CHE

Chemistry

CHE 501: Instrumental Methods in Chemistry
Practical and theoretical aspects of instrumentation in chemistry. The primary emphasis is on contemporary methods of molecular structure determination such as X-ray crystallography, NMR, IR, and MS. Other topics may also be presented.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

CHE 502: Mechanisms and Strategies in Organic Synthesis
This course will focus on (1) the meaning and practice of writing organic reaction mechanisms and (2) standard synthetic reactions, their mechanisms, and modern refinements. Examples and applications will be presented. The course will also discuss biomimetic syntheses and the use of mechanism in designing total syntheses.
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

CHE 503: Synthetic Organic Chemistry
A survey of the most important organic reactions from the viewpoint of synthetic utility, including many recent innovations in this field. Throughout the discussion of these methods, emphasis is placed upon their use in the synthesis of complex organic structures.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

CHE 504: Structure and Reactivity in Organic Chemistry
Electronic and stereochemical theories relating to organic structure and reactions. Topics such as bonding, strain, aromaticity, MO theory, molecular rearrangements, pericyclic reactions, and photochemistry are covered. This course is intended to provide a foundation of knowledge at the beginning graduate level as preparation for advanced subjects in CHE 502 and CHE 503, and is complementary to CHE 501.
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

CHE 511: Structural Inorganic Chemistry
Properties and reactions of inorganic compounds are considered from the viewpoint of molecular and electronic structure. The modern bonding theories used in inorganic chemistry including molecular orbital, valence bond, and ligand field theories are developed using symmetry and group theory. Selected main group, transition metal, and organometallic compounds are discussed. An introduction to crystallography and solid-state structure is included.
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

CHE 514: Transition Metal Chemistry
A survey course with an emphasis on the transition metals. Reaction mechanisms, synthesis, and structure are covered. Specific areas of concern include coordination chemistry, organometallic chemistry, bioinorganic chemistry, and selected topics from solid-state and non-transition metal chemistry.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

CHE 515: Advanced Inorganic Chemistry
A topical course with an emphasis on the current literature. Subject matter varies and is announced in advance. Possible subjects include reaction mechanisms, organometallic chemistry, bioinorganic chemistry, and physical inorganic chemistry. May be repeated as the subject matter varies.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

CHE 516: Solid-State Chemistry
This course will provide an introduction to structure and bonding in solid materials. This class will survey the important structural classes of periodic solids and will discuss space groups and the crystallographic symmetry elements important to these materials. Topics that will be covered may include, but are not limited to: (i) The mechanisms by which crystals grow and common types of defects. (ii) An introduction to the basics of band theory. (iii) An overview of the important synthetic methods for preparing solid state materials in nanocrystalline, powder, thin film, and single crystal form. (iv) A survey of the important techniques for assessing the composition, homogeneity, and crystallinity of materials (such as SEM, TEM, AFM, STM), with an emphasis on powder x-ray diffraction.
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

CHE 517: Structural Chemistry
Much of chemistry is concerned with the properties of atoms and molecules that are too small to see directly. This course will cover a variety of advanced techniques for elucidating the atomic-scale structure of molecules and periodic solids. A central technique is diffraction, which probes periodic arrays. The mathematical basis for diffraction will be presented, followed by practical examples of obtaining atomic coordinates from diffraction data (powder and/or single crystal). Other techniques that may be covered include the analysis of local structure in partially ordered or disordered solids (via techniques such as PDF, EXAFS, small angle scattering, or solid state NMR), and the basis of more complex diffraction experiments (neutron/electron diffraction, energy-dispersive/Laue diffraction, and diffraction under extreme pressure/temperature conditions).
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

CHE 518: Materials Chemistry
Our high technology world is driven forward by advances in materials chemistry. This class will discuss the origin of this technology, covering the synthesis, structures, and properties of advanced materials. These materials will be studied from a multidisciplinary perspective, since the knowledge required for their development spans more than one traditional academic discipline. This class will focus on broad topics with great current societal importance (energy, computing, nanoscience, etc.), and will discuss the materials at the heart of our present technology as well as novel classes of materials being developed for future technology applications. Specific topics may include batteries, fuel cells, catalysts, metallic conductors, semiconductors, superconductors, permanent magnets, magnetic films.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

