

Chemistry Courses (CHEM)

CHEM Courses

This is a list of courses with the subject code CHEM. For more information, see Chemistry (College of Liberal Arts and Sciences) in the catalog.

CHEM:0500 Review of Chemistry Fundamentals 0 s.h.

Self-paced course to prepare for and improve success in CHEM:1110; students acquire an appropriate mathematics background and a sound understanding of some fundamentals of chemistry; use of ALEKS to test individual chemistry knowledge and then computerized adaptive learning software to fill gaps in knowledge.

CHEM:1000 First-Year Seminar 1-2 s.h.

Small discussion class taught by a faculty member; topics chosen by instructor; may include outside activities (e.g., films, lectures, performances, readings, visits to research facilities). Requirements: first- or second-semester standing.

CHEM:1050 Chemistry of Our World 3 s.h.

Nonmathematical exploration of selected areas of technology; basic science background, current technological applications, implications for society; for non-science majors. GE: Natural Sciences without Lab.

CHEM:1060 Technology and Society Laboratory 1 s.h.

Laboratory for CHEM:1050; demonstrations, student experiments. GE: Natural Sciences Lab only.

CHEM:1070 General Chemistry I 3 s.h.

Atomic structure, chemical bonds, mole relations, stoichiometry, states of matter, acids and bases, reaction rates, electrochemistry, nuclear chemistry. GE: Natural Sciences without Lab.

CHEM:1080 General Chemistry II 3 s.h.

Organic chemistry and biochemistry. GE: Natural Sciences without Lab.

CHEM:1090 Supplemental Chemistry Lab 1 s.h.

Lab techniques, elementary synthesis, measurement, analysis, case-study lectures and experiments; safety glasses, appropriate dress, compliance with laboratory safety protocols required.

CHEM:1100 Chemistry in Industry and the Economy 3 s.h.

Atomic structure, chemical bonding, acid and bases, polymers, pharmaceuticals, DNA, proteins, and basic economics. GE: Natural Sciences without Lab.

CHEM:1110 Principles of Chemistry I 4 s.h.

Chemical bonding and chemical reactions; atomic and molecular structure, chemical equations, stoichiometry, gases, liquids, thermodynamics of phase changes, solutions, equilibrium, acids, bases, pH, elementary organic chemistry; the solid state, including modern materials; lecture, discussion, laboratory. Prerequisites: ALEKS score of 55 or higher or MPT Level 3 score of 9 or higher or MATH:1005 with a minimum grade of C- or MATH:1010 with a minimum grade of C- or MATH:1020 with a minimum grade of C- or MATH:1340 with a minimum grade of C- or MATH:1380 with a minimum grade of C- or MATH:1440 with a minimum grade of C- or MATH:1460 with a minimum grade of C- or MATH:1550 with a minimum grade of C- or MATH:1850 with a minimum grade of C-. Recommendations: Chemistry Diagnostic Test score of 16. GE: Natural Sciences with Lab.

CHEM:1120 Principles of Chemistry II 4 s.h.

Continuation of CHEM:1110; colligative properties of solutions, chemical thermodynamics, electrochemistry, chemical kinetics, chemical bonding, aspects of industrial chemistry, nuclear chemistry; lecture, discussion, laboratory. Prerequisites: CHEM:1110 with a minimum grade of C-. GE: Natural Sciences with Lab.

CHEM:1160 Principles of Chemistry Lab 2 s.h.

Laboratory techniques. GE: Natural Sciences Lab only.

CHEM:2021 Fundamentals of Chemical Measurements 3 s.h.

Introduction to experimental and data analysis techniques used in performing quantitative chemical measurements; topics include titrations, spectrophotometry, potentiometry, chromatography, and statistical techniques for use in data processing and interpretation; laboratory. Prerequisites: CHEM:1120 with a minimum grade of C-. Requirements: chemistry major.

CHEM:2210 Organic Chemistry I 3 s.h.

Carbon-containing compounds; structure, stereochemistry, physical properties, reactivity, reaction mechanisms, synthesis; emphasis on alkanes, alkenes, alkynes, ethers, alcohols, and alkyl halides. Prerequisites: CHEM:1120 with a minimum grade of C-.

CHEM:2220 Organic Chemistry II 3 s.h.

Continuation of CHEM:2210; use of spectroscopic techniques to determine chemical structures; chemistry of carbonyl compounds, amines, aromatics, amino acids, carbohydrates, nucleosides. Prerequisites: CHEM:2210 with a minimum grade of C- or CHEM:2230 with a minimum grade of C-.

CHEM:2230 Organic Chemistry I for Majors 3 s.h.

