31358

CHEM 32100. Physical Organic Chemistry I. 100 Units.
This course focuses on the quantitative aspects of structure and reactivity, molecular orbital theory, and the insight it provides into structures and properties of molecules, stereochemistry, thermochemistry, kinetics, substituent and isotope effects, and pericyclic reactions.
Instructor(s): M. Levin Terms Offered: Autumn
Prerequisite(s): CHEM 22200/23200 and 26200, or consent of instructor

CHEM 32200. Organic Synthesis and Structure. 100 Units.
This course considers the mechanisms, applicability, and limitations of the major reactions in organic chemistry, as well as of stereochemical control in synthesis.
Instructor(s): V. Rawal Terms Offered: Autumn
Prerequisite(s): CHEM 22200/23200 or consent of instructor

CHEM 32300. Strategies and Tactics of Organic Synthesis. 100 Units.
This course discusses the important classes for organic transformation. Topics include carbon-carbon bond formation; oxidation; and reduction using a metal, non-metal, or acid-base catalyst. We also cover design of the reagents and the scope and limitation of the processes.
Instructor(s): S. Snyder Terms Offered: Winter
Prerequisite(s): CHEM 22200/23200 or consent of instructor

CHEM 33200-33300. Chemical Biology I-II.
This course emphasizes the concepts of physical organic chemistry (e.g., mechanism, molecular orbital theory, thermodynamics, kinetics) in a survey of modern research topics in chemical biology. Topics, which are taken from recent literature, include the roles of proteins in signal transduction pathways, the biosynthesis of natural products, strategies to engineer cells with novel functions, the role of spatial and temporal inhomogeneities in cell function, and organic synthesis and protein engineering for the development of molecular tools to characterize cellular activities.

CHEM 33200. Introduction to Chemical Biology. 100 Units.
This course will introduce biomolecules, chemical biology approaches and genomics from chemistry perspectives. The course will be an introduction to genomics and genomics tools in research and medicine, and will provide a well-rounded view of cell structure and function, the main signaling pathways in cells, and modern methods to chemically probe, program and reprogram cells.
Instructor(s): Y. Krishnan. Terms Offered: Autumn
Prerequisite(s): A grade of C or higher in CHEM 22200 or 23200, or consent of instructor
Equivalent Course(s): CHEM 23300

CHEM 33300. Chemical Biology II. 100 Units.
This course will further explore the principles of biochemistry and cell biology from a chemical perspective. Molecular structure, reactivity and functional organization in biological systems - ranging from single molecules to whole organisms will be examined. Chemical concepts and tools will be applied to solve problems at the interface of chemistry, biology, and medicine. This course aims to develop and refine skills on experimental design, data analysis, interpretation and presentation while promoting the critical analysis of recent research in chemical biology. The focus of this course will be on the design, synthesis, validation and application of chemical probes, broadly defined, in modern biological research.
Instructor(s): W. Tang. Y. Krishnan Terms Offered: Winter
Prerequisite(s): CHEM 33200, or consent of instructor

CHEM 33800. Current Topics and Methods in Chemical Biology. 100 Units.
The aim of this course is to teach modern chemical biology methods, technologies, and applications as applied to problems and challenges in human health and biotechnology. Both classics in translational chemical biology and emerging technologies will be used to teach general principles in the application of chemistry to therapeutic development and biotechnology. As compared to the Chemical Biology course track (Chem332/Chem333), this course is geared more toward non-experts in chemical biology or those with a less extensive chemistry background.
Instructor(s): B. Dickinson. R. Moellering Terms Offered: Winter
Prerequisite(s): CHEM 22200/23200

CHEM 33900. Discovery and Translation of Molecular Therapeutics. 100 Units.
The aim of this course is to broadly expose students to emerging classes of molecular therapeutics and diagnostics with a focus on the chemistry and molecular engineering underlying their discovery, development and translation into use by society. This material will be presented through the lens of academic, industrial and clinical experts, which will collectively expose students to the diverse disciplines that come together in the creation of new medicines and diagnostics.
Instructor(s): R. Moellering. Terms Offered: Spring
Prerequisite(s): CHEM 33200 or CHEM 33800

CHEM 35000. Intro To Research: Chemistry. 300.00 Units.
For course description contact Chemistry.