CHE 519: Electrochemistry and Electrochemical Materials Science
This course will survey electrochemistry and electrochemical materials science. Topics will include fundamental measurements in electrochemistry, galvanostatic and potentiostatic methods, the electrochemical double layer, corrosion and passivation. Relevant applications such as fuel cells, batteries, and supercapacitors will be discussed.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

CHE 521: Quantum Chemistry I
Quantum theoretical concepts are discussed. Schroedinger wave mechanics and related mathematical techniques are illustrated by treatment of systems of chemical interest. Designed to form the theoretical basis for the study of chemical bonding, molecular structure, spectroscopy, and molecular collision phenomena.
**CHE 522: Molecular Spectroscopy**  
A detailed description of the theory and practice of molecular spectroscopy. Topics include the interaction of molecules with electromagnetic radiation and the time evolution of molecular energy states.  
*Prerequisite:* CHE 521  
*Spring, 3 credits, Letter graded (A, A-, B+, etc.)*

**CHE 523: Chemical Thermodynamics**  
A rigorous development of the fundamentals of thermodynamics and its application to a number of systems of interest to chemists, such as electrochemical cells, gases, and homogeneous and heterogeneous equilibrium. An introduction to statistical mechanics will also be included.  
*Fall, 1-3 credits, Letter graded (A, A-, B+, etc.)*

**CHE 524: Magnetic Resonance**  
This course provides an introduction to the fundamental quantum mechanics of the magnetism of spin-1/2 (and higher) particles. It includes a study of the Bloch equations (the responses of the magnetism to continuous-wave and pulsed irradiation) and a discussion of the experimental hardware and techniques commonly employed. Topics covered include the basics of the spin Hamiltonian (chemical shifts, J, dipolar, and quadrupolar couplings), dynamics and relaxation 1-D spectroscopy (spin and chemical exchange, lineshapes, spin echoes, etc.), 2-D spectroscopy (homonuclear and heteronuclear correlation), techniques for studies of solids and liquid crystals (magic angle spinning, cross polarization, quadrupolar echo), and the principles of magnetic resonance imaging. Applications to the biological and material sciences, as well as chemical problems, will be discussed.  
*Spring, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)*

**CHE 525: Theoretical Chemistry**  
This course stresses the physical theory underlying chemical phenomena. Special emphasis is given to advanced topics in electronic structure theory, molecular dynamics, condensed matter and surfaces, many-body and quantum ensemble theory, and the interaction of light and molecules.  
*3 credits, Letter graded (A, A-, B+, etc.)*

**CHE 528: Statistical Mechanics**  
Statistical theory of equilibrium systems and rate processes. Ensemble theory, spatial and time correlation functions. Model systems and methods of estimating their properties. Designed to enable the student to use the current literature dealing with application of statistical mechanics to problems in chemistry.  
*Spring, 3 credits, Letter graded (A, A-, B+, etc.)*

**CHE 530: Physical Chemistry of Macromolecules**  
An investigation of the gross and fine structures of macromolecules and molecular aggregates in solution as revealed by hydrodynamic behavior (e.g., ultracentrifugation, viscosity), light scattering, spectroscopic properties (e.g., ultraviolet hypochromism, circular dichromism, Raman, fluorescence, magnetic resonance spectra), and the thermodynamics and kinetics of interaction with small molecules and ions. Theory of conformation changes and phase transitions.  
*3 credits, Letter graded (A, A-, B+, etc.)*

**CHE 534: Computing in Chemistry**  
The basic elements of scripting, design of computer programs, and numerical analysis are discussed within the framework of solving a variety of exciting problems chosen from all areas of chemistry. Topics include automation of repetitive tasks, fitting of data, numerical integration of rate equations, signal and image analysis, and quantum chemistry. No previous knowledge of computer programming is assumed.  
*Fall, 3 credits, Letter graded (A, A-, B+, etc.)*