Carbon-containing compounds; structure, stereochemistry, physical properties, reactivity, reaction mechanisms, synthesis; emphasis on alkanes, alkenes, alkynes, alcohols, alkyl halides, aromatics. Prerequisites: CHEM:1120 with a minimum grade of C-. Recommendations: chemistry, biochemistry, or chemical engineering major.

CHEM:2240 Organic Chemistry II for Majors 3 s.h.

Continuation of CHEM:2230; use of spectroscopic techniques to determine chemical structures; chemistry of carbonyl compounds, amines, ethers, amino acids, carbohydrates, and nucleosides. Prerequisites: CHEM:2210 with a minimum grade of C- or CHEM:2230 with a minimum grade of C-. Recommendations: chemistry, biochemistry, or chemical engineering major.

CHEM:2410 Organic Chemistry Laboratory 3 s.h.

Preparation, purification, identification, analysis of chemical compounds, principally organic compounds. Prerequisites: CHEM:1120 with a minimum grade of C- and (CHEM:2210 with a minimum grade of C- or CHEM:2230 with a minimum grade of C-). Corequisites: CHEM:2220 or CHEM:2240.

CHEM:2420 Organic Chemistry Laboratory for Majors 3 s.h.

Preparation, purification, identification, analysis of chemical compounds, principally organic compounds. Prerequisites: CHEM:1120 with a minimum grade of C- and (CHEM:2210 with a minimum grade of C- or CHEM:2230 with a minimum grade of C-). Corequisites: CHEM:2220 or CHEM:2240. Recommendations: chemistry, biochemistry, or chemical engineering major.

CHEM:3110 Equilibria and Electrochemistry 3 s.h.

Modern theory and practice; emphasis on chemical equilibria (acid-base chemistry, solubility, complexation) and electroanalytical chemistry (potentiometry, voltammetry, coulometry). Prerequisites: CHEM:1120 with a minimum grade of C-.

CHEM:3120 Spectroscopy and Separations 3 s.h.

Modern theory and practice; emphasis on atomic and molecular spectroscopy, mass spectrometry, chemical separations. Prerequisites: CHEM:1120 with a minimum grade of C-.

CHEM:3250 Inorganic Chemistry 3 s.h.

Modern principles; emphasis on descriptive chemistry of the main group and transition elements, ionic and covalent chemical bonding theories, symmetry, inorganic stereochemistry. Prerequisites: CHEM:2210 with a minimum grade of C- or CHEM:2230 with a minimum grade of C-. Corequisites: CHEM:2220 or CHEM:2240.

CHEM:3430 Analytical Measurements 3 s.h.

Modern theory and practice of laboratory methods; emphasis on experimental techniques and data analysis in spectroscopy, chromatography, electrochemistry. Prerequisites: CHEM:2021 with a minimum grade of C- and (CHEM:3110 with a minimum grade of C- or CHEM:3120 with a minimum grade of C-). Recommendations: (PHYS:1511 or PHYS:1611) and (PHYS:1512 or PHYS:1612).

CHEM:3440 Physical Measurements 3 s.h.

Laboratory experience using advanced instrumental and computational methods to generate and analyze data relevant to modern physical chemistry. Prerequisites: CHEM:2021 with a minimum grade of C- and (CHEM:4431 with a minimum grade of C- or CHEM:4432 with a minimum grade of C-).

CHEM:3530 Inorganic Chemistry Laboratory 3 s.h.

Preparation and characterization of a variety of inorganic, organometallic, and coordination compounds of the main group and transition elements; emphasis on synthetic techniques, methods for characterization of inorganic species. Prerequisites: CHEM:3250 with a minimum grade of C- and (CHEM:2410 with a minimum grade of C- or CHEM:2420 with a minimum grade of C-) and CHEM:2021 with a minimum grade of C-.

CHEM:3560 Advanced Methods in Chemical Research: Special Topics 1-3 s.h.

Introduction to advanced research methods.

CHEM:3994 Undergraduate Research 1-4 s.h.**CHEM:4000 Scientists and Writers 1 s.h.**

Science communication and collaborative skills that are highly sought after by employers in STEM firms including pharmaceutical firms, biotech start-ups, and many others; these same skills essential for reporting on, writing about, or translating science in any area; studio-style format. Same as JMC:4000, WRIT:4002.

CHEM:4261 Selected Topics in Chemistry 1-3 s.h.**CHEM:4270 Advanced Inorganic Chemistry 3 s.h.**

Modern principles, including crystal field/ligand field/molecular orbital theory, inorganic reaction mechanisms, coordination chemistry, bioinorganic chemistry, main group and transition metal organometallic chemistry, solid-state inorganic chemistry. Prerequisites: CHEM:3250 with a minimum grade of C-.

