CHEMISTRY

Department of Chemistry
College of Natural Science

121 Explorations in Chemistry
Fall, Spring. 3(4-0) P: MTH 103 or concurrently R: Approval of department.
Introduction to core ideas in chemistry (structure and properties of matter, energy, and electrical forces) blended with science practices (use of models, argumentation, construction of scientific explanations, mathematical thinking) to understand and explain chemical phenomena.

141 General Chemistry
Fall, Spring, Summer. 4(4-0) P: (MTH 103 or concurrently) or (MTH 110 or concurrently) or (MTH 116 or concurrently) or (MTH 124 or concurrently) or (MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 118 or concurrently) or designated score on Mathematics Placement test.
Elements and compounds; reactions; stoichiometry; thermodynamics; atomic structure; chemical bonding; states of matter; solutions; acids and bases; aqueous equilibria.

142 General and Inorganic Chemistry
Fall, Spring, Summer. 4(4-0) P: CEM 141 or CEM 151 or CEM 181H or LB 171
Kinetics; gaseous equilibria; acids and bases; pH; buffers; hydrolysis; titrations; heterogeneous equilibria; thermodynamics; redox and electrochemistry; transition metal chemistry; nuclear chemistry; main group chemistry.

143 Survey of Organic Chemistry
Fall, Spring, Summer. 3(4-3) P: CEM 141 or CEM 151 or CEM 181H or LB 171 Not open to students with credit in CEM 351.
Chemistry of carbon compounds. Chemistry of the main organic functional groups with applications to everyday life, industry, and biology.

151 General and Descriptive Chemistry
Fall. 4(4-0) P: (MTH 116 or concurrently) or (MTH 124 or concurrently) or (MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 118 or concurrently) or designated score on Mathematics Placement test.
Stoichiometry; solutions; reactions and thermochromism; quantum mechanics and atomic structure; periodic properties; chemical bonding; molecular structure; coordination chemistry; organic molecules and functional groups.

152 Principles of Chemistry
Spring. 3(4-0) P: CEM 151 or CEM 181H or LB 171 Not open to students with credit in CEM 182H or LB 172.
Gases, liquids, and solids; thermodynamics; changes of state; solutions and colligative properties; chemical equilibria; acids, bases, and aqueous equilibria; kinetics; redox reactions and electrochemistry; nuclear chemistry.

161 Chemistry Laboratory I
Fall, Spring, Summer. 1(0-3) P: (CEM 141 or concurrently) or (CEM 151 or concurrently) or (CEM 181H or concurrently) or (LB 171 or concurrently) Not open to students with credit in CEM 185H or LB 171L.
Introduction to basic chemistry laboratory techniques, including measurements, chemical reactions and basic spectroscopy.

162 Chemistry Laboratory II
Fall, Spring, Summer. 1(0-3) P: CEM 161 or CEM 185H or LB 171L, RB: (CEM 142 or concurrently) or (CEM 152 or concurrently) or (CEM 182H or concurrently) Not open to students with credit in LB 172L.
Continuation of CEM 161 with additional emphasis on kinetics, thermochromism, titration, and synthesis.

181H Honors Chemistry I
Fall. 4(4-0) P: (MTH 124 or concurrently) or (MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 119 or concurrently) R: Approval of department.
Atomic structure and quantum mechanics; chemical bonding and molecular structure; spectroscopy; coordination chemistry; materials or biological macromolecules.

182H Honors Chemistry II
Spring. 4(4-0) P: (CEM 151 or CEM 181H or LB 171) and (MTH 126 or concurrently) or (MTH 133 or concurrently) or (MTH 153H or concurrently) or (LB 119 or concurrently) R: Approval of department.
Gases, solids, liquids, solutions, and phase transitions; thermodynamics; spontaneity and the second law of thermodynamics; chemical equilibria; acid-base equilibria; redox reactions and electrochemistry; kinetics.

185H Honors Chemistry Laboratory I
Fall. 2(0-6) P: CEM 355
Common classes of organic compounds including their nomenclature, structure, bonding, reactivity, and spectroscopic characterization.

186H Honors Chemistry Laboratory II
Fall. 2(0-6) P: CEM 355
Multi-step organic synthesis. Qualitative organic analysis; separation, identification, and characterization of unknowns.