**CHE 535: Introduction to Computational Structural Biology and Drug Design**  
This course will provide an introduction to Computational Structural Biology with application to Drug Design. Methods and applications that use computation to model biological systems involved in human disease will be emphasized. The course aims to foster collaborative learning and will consist of presentations by the instructor, guest lecturers, and by course participants with the goal of summarizing key methods, topics, and papers relevant to Computational Structural Biology.  
*Fall, 0-3 credits, Letter graded (A, A-, B+, etc.)*

**CHE 536: Molecular Modeling of Biological Molecules**  
This course is designed for students who wish to gain hands-on experience modeling biological molecules at the atomic level. In conjunction with the individual interests, Molecular Mechanics, Molecular Dynamics, Monte Carlo, Docking (virtual screening), or Quantum Mechanics software packages can be used to study relevant biological system(s). Projects will include setup, execution, and analysis. Course participants will give literature presentations relevant to the simulations being performed and a final project report will be required. Familiarity with UNIX (Linux) is desirable.  
*Prerequisite: CHE 535 or permission of instructor*  
*Spring, 0-3 credits, Letter graded (A, A-, B+, etc.)*

**CHE 541: Biomolecular Structure and Analysis**  
The structures of biological macromolecules and the relationship of their structure to biological function are described. Methodology employed to study macromolecules is also discussed. Topics include chemical and physical properties of cell and tissue constituents, including carbohydrates, lipids, nucleic acids, proteins and peptides. Prerequisite: Strong foundation in physical and organic chemistry.  
*Fall, 3 credits, Letter graded (A, A-, B+, etc.)*

**CHE 542: Chemical Biology**  
The reactivity and physiological function of biological macromolecules and their cofactors are described at the chemical biochemical level. The emphasis of this course reflects recent advances in chemical biology. Possible topics include catalysts, reaction mechanisms, correlation between three-dimensional structure and reactivity, receptor-ligand interactions in extracellular and intracellular signaling, protein folding in vitro and in vivo.  
*Spring, 3 credits, Letter graded (A, A-, B+, etc.)*

**CHE 543: Chemical Approaches to Biology**  
The use of molecular concepts and methodology to solve problems in biology and medicine. The course covers methods to elucidate and control biological systems. Possible topics include chemical genomics, metabolomics, and chemotherapeutics.  
*Prerequisite CHE 542*  
*Fall, 3 credits, Letter graded (A, A-, B+, etc.)*

**CHE 558: Physical Biology**  
This is a course on the principles of physical chemistry. We describe the nature of the forces and energies and entropies that drive molecular systems toward their states of equilibrium. We consider a broad range of applications throughout chemistry, biology, materials engineering and nanoscience. This course aims to give students an understanding of how the actions and behaviors of materials arise from...
their atomic and molecular structures. Co-listed with PHY 558

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

CHE 559: Biological Dynamics and Networks

This course will provide a solid foundation in key theoretical concepts for the study of dynamics in biological systems and networks at different scales ranging from the molecular level to metabolic and gene regulatory networks. Topics of this course include but are not limited to: Physical kinetics; Diffusion/Smoluchowskii; Random flights; Waiting times; Poisson; Brownian ratchets; Chemical kinetics; Transition states; Stability, bifurcations, pattern development; Noise in cells: intrinsic and Extrinsic; Feedback; Biological Oscillators; Recurrence, period doubling, chaos; Networks; Topologies; Degree distribution, betweenness; Models of nets: Erdos-Renyi, scale-free, social, Watts-Strogatz, agents; Robustness, highly-optimized tolerance, bowties, epidemics; Biological networks: Protein-protein nets, regulatory and metabolic nets; Known biological circuits and their behaviors; How networks evolve: Preferential attachment, rewiring; Power laws; Fluxed through networks; Information and communication, entropy; Metabolic flux analysis; Artificial and Natural selection for traits; Darwinian evolution; Population dynamics.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

CHE 581: Departmental Research Seminar

Meetings in which first-year graduate students learn about the research activities of the departmental faculty.