CHEM:4372 Advanced Organic Chemistry 3 s.h.

Basic concepts from perspectives of structure, mechanism, synthesis, stereochemistry. Prerequisites: CHEM:2220 with a minimum grade of C- or CHEM:2240 with a minimum grade of C-.

CHEM:4430 Principles of Physical Chemistry 3 s.h.

Kinetics, transport properties, elementary thermodynamics, and selected topics in quantum mechanics and spectroscopy; emphasis on application of chemistry to areas of science including health and biosciences, environmental sciences, and related areas. Prerequisites: CHEM:1120 with a minimum grade of C- and (MATH:1460 with a minimum grade of C- or MATH:1550 with a minimum grade of C- or MATH:1850 with a minimum grade of C-). Recommendations: (PHYS:1511 or PHYS:1611) and (PHYS:1512 or PHYS:1612).

CHEM:4431 Chemical Thermodynamics 3 s.h.

Chemical thermodynamics and its application to chemical equilibrium, phase changes and chemical equilibria; ideal and real gases; kinetic theory; surface absorption and electrochemistry; thermodynamics. Prerequisites: CHEM:1120 with a minimum grade of C- and (MATH:1560 with a minimum grade of C- or MATH:1860 with a minimum grade of C-).

CHEM:4432 Quantum Mechanics and Chemical Kinetics 3 s.h.

Quantum mechanics and its application to atomic and molecular structure; determination of structure and bonding by various spectroscopic methods; chemical kinetics. Prerequisites: CHEM:1120 with a minimum grade of C- and (MATH:1560 with a minimum grade of C- or MATH:1860 with a minimum grade of C-). Recommendations: PHYS:1512 or PHYS:1612.

CHEM:4450 Synthesis and Measurement 3 s.h.

Laboratory investigations integrating synthesis and measurement techniques from inorganic, analytical, and physical chemistry; emphasis on modern applications of chemistry in biology, medicine, environmental science, catalysis, and materials science. Prerequisites: (CHEM:4432 with a minimum grade of C- or CHEM:4430 with a minimum grade of C- or CHEM:4431 with a minimum grade of C-) and (CHEM:2420 with a minimum grade of C- or CHEM:2410 with a minimum grade of C-) and (CHEM:3120 with a minimum grade of C- or CHEM:3110 with a minimum grade of C-) and CHEM:3250 with a minimum grade of C- and CHEM:2021 with a minimum grade of C-.

CHEM:4480 Introduction to Molecular Modeling 3 s.h.

Theory and application of *ab initio* quantum mechanics, semiempirical molecular orbital theory, and molecular mechanics force fields to chemical research problems; underlying theory of these methods (with emphasis on *ab initio* theory) and their practical application to chemical problems; computational chemistry projects using modeling software. Prerequisites: CHEM:2220 with a minimum grade of C- or CHEM:2240 with a minimum grade of C-. Recommendations: CHEM:4432.

CHEM:4760 Radiochemistry: Energy, Medicine, and the Environment 3 s.h.

Fundamental theoretical concepts of radiochemistry and their application in energy, medicine, and environmental sectors. Prerequisites: CHEM:2210 with a minimum grade of C- or CHEM:2230 with a minimum grade of C-.

CHEM:4850 Upstream Biotechnology Processes 2 s.h.

Introduction to fermentation, fermenter preparation, cell growth and medium requirements, inoculation, sampling, process termination, separation of cells, fermentation case study, enzyme activity, and biocatalysis. Same as PHAR:4850.

CHEM:4873 Atmospheric and Environmental Chemistry 3 s.h.

Fundamental chemical processes of importance in the atmosphere, soil, and water, with emphasis on kinetics and photochemistry of homogeneous and heterogeneous reactions, atmospheric structure and dynamics, global geochemical cycling, chemistry-climate relationships, environmental remediation strategies; experimental methods in field and laboratory studies.

CHEM:5013 Science Writing in Chemistry 1 s.h.

How to providing clear, simple, and direct scientific documents; formulating good scientific questions; developing scientific context; process of writing, critiquing, and rewriting scientific documents; accepting constructive criticism; creating constructive criticism for others; student-created independent scientific proposal suitable as a funding application. Prerequisites: CHEM:5091 and CHEM:7270. Corequisites: CHEM:7999. Requirements: all comprehensive exams completed and passed.

CHEM:5091 Graduate Chemistry Orientation 2-3 s.h.

Pedagogy, safety, and research issues relevant to advanced chemistry careers.

CHEM:5107 Electrochemistry 2-3 s.h.