262 Quantitative Analysis
Fall, Spring, Summer. 3(3-3) P: (CEM 142 or CEM 152 or CEM 182H or LB 172) and (CEM 162 or CEM 185H or LB 172L)
Introduction to analytical chemistry and quantitative methods; aqueous solution equilibria and statistics related to quantitative chemical analysis; titrimetric, gravimetric, and spectrophotometric measurements.

311 Inorganic Chemistry
Fall. 3(3-0) P: CEM 142 or CEM 152 or CEM 182H or LB 172 Not open to students with credit in LB 172.
Basic symmetry, molecular orbital theory, and valence bond theory applications to inorganic systems. Physical properties and reactivity of transition metal systems.

333 Instrumental Methods and Applications
Spring. 3(2-3) P: (CEM 262 or (CEM 162 and BLD 213 and BLD 417)) and (CEM 143 or CEM 251 or CEM 351) and completion of Tier I writing requirement
Principles and applications of instrumental analysis of separation techniques.

351 Organic Chemistry I
Fall. 3(4-0) P: CEM 152 or CEM 182H or CEM 142 or LB 172 Not open to students with credit in LB 172.
Structure, bonding, and reactivity of organic molecules.

352 Organic Chemistry II
Spring. 3(4-0) P: CEM 351 Not open to students with credit in CEM 351.

355 Organic Laboratory I
Spring. 2(0-6) P: (CEM 162 or CEM 185H or LB 172L) and ((CEM 352 or concurrently) or (CEM 252 or concurrently))

356 Organic Laboratory II
Fall. 2(0-6) P: CEM 355
Physical chemistry of macroscopic systems: thermodynamics, kinetics, electrochemistry.

383 Introductory Physical Chemistry I
Fall. 3(4-0) P: (CEM 142 or CEM 152 or CEM 182H or LB 172) and (MTH 133 or MTH 153H or MTH 126 or LB 119) RB: PHY 184 or PHY 232 or PHY 232C or PHY 234H or LB 274 SA: CEM 391
Physical chemistry of macroscopic systems: thermodynamics, kinetics, electrochemistry.

384 Introductory Physical Chemistry II
Spring. 3(4-0) P: (CEM 142 or CEM 152 or CEM 182H or LB 172) and (MTH 133 or MTH 153H or MTH 126 or LB 119) and (PHY 184 or PHY 232 or PHY 232C or PHY 234H or LB 274) RB: CEM 383
Physical chemistry of microscopic systems: quantum mechanics, spectroscopy.
Faculty supervised independent investigations in chemistry. Readings and investigations in chemistry.

Methods of synthesizing inorganic and organometallic compounds.

Design, operational principles and practical application of modern instrumental methods used for the separation, identification and quantification of neurochemical species in neuroscience. Application of methods of chemical analysis to study neurosignalining, chemical composition in single secretory cells, separation, identification and quantification of neuroactive compounds.

Application of instrumental spectroscopic, electrochemical, and chromatographic methods to solve quantitative chemical problems in the laboratory.

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Principles of structure and bonding. Symmetry. Solid state chemistry. Acid-base and redox reactions. Main group chemistry; transition metal bonding, spectra, and reaction mechanisms.

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Descriptive chemistry of inorganic compounds. Emphasis on synthesis, structure, and reactivity patterns of coordination, organometallic, and solid state compounds of transition metal compounds. Concepts of group theory.

Principles of chemical bonding, electronic structure, and reaction mechanisms of main group and transition metal compounds. Concepts of group theory.

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Organometallic functional groups. Principles of electronic structure, and bonding in organometallic species will be related to reactivity patterns in common systems. Preparation of complexes with applications to catalytic and stoichiometric organic syntheses.

Separations, molecular spectroscopy and mass spectrometry

Physical and chemical principles of separations, column technology, and instrumentation for gas, liquid, and supercritical fluid chromatography.

Modern electroanalytical chemistry. Theory and applications to chemical and biological problems. Coulometry, voltammetry, ion-selective potentiometry, and other electrochemical techniques.

Structure and spectroscopy of organic compounds

Structural and stereochemical principles in organic chemistry. Applications of spectroscopic methods, especially nuclear magnetic resonance, static and dynamic aspects of stereochemistry. Spectroscopy in structure determination.

Intermediate organic chemistry

Traditional and modern basic reaction mechanisms and principles and their synthetic applications.