Fall, S/U grading

CHE 582: Literature Seminar

Students select and discuss topics from the current literature.

Spring, Letter graded (A, A-, B+, etc.)

CHE 586: Professional Skills for Scientists

Development and refinement of the professional skills used by scientists: An exploration of more sophisticated presentation skills used in oral and poster presentations; incorporation of collaborative problem solving that mimics real world situations, including simple proposal writing; exposure to professional societies and meetings; an exploration of career options and employment resources; tips for resume preparation and interviews. Recommended for upper division undergraduates and masters students. Winter, 2 credits, ABCF Grading

2 credits, Letter graded (A, A-, B+, etc.)

CHE 588: Graduate Workshop

Additional problem solving and team learning on topics from a concurrent formal graduate course. Topics vary.

Fall and Spring, 0-1 credits, S/U grading May be repeated for credit.

CHE 589: Directed Study

Subject matter varies according to needs of student.

Fall and Spring, 0-12 credits, Letter graded (A, A-, B+, etc.) May be repeated for credit.

CHE 590: M.S. Term Paper

Seminar leading to a term paper on a selected topic in chemistry, chemical applications, or chemical pedagogy.

Fall, Spring, 3 credits, Letter graded (A, A-, B+, etc.)

May be repeated for credit.

CHE 591: Chemistry of the Environment

This course provides an overview of the chemistry of environmental processes, environmental degradation, remediation and abatement processes, and energy production. Past actions and current efforts of the chemical enterprise in both exacerbating and addressing anthropogenic environmental degradation are discussed.

3 credits, Letter graded (A, A-, B+, etc.)

CHE 593: Chemical Demonstrations

The design and implementation of demonstrations to illustrate modern concepts of chemistry.

3 credits, Letter graded (A, A-, B+, etc.)

CHE 596: Teaching and Learning Chemistry

The objective of CHE 596 is to better prepare students for the kinds of interactions they are likely to have in their careers when communicating their chemistry. Specifically, this course will help students to: (i) develop competency with research-based approaches to facilitating discourse that is generative for improving scientific understandings of chemistry phenomena; (ii) recognize the importance of representations in chemistry and to incorporate a more explicit modeling perspective and approach for developing scientific literacy; (iii) develop teaching strategies to effectively communicate abstract and complex chemical concepts to advise expert and non-expert audiences; (iv) develop curricular interventions aimed at improving individual and community practice of challenging conceptual ideas; (v) incorporate historical and philosophical perspectives on the development of fundamental chemical principles into the teaching of those topics in diverse settings; (vi) become aware of recent developments in the learning progressions literature to inform understanding of appropriate curriculum planning and implementation; and (vii) develop an identity towards reflective practice and empowerment of fellow chemistry educators into positions of leadership.

3 credits, Letter graded (A, A-, B+, etc.)

CHE 597: M.S. Research Thesis Development

This course provides a structured environment for students to develop their research project into a written thesis. Students will receive instruction and guidance in performing literature research related to their project and in developing this background material along with their own research into a properly written document.

3 credits, S/U grading May be repeated for credit.

CHE 598: Professional Masters Internship

Participation in private corporations, public agencies, or non-profit institutions for research and other experiential training activities related to the completion of a Master term paper. Students will be required to have a faculty coordinator as well as a contact in the outside organization, to participate with them in regular consultations on the project, and to successfully complete CHE 590. Prerequisites: Permission of Master's Program Director. 0-12 credits, S/U grading May be repeated for credit Offered

Fall, Spring, and Summer, 0-12 credits, S/U grading May be repeated for credit.

CHE 599: Research

Fall, Spring, 1-12 credits, S/U grading May be repeated for credit.