Fundamental aspects, including mass transport and electron transfer, electrochemical methodology (e.g., voltammetry and potentiometry), determination of homogeneous and heterogeneous reaction mechanisms. Recommendations: CHEM:3110 and CHEM:3120.

CHEM:5108 Spectroscopy 3 s.h.

Principles of atomic and molecular absorption and emission spectroscopy in ultraviolet, visible, and infrared regions of the spectrum, including fluorescence, phosphorescence, Raman spectroscopy; applications to analytical problems, with emphasis on modern instrumentation and methodology. Recommendations: CHEM:3110 and CHEM:3120.

CHEM:5109 Separations 3 s.h.

Analytical separations; basic theory, practical applications, instrumentation, modern techniques (extractions, gas and liquid chromatography, capillary electrophoresis), and detection (mass spectrometry). Recommendations: CHEM:3110 and CHEM:3120.

CHEM:5110 Chemical Sensors 2 s.h.

Theory, practical limitations, analytical utility based on immobilized reagents with electrochemical, thermal, optical transduction mechanisms. Recommendations: CHEM:3110 and CHEM:3120.

CHEM:5114 Chemical Systems Modeling 3 s.h.

Basic processes and techniques; these methods applied to systems relevant to students' own research. Recommendations: CHEM:3110 or CHEM:3120.

CHEM:5115 Biophotonics 3 s.h.

Structure, dynamics of biomolecules and their optical spectroscopy; ultrasensitive fluorescence spectroscopy, vibrational spectroscopy, optical activity and circular dichroism, time-resolved spectroscopy. Recommendations: CHEM:3110 and CHEM:3120.

CHEM:5118 Nanomaterials 3 s.h.

Basic principles associated with nanoscience and nanotechnology; fabrication and synthesis, size dependent properties, characterization, applications of materials at nanometer length scales, recent technological breakthroughs in the field. Requirements: graduate standing or advanced undergraduate standing in engineering and science. Recommendations: knowledge of basic chemistry.

CHEM:5120 Electrochemistry of Polymer Films 1 s.h.

Use of electrochemical methods to characterize polymer and thin films; transport through polymer films and composites, electrochemistry of polymer films. Requirements: physical chemistry course.

CHEM:5150 Chemometrics 3 s.h.

Mathematical, statistical, and signal processing methods for analytical chemistry; hypothesis testing, experimental design, model building, optimization, digital filtering.

CHEM:5190 Seminar: Analytical Chemistry 0-1 s.h.

CHEM:5199 Special Topics in Analytical Chemistry arr.
Content varies.

CHEM:5202 Coordination Chemistry and Spectroscopy 1,3 s.h.

Structure and bonding of d-block metal complexes, theory and application of relevant spectroscopic methods, inorganic reaction mechanisms, transition metals in catalysis. Recommendations: CHEM:4270.

CHEM:5203 Organometallic Chemistry 3 s.h.

Emphasis on organometallic compounds of transition metal elements. Corequisites: CHEM:4270.

CHEM:5204 Physical Methods in Inorganic Chemistry 3 s.h.

Application of physical methods to problems; recent developments; emphasis on magnetic resonance spectroscopy. Recommendations: CHEM:4270.

CHEM:5205 Bioinorganic Chemistry 2-3 s.h.

The role of metal ions in biology from an inorganic chemical perspective; emphasis on structure and mechanism for transition metal-containing metallo-enzymes.

CHEM:5206 Solid-State and Materials Chemistry 3 s.h.

Introduction to the chemical concepts of solid-state chemistry; focus on synthesis and characterization of various inorganic materials; structure/property relationships, real-world examples. Recommendations: CHEM:4270.

