## Chemistry Courses (CHEM)

This is a list of all chemistry courses. For more information, see Chemistry.

### 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 Technology and Society 3 s.h.
Nonmathematical exploration of selected areas of technology; basic science background, current technological applications, implications for society; for nonscience majors. Recommendations: closed to students who have taken college chemistry courses. GE: Natural Sciences without Lab.

### CHEM:1060 Technology and Society Laboratory 1 s.h.
Laboratory for CHEM:1050; demonstrations, student experiments. Corequisites: CHEM:1050 if not taken as a prerequisite. Requirements: closed to students who have earned more than 3 s.h. in chemistry courses. 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. Requirements: elementary algebra. GE: Natural Sciences without Lab.

### CHEM:1080 General Chemistry II 3 s.h.
Organic chemistry and biochemistry. Requirements: CHEM:1070 or high school chemistry. 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, pharmaceutics, DNA, proteins, and basic economics. Requirements: non-science major. 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. Requirements: MATH:1005 with a minimum grade of C-, or ACT math subscore of 24, or ALEKS score above 60%. 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. Requirements: CHEM:1110. GE: Natural Sciences with Lab.

### CHEM:1160 Principles of Chemistry Lab 2 s.h.
Laboratory techniques. Requirements: grades of C or higher in CHEM:1180 and CHEM:1190. GE: Natural Sciences Lab only.

### CHEM:1180 Chemical Science I 3 s.h.
GE: Natural Sciences without Lab.

### CHEM:1190 Chemical Science II 3 s.h.
GE: Natural Sciences without Lab.

### CHEM:1200 Chemical Science Laboratory 2 s.h.
GE: Natural Sciences Lab only.

### CHEM:2021 Fundamentals of Chemical Measurements 3 s.h.
Continuation of CHEM:1120; laboratory introducing 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. Prerequisites: CHEM:1120. 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.

### 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 or CHEM:2230.

### 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 or CHEM:1190. Requirements: 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 or CHEM:2230. Requirements: 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 and (CHEM:2210 or CHEM:2230). 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:2210 or CHEM:2230) and CHEM:1120. Corequisites: CHEM:2220 or CHEM:2240. Requirements: chemistry, biochemistry, or chemical engineering major.

### CHEM:3110 Analytical Chemistry I 3 s.h.
Modern theory and practice; emphasis on chemical equilibria (acid-base chemistry, solubility, complexion) and electroanalytical chemistry (potentiometry, voltammetry, coulometry). Requirements: CHEM:1120 and (MATH:1460 or MATH:1850) and (PHYS:1511 or PHYS:1611).

### CHEM:3120 Analytical Chemistry II 3 s.h.
Modern theory and practice; emphasis on atomic and molecular spectroscopy, mass spectrometry, chemical separations. Requirements: CHEM:1120, and MATH:1460 or MATH:1850, and PHYS:1511 or PHYS:1611.


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. Requirements: chemistry major, CHEM:2021 and (CHEM:4431 or CHEM:4432).

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. Requirements: CHEM:2021 and (CHEM:2410 or CHEM:2420) and CHEM:3250.

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: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. Requirements: CHEM:3250 and CHEM:4432.


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. Requirements: CHEM:1120 and (MATH:1460 or MATH:1850) and (PHYS:1512 or PHYS:1612).

CHEM:4431 Physical Chemistry I 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. Requirements: CHEM:1120 and (MATH:1560 or MATH:1860) and (PHYS:1512 or PHYS:1612).

CHEM:4432 Physical Chemistry II 3 s.h. Quantum mechanics and its application to atomic and molecular structure; determination of structure and bonding by various spectroscopic methods; chemical kinetics. Requirements: CHEM:1120 and (MATH:1560 or MATH:1860) and (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 or CHEM:4430 or CHEM:4431) and (CHEM:2420 or CHEM:2410) and (CHEM:3120 or CHEM:3110) and CHEM:3250 and CHEM:2021.

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. Corequisites: CHEM:4432, if not taken as a prerequisite.


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.

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. Corequisites: CHEM:4431 or CHEM:4432, if not taken as a prerequisite.