CHE 602: Special Topics in Physical Organic Chemistry

The subject matter varies depending on interests of students and staff. It may cover such areas as photochemistry, theoretical organic chemistry, and the chemistry of unstable intermediates; the emphasis is on fundamental considerations and recent developments.
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<th>Course Code</th>
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<td>CHE 603</td>
<td>Special Topics in Bioorganic Chemistry</td>
<td>0-3</td>
<td>Letter</td>
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<tr>
<td>CHE 606</td>
<td>Special Topics in Synthetic Chemistry</td>
<td>1-3</td>
<td>Letter</td>
<td>May be repeated for credit.</td>
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<td>CHE 607</td>
<td>Modern Drug Design &amp; Discovery</td>
<td>1-3</td>
<td>Letter</td>
<td>May be repeated for credit.</td>
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<td>CHE 610</td>
<td>Practicum in Teaching</td>
<td>1-3</td>
<td>Letter</td>
<td>May be repeated for credit.</td>
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<tr>
<td>CHE 611</td>
<td>Practicum in Teaching</td>
<td>0-1</td>
<td>S/U</td>
<td>May be repeated 1 times FOR credit.</td>
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<td>CHE 619</td>
<td>Critical Readings of Current Topics in Chemistry</td>
<td>0-3</td>
<td>Letter</td>
<td>May be repeated for credit.</td>
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<td>CHE 625</td>
<td>Molecular Structure and Crystallography</td>
<td>3</td>
<td>Letter</td>
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<td>CHE 641</td>
<td>Organometallic Chemistry</td>
<td>3</td>
<td>Letter</td>
<td>May be repeated for credit.</td>
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<td>CHE 682</td>
<td>Special Topics in Inorganic Chemistry</td>
<td>3</td>
<td>Letter</td>
<td>May be repeated for credit.</td>
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<tr>
<td>CHE 690</td>
<td>Internship in Dissertation-Related Research</td>
<td>1-9</td>
<td>S/U</td>
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<td>CHE 693</td>
<td>Physical Chemistry Seminar</td>
<td>0-12</td>
<td>S/U</td>
<td>May be repeated for credit.</td>
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<tr>
<td>CHE 694</td>
<td>Biological Chemistry Seminar</td>
<td>0-12</td>
<td>S/U</td>
<td>May be repeated for credit.</td>
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<td>CHE 695</td>
<td>Inorganic Chemistry Seminar</td>
<td>0-12</td>
<td>S/U</td>
<td>May be repeated for credit.</td>
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<tr>
<td>CHE 696</td>
<td>Organic Chemistry Seminar</td>
<td>0-12</td>
<td>S/U</td>
<td>May be repeated for credit.</td>
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**Fall and Spring, 0-12 credits, S/U grading**

May be repeated for credit.

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**CHE 697: Seminar in Physical and Quantitative Biology**

Fall and Spring, 0-1 credits, S/U grading. May be repeated for credit.

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**CHE 698: Colloquium**

Fall and Spring, 0-12 credits, S/U grading. May be repeated for credit.

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**CHE 699: Dissertation Research on Campus**

Prerequisite: Must be advanced to candidacy. Major portion of research will take place in the United States and/or U.S. provinces. Domestic students must enroll in one of the graduate student insurance plans and should be advised by an International Advisor. Fall, Spring, and Summer, 1-9 credits, S/U grading. May be repeated for credit.

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**CHE 700: Dissertation Research off Campus - Domestic**

Prerequisite: Must be advanced to candidacy. Major portion of research will take place off-campus, but in the United States and/or U.S. provinces. Please note, Brookhaven National Labs and the Cold Spring Harbor Lab are considered on-campus. All international students must enroll in one of the graduate student insurance plans and should be advised by an International Advisor. Fall, Spring, 1-9 credits, S/U grading. May be repeated for credit.

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**CHE 701: Dissertation Research off Campus - International**

Prerequisite: Must be advanced to candidacy. Major portion of research will take place outside of the United States and/or U.S. provinces. Domestic students have the option of the health plan and may also enroll in MEDEX. International students who are in their home country are not covered by mandatory health plan and must contact the Insurance Office for the insurance charge to be removed. International students who are not in their home country are charged for the mandatory health insurance. If they are to be covered by another insurance plan they must file a waiver second week of classes. The charge will only be removed if other plan is deemed comparable. All international students must receive clearance from an International Advisor. Fall, Spring, 1-9 credits, S/U grading. May be repeated for credit.
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