CHEM:5212 Mass Spectrometry	3 s.h.	CHEM:5436 Electronic Structure and Informatics in Chemistry	3 s.h.
Examination of mass spectrometry in terms of basic theory, instrumentation, qualitative and quantitative analysis, and its application to the environmental and biological sciences. Recommendations: CHEM:3110 or CHEM:3120.		Basic principles of molecular electronic structure theory; molecular structure and reactivity; molecular orbital theory; density functional theory; introduction to informatics and data science; how calculations can be used to enhance experimental research projects. Recommendations: CHEM:4432. Same as IGPI:5436.	
CHEM:5290 Seminar: Inorganic and Chemical Education Research	0-1 s.h.	CHEM:5438 Surface Chemistry and Heterogeneous Processes	3 s.h.
CHEM:5299 Special Topics in Inorganic Chemistry	1-3 s.h.	Fundamental and applied aspects of surface chemical processes; theories of molecular adsorption/desorption and surface complexation; kinetics; surface analysis and instrumentation; applications of surface chemistry in heterogeneous catalysis, heterogeneous environmental/atmospheric processes, and materials chemistry. Recommendations: CHEM:4431.	
Recommendations: CHEM:4270.		CHEM:5490 Seminar: Physical and Environmental Chemistry	0-1 s.h.
CHEM:5321 Spectroscopic Methods in Organic Chemistry	3-4 s.h.	CHEM:5499 Physical Chemistry Topics	1-3 s.h.
Methods and techniques of structure determination for organic compounds.		Advanced topics relevant to modern physical chemistry. Recommendations: CHEM:4432 and MATH:1860.	
CHEM:5326 Organic Reactions	3 s.h.	CHEM:5599 Special Topics in Chemistry Education	3 s.h.
Survey of organic reactions used in contemporary organic synthesis; emphasis on C-C bond forming reactions, functional group interconversions, oxidations and reductions; mechanistic details of reaction types; innovations in catalytic and asymmetric organic reactions. Recommendations: CHEM:4372.		Special topics related to chemistry education; topics vary.	
CHEM:5328 Mechanisms of Organic Reactions	3 s.h.	CHEM:5875 Perspectives in Biotechnology	1 s.h.
Application of basic mechanistic concepts.		Topics related to careers in biotechnology with an emphasis on preparing graduate students for careers outside of academia; discussions led by a series of guest speakers from leading biotech industries; understanding the societal impact of basic research; participation in round-table discussions; and presentation of student research findings. Requirements: graduate standing and good academic standing in a participating department supported by the Predoctoral Training Program in Biotechnology. Same as BMB:5875, CBE:5875, CEE:5875, MICR:5875, PHAR:5875.	
CHEM:5329 Advanced Organic Synthesis	1-3 s.h.	CHEM:5890 Research Frontiers in Chemistry	1 s.h.
Preparation of complex organic compounds. Recommendations: CHEM:4372.		CHEM:5990 Chemistry Colloquium	0-1 s.h.
CHEM:5390 Seminar: Organic Chemistry	0-1 s.h.	Presentation and discussion of research by invited presenters.	
CHEM:5399 Organic Chemistry Special Topics	1,3 s.h.	CHEM:6990 Research Seminar	0-1 s.h.
Recommendations: CHEM:4372.		Presentation and discussion of thesis research for advanced degrees.	
CHEM:5431 Statistical Thermodynamics I	3 s.h.	CHEM:7270 Ethics in Chemical Sciences	1 s.h.
Fundamentals of classical thermodynamics and equilibria; ensembles; noninteracting systems; theory of phase transitions; Monte-Carlo methods; classical fluids; nonequilibrium systems. Recommendations: CHEM:4431.		Scholarly integrity for being a responsible chemist on graduate-level research; introduction to infrastructure of scientific scholarship with emphasis on interacting with peers, funding agencies, industrial entities; responsible conduct in research in the context of creation of knowledge, dissemination of scientific findings, intellectual property, and conflict of interest; workshops to study cases in chemical research to illustrate the principles of scholarly integrity.	
CHEM:5433 Quantum and Computational Chemistry	3 s.h.	CHEM:7604 Ethics in Chemical Sciences for Postdocs	0 s.h.
Fundamental principles of quantum chemistry; angular momentum; approximation methods; theory of atomic and molecular electronic structure; applications of computational quantum mechanics to chemical systems. Corequisites: CHEM:4432, if not taken as a prerequisite.		Introduction to infrastructure of scientific scholarship; emphasis on interacting with peers, funding agencies, industrial entities; scholarly integrity for being a responsible chemist on graduate-level research; responsible conduct in research in context of creation of knowledge, dissemination of scientific findings, intellectual property, conflict of interest; workshop cases in chemical research that illustrate principles of scholarly integrity.	
CHEM:5434 Molecular Spectroscopy	3 s.h.	CHEM:7999 Research in Chemistry	arr.
Quantum mechanical models of atoms, molecules, and chemical oscillators; electrostatics and magnetism; electromagnetic waves; refractive index and polarization; matter waves; symmetry and orbitals; vibronic and spin-orbit coupling; electron correlation and exchange; selection rules. Recommendations: CHEM:5433.		Thesis work for advanced degrees.	
CHEM:5435 Chemical Kinetics	3 s.h.		
Potential energy surfaces, transition state theory, diffusion limited rates, linear free energy relationships, isotope effects, solvent effects, RRKM theory; connection between experiment and various theories in the gas and solution phases; emphasis on assignment of experimental error to derived quantities. Recommendations: CHEM:4432.			