CHEM:4875 Introduction to Polymer Chemistry 2-3 s.h. Synthesis, structures, characterization, properties, and applications of polymers. Recommendations: CHEM:2220 or CHEM:2240.

CHEM:5091 Graduate Chemistry Orientation 2-3 s.h. Pedagogy, safety, and research issues relevant to advanced chemistry careers.

CHEM:5092 Ethics in Chemical Sciences 1 s.h. 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: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, CHEM:3120, and CHEM:4171.
**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, CHEM:3120, and CHEM:4171.

**CHEM:5109 Separations** 3 s.h.
Analytical separations; basic theory, practical applications, instrumental techniques, modern techniques (extractions, gas and liquid chromatography, capillary electrophoresis), and detection (mass spectrometry). Recommendations: CHEM:3110, CHEM:3120, and CHEM:4171.

**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, or CHEM:4171.

**CHEM:5114 Chemical Systems Modeling** 2 s.h.
Basic processes and techniques; these methods applied to systems relevant to students' own research. Recommendations: CHEM:3110 or CHEM:3120 or CHEM:4171.

**CHEM:5115 Biophotonics** 3 s.h.

**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.

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

**CHEM:5199 Special Topics in Analytical Chemistry** arr.

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

**CHEM:5203 Organometallic Chemistry** 3 s.h.

**CHEM:5204 Physical Methods in Inorganic Chemistry** 2 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.
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.

**CHEM:5290 Seminar: Inorganic Chemistry** 0-1 s.h.

**CHEM:5299 Special Topics in Inorganic Chemistry** 1-3 s.h.
Recommendations: CHEM:4270.

**CHEM:5321 Spectroscopic Methods in Organic Chemistry** 3-4 s.h.

**CHEM:5326 Organic Reactions** 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.

**CHEM:5328 Mechanisms of Organic Reactions** 3 s.h.
Application of basic mechanistic concepts.

**CHEM:5329 Advanced Organic Synthesis** 1-3 s.h.

**CHEM:5390 Seminar: Organic Chemistry** 0-1 s.h.

**CHEM:5399 Organic Chemistry Special Topics** 1,3 s.h.
Recommendations: CHEM:4372.

**CHEM:5431 Statistical Thermodynamics I** 3 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.

**CHEM:5433 Quantum and Computational Chemistry** 3 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.

**CHEM:5434 Molecular Spectroscopy** 3 s.h.
Quantum mechanical theory of molecular spectroscopy; time-dependent perturbation theory, selection rules, lineshapes; selected applications in microwave, vibrational (infrared and Raman), electronic, optical, and magnetic resonance spectroscopy. Recommendations: CHEM:5433.

**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.
CHEM: 5436 Electronic Structure and Informatics in Chemistry 3 s.h.
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. Prerequisites: CHEM: 4432.

CHEM: 5438 Surface Chemistry and Heterogeneous Processes 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.

CHEM: 5490 Seminar: Physical and Environmental Chemistry 0-1 s.h.

CHEM: 5499 Physical Chemistry Topics 1-3 s.h.
Advanced topics relevant to modern physical chemistry. Recommendations: CHEM: 4432 and MATH: 1860.

CHEM: 5599 Special Topics in Chemistry Education 3 s.h.
Special topics related to chemistry education; topics vary.

CHEM: 5875 Perspectives in Biocatalysis 1-3 s.h.
Applied enzymology, protein design, structure-activity relationships, biosensor technology, microbial transformations, biodegradation of environmental pollutants. Requirements: graduate standing in a participating department supported by the Predoctoral Training Program in Biotechnology. Same as BIOP: 5875, CBE: 5875, CEE: 5875, MICR: 5875, PHAR: 5875.

CHEM: 5890 Research Frontiers in Chemistry 1 s.h.

CHEM: 5990 Chemistry Colloquium 0-1 s.h.
Presentation and discussion of research by invited presenters.

CHEM: 6990 Research Seminar 0-1 s.h.
Presentation and discussion of thesis research for advanced degrees.

CHEM: 7604 Ethics in Chemical Sciences for Postdocs 0 s.h.
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: 7999 Research in Chemistry arr.
Thesis work for advanced degrees.