CHEM 36100. Wave Mechanics and Spectroscopy. 100 Units.
This course presents the introductory concepts, general principles, and applications of wave mechanics to spectroscopy.
Instructor(s): A. Dinner Terms Offered: Autumn
Prerequisite(s): CHEM 26300

CHEM 36200. Quantum Mechanics. 100 Units.
This course builds upon the concepts introduced in CHEM 36100 with greater detail provided for the role of quantum mechanics in chemical physics.
Instructor(s): D. Mazziotti Terms Offered: Winter
Prerequisite(s): CHEM 36100

CHEM 36300. Statistical Thermodynamics. 100 Units.
This course covers the thermodynamics and introductory statistical mechanics of systems at equilibrium.
Instructor(s): S. Vaikuntanathan Terms Offered: Autumn
Prerequisite(s): CHEM 26100-26200

CHEM 36400. Advanced Statistical Mechanics. 100 Units.
Topics covered in this course may include statistics of quantum mechanical systems, weakly and strongly interacting classical systems, phase transitions and critical phenomena, systems out of equilibrium, and polymers.
Instructor(s): V. Goth Terms Offered: Winter
Prerequisite(s): CHEM 36300 or equivalent

CHEM 36500. Chemical Dynamics. 100 Units.
This course develops a molecular-level description of chemical kinetics, reaction dynamics, and energy transfer in both gases and liquids. Topics include potential energy surfaces, collision dynamics and scattering theory, reaction rate theory, collisional and radiationless energy transfer, molecule-surface interactions, Brownian motion, time correlation functions, and computer simulations.
Instructor(s): G. Voth Terms Offered: Spring
Prerequisite(s): CHEM 36100 required; 36300 recommended

CHEM 36800. Quantum Molecular and Materials Modeling. 100 Units.
Quantum mechanical methods, including quantum chemistry, density functional theory (DFT), and many body perturbation theory, for simulating the properties of molecules and materials will be explored in this course. Numerical algorithms and techniques will be introduced that allow for solution of approximate forms of the Schroedinger and Boltzmann Equations that model structural and transport properties of molecules and materials. The coupling of DFT with molecular dynamics will be detailed for determining finite temperature

properties. Coupling of DFT with spin Hamiltonians to study dynamical spin correlations in materials will also be described. Examples of the application of quantum mechanical methods to materials for energy conversion and quantum information technologies will be provided.
Instructor(s): Laura Gagliardi,Giulia Galli Terms Offered: Spring
Prerequisite(s): MENG 21300 or CHEM 26100 or PHYS 23400 or instructor consent
Equivalent Course(s): CHEM 26800, MENG 25510, MENG 35510

CHEM 37000. Introduction to Laboratory Research. 100 Units.
TBD
Instructor(s): Moellering, R. Terms Offered: Autumn

CHEM 38700. Biophysical Chemistry. 100 Units.
This course develops a physicochemical description of biological systems. Topics include macromolecules, fluid-phase lipid-bilayer structures in aqueous solution, biomembrane mechanics, control of biomolecular assembly, and computer simulations of biomolecular systems.
Instructor(s): R. Benoit Terms Offered: Spring
Prerequisite(s): ONE of the following: CHEM 31358 Simulation, Modeling, and Computation in Biophysics; CHEM 36300 Statistical Thermodynamics; CHEM 36400 Advanced Statistical Mechanics. Knowledge of basic calculus, matrix algebra, statistical mechanics, and kinetics are recommended.

CHEM 39000. Solids, Materials, Surfaces. 100 Units.
This course is an introduction to modern materials chemistry. It covers basic chemistry and physics of condensed systems, such as solids, polymers, and nanomaterials. The electronic structure of metals, semiconductors and magnetically ordered phases will be discussed. We will review optical and electronic properties of different classes of materials using examples of hard and soft condensed matter systems and drawing structure-property relationships for conventional solids, polymers, and nanomaterials. Finally, the course will cover the fundamentals of surface science and material synthesis, applying modern understanding of nucleation and growth phenomena.
Instructor(s): D. Talapin Terms Offered: Autumn
Prerequisite(s): CHEM 26100, CHEM 26200, and CHEM 26300, or equivalent
Equivalent Course(s): MENG 35200

CHEM 39100. Polymer Synthesis. 100 Units.
This course introduces the most important polymerization reactions, focusing on their reaction mechanisms and kinetic aspects. Topics include free radical and ionic chain polymerization, step-growth polymerization, ring-opening, insertion, controlled living polymerization, crosslinking, copolymerization, and chemical modification of preformed polymers.
Instructor(s): Stuart Rowan Terms Offered: Winter
Prerequisite(s): CHEM 22000 and CHEM 22100
Equivalent Course(s): MENG 25110, MENG 35110