Advanced organic chemistry

Structure, reactivity, and methods. Acid-base reactions, substitution, addition, elimination, and pericyclic processes. Major organic intermediates related to simple bonding theory, kinetics, and thermodynamics.

Methods of organic synthesis


Atomic and molecular structure

Postulates of quantum mechanics, analytical solutions of the Schroedinger equation, theoretical descriptions of chemical bonding, spectroscopy, statistical mechanics, and statistical thermodynamics.

Kinetic and spectroscopic methods

Rate equations and mechanisms of chemical reactions: reaction rate theory, kinetic theory of gases, photochemistry. Spectroscopic methods, and applications of spectroscopy in reaction kinetics.

Computational quantum chemistry

Computational methods in determining electronic energy levels, equilibrium nuclear configurations, and other molecular properties.

Chemical problems and reports

Investigation and report of a nomenclature problem in chemistry.

Master’s thesis research

Master’s thesis research.

Selected topics in inorganic chemistry

A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to doctoral students in the College of Engineering or in the College of Natural Science.

Inorganic chemistry seminar

Advances in inorganic chemistry reported by graduate students.

Selected topics in analytical chemistry

A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to doctoral students in the College of Engineering or in the College of Natural Science.

Analytical chemistry seminar

Advances in analytical chemistry reported by graduate students, faculty, and guest lecturers.

Selected topics in organic chemistry

A student may earn a maximum of 12 credits in all enrollments for this course. R: Open only to graduate students in College of Natural Science or College of Engineering.

Heterocyclic and organometallic chemistry, natural products, photochemistry, free radicals, or reaction mechanisms.

Organic chemistry seminar

Advances in organic chemistry reported by graduate students.

Emerging topics in chemistry

Discussion of a research topic of emerging interest in chemistry. Preparation of a proposal for funding of research.

Selected topics in nuclear chemistry

A student may earn a maximum of 12 credits in all enrollments for this course. R: Thermodynamics, Statistical Mechanics, Quantum Mechanics, Electricity and Magnetism, Differential and Integral Calculus, Differential Equations: Open to doctoral students in the College of Engineering or in the College of Natural Science or in the Department of Chemistry.

Nuclear instruments, detectors and electronics, vacuum technology, electric and magnetic properties of nuclei, nuclear simulation tools, or nuclear spectroscopy and reactions.

Selected topics in physical chemistry I

A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to doctoral students or approval of department.

Topics such as kinetics and photophysics, macromolecular and surface chemistry, molecular spectroscopy, electric and magnetic properties of matter, or applications of statistical mechanics to chemical problems.

Selected topics in physical chemistry II

A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to graduate students in College of Natural Science or College of Engineering.

Principles and applications of quantum chemistry. Partition functions, spectroscopic measurements, and thermodynamic applications.
992 Quantum Chemistry and Statistical Thermodynamics II  
Spring. 3(3-0) RB: CEM 991  
Analytical and numerical methods for solving quantum chemical problems. Statistical mechanics of solids and liquids.

993 Advanced Topics in Quantum Chemistry  
Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. R: Open to graduate students in the College of Engineering or in the College of Natural Science.  
Spectroscopic theory, properties of atoms and molecules in electric and magnetic fields, intermolecular forces. Many-body theory, molecular electronic structure, solid state chemistry, or molecular reaction dynamics.

994 Advanced Topics in Statistical Mechanics  
Fall. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. R: Open to graduate students in the College of Engineering or in the College of Natural Science.  
Nonequilibrium statistical mechanics and thermodynamics. Correlation functions and spectroscopy, light scattering, magnetic relaxation, transport properties of fluids and gases, or statistical mechanics of chemical reactions.

995 Nuclear Chemistry Seminar  
Fall, Spring. 1 credit. A student may earn a maximum of 2 credits in all enrollments for this course. R: Open to graduate students in the Department of Chemistry or in the Department of Physics and Astronomy.  
Advances in nuclear chemistry reported by graduate students, faculty, and guest lecturers.

998 Physical Chemistry Seminar  
Fall, Spring. 1(1-0) A student may earn a maximum of 3 credits in all enrollments for this course. R: Open to graduate students in the Department of Chemistry.  
Advances in physical chemistry reported by graduate students.

999 Doctoral Dissertation Research  
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 36 credits in all enrollments for this course. R: Open to doctoral students in the Department of Chemistry.  
Doctoral dissertation research.