CHEM 39200. Polymers. 100 Units.
The course covers the following advanced topics in polymer science, by a combination of lectures and student presentations: 1) Electrical-conductivity, mobility, applications in various fields 2) Biological polymers-biocompatibility, degradable drug delivery, (Protein, DNA and RNA delivery), tissue engineering 3) Liquid crystal polymers 4) Polymers for catalytic function 5) Ferroelectric/ferromagnetic polymers 6) Optical polymers (linear, nonlinear optical polymers) 7) Block copolymers for nanostructures 8) Supramolecular polymers-polymers with self-healing properties.
Instructor(s): Luping Yu Terms Offered: Winter
Prerequisite(s): CHEM 22000-22100-22200 and CHEM 26100

CHEM 39300. Electronic and Quantum Materials for Technology. 100 Units.
This is a one-quarter introductory course on the science and engineering of electronic and quantum materials. The intended audience is upper-level undergraduate students and first-year graduate students in Molecular Engineering and other related fields, including Chemistry and Physics. We will learn the basics of electrical and optical properties of electronic materials, including semiconductors, metals, and insulators starting from a simple band picture, and will discuss how these materials enable modern electronic and optoelectronic devices and circuitry. We will also explore the modern synthesis techniques for these materials and the effects of reduced dimensions and emergent quantum properties. No comprehensive exposure to quantum mechanics, thermodynamics, or advanced mathematical skills will be assumed, even though working knowledge of these topics will be helpful.
Instructor(s): Jiwoong Park Terms Offered: Spring
Prerequisite(s): CHEM 26200 or PHYS 23500 or instructor consent
Equivalent Course(s): MENG 26600, MENG 36600

CHEM 40000. Rsch: Related Depts/Institutes. 300.00 Units.
Doctoral research on an original project in Related Depts/Institutes under the supervision of the professor.

CHEM 40100. Research: Physical Chemistry. 300.00 Units.
Doctoral research on an original project in Physical Chemistry under the supervision of the professor.

CHEM 40200. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 40300. Research: Inorganic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 40400. Rsch: Org/Phys/Polymer Chem. 300.00 Units.
Doctoral research on an original project in Org/Phys/Polymer Chemistry under the supervision of the professor.

CHEM 40500. Rsch: Laser/Surface/Phys Chem. 300.00 Units.
Doctoral research on an original project in Laser/Surface/Physical Chemistry under the supervision of the professor.

CHEM 40600. Research: Bioorganic Chemistry. 300.00 Units.
Doctoral research on an original project in Bioorganic Chemistry under the supervision of the professor.

CHEM 40700. Research: Inorganic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 40800. Research: Organic Chemistry. 300.00 Units.
Doctoral research on an original project in Organic Chemistry under the supervision of the professor.

CHEM 40900. Research: Organic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 41000. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 41100. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 41200. Research: Physical Chemistry. 300.00 Units.
Doctoral research on an original project in Physical Chemistry under the supervision of the professor.

CHEM 41300. Research: Inorganic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 41400. Research: Org/Biological Chem. 300.00 Units.
Readings and Research for working on their PhD

CHEM 41500. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 41600. Research: Biophysical Chem. 300.00 Units.
Doctoral research on an original project in Biophysical Chemistry under the supervision of professor.

CHEM 41700. Research: Geochemistry. 300.00 Units.
Doctoral research on an original project in Geochemistry under the supervision of the professor.

CHEM 41800. Rsch: Org/Phys-Org Chemistry. 300.00 Units.
Doctoral research on an original project in Org/Phys-Org Chemistry under the supervision of the professor.

CHEM 41900. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 42000. Research: Physical Chemistry. 300.00 Units.
Doctoral research on an original project in Physical Chemistry under the supervision of the professor.

CHEM 42100. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 42200. Research: Inorganic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 42300. Research: Organic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 42400. Research: Org/Biological Chem. 300.00 Units.
Readings and Research for working on their PhD

CHEM 42500. Research: Organic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 42600. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 42700. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 42800. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 42900. Research: Organic Chemistry. 300.00 Units.

CHEM 43000. Research: Inorganic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 43100. Research: Inorganic Chemistry. 300.00 Units.
Doctoral research on an original project in Inorganic Chemistry under the supervision of the professor.

CHEM 43200. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 43300. Research: Organic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 43400. Research: Organic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 43500. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 43600. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 43800. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 43900. Research: Org/Biotheoretical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 44000. Research: Organic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 44100. Research: Organic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 44200. Research: Organic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 44300. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 44400. Research: Organic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 44500. Research: Inorganic Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 44600. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 44700. Research: Physical Chemistry. 300.00 Units.
Readings and Research for working on their PhD

CHEM 44800. Research: Organic Chemistry. 100-300 Units.
Readings and Research for working on their PhD

CHEM 44900. Polymer Chemistry. 300.00 Units.
Laboratory Research on an original project in Polymer Chemistry for Ph.D. dissertation.

CHEM 45000. Research: Physical Chemistry. 300.00 Units.
TBD

CHEM 45100. Research: Physical Chemistry. 300.00 Units.
Laboratory research in physical chemistry.
Instructor(s): Sarah King Terms Offered: Autumn Spring Summer Winter. Start in 2018 - 2019 and continue every year/quarter after that

CHEM 45200. Research: Organic Chemistry. 300.00 Units.
Conduct research towards a dissertation research project in Organic Chemistry.
Instructor(s): Prof. Mark Levin Terms Offered: Autumn Spring Summer Winter

CHEM 45300. Research: Organic/Biological Chemistry. 300.00 Units.
Conduct research for Ph.D. dissertation in the laboratory of a Chemistry Department faculty member.
Instructor(s): Prof. Weixing Tang Terms Offered: Autumn Spring Summer Winter. Offered every quarter

CHEM 45400. Research: Physical Chemistry. 300.00 Units.
Research in computational/theoretical/physical chemistry toward a Ph.D. dissertation project.
Instructor(s): Prof. Laura Gagliardi Terms Offered: Autumn Spring Summer Winter

CHEM 45500. Research: Inorganic Chemistry. 300.00 Units.
Ph.D. laboratory research in a faculty research laboratory.
Instructor(s): Anna Wuttig Terms Offered: Autumn Spring Summer Winter

CHEM 45600. Research: Inorganic Chemistry. 300.00 Units.
Laboratory research on a Ph.D. dissertation project in Inorganic Chemistry.
Instructor(s): Paul Alivatsos Terms Offered: Autumn Spring Summer Winter

CHEM 45700. RESEARCH: ORGANIC/BIOLOGICAL CHEMISTRY. 300.00 Units.
Conduct Ph.D.dissertation research in the laboratory of a faculty member in Chemistry.
Instructor(s): Prof. Jack Szostak Terms Offered: Autumn Spring Summer Winter

CHEM 49000. Chemistry External Research/ Professional Development. 300.00 Units.
Off site research internship.
Instructor(s): Dr. Vera Dragisich Terms Offered: Autumn Spring Summer Winter
Prerequisite(s): Approval of dissertation advisor

CHEM 50000-50001-50002. Advanced Training for Teachers and Researchers in Chemistry I-II-III.
This sequence will extend the traditional two-week departmental TA training into a full year, covering both the materials that are critical to becoming an excellent TA and the skills to produce well-rounded PhD candidates. At the end of this sequence, students are expected to develop an enhanced understanding and talent of critical thinking, an enriched knowledge base that is critical in solving real-world problems, an improved ability in the consideration and use of innovative pedagogical tools, the ability to transition into independent research, and effective skills in preparing high-quality written reports and oral presentations, as well as to begin thinking about career development skills.

CHEM 50000. Advanced Training for Teachers and Researchers in Chemistry I. 100 Units.
All organic chemistry TAs should enroll in discussion section 1D01; all general chemistry TAs should enroll in discussion section 1D02.
Instructor(s): Dr. Vera Dragisich Terms Offered: Autumn
Note(s): All organic chemistry TAs should enroll in discussion section 1D01; all general chemistry TAs should enroll in discussion section 1D02.

CHEM 50001. Advanced Training for Teachers and Researchers in Chemistry II. 100 Units.
See above.
Instructor(s): Dr. Vera Dragisich Terms Offered: Winter

CHEM 50002. Advanced Training for Teachers and Researchers in Chemistry III. 100 Units.
See above.
Instructor(s): Dr. Vera Dragisich Terms Offered: Spring

CHEM 70000. Advanced Study: Chemistry. 300.00 Units.
Advanced Study: Chemistry