## Chemistry Courses (CHEM)

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

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<td>CHEM:3120</td>
<td>Analytical Chemistry II</td>
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### CHEM:1180 Chemical Science I
- GE: Natural Sciences without Lab.

### CHEM:1190 Chemical Science II
- GE: Natural Sciences without Lab.

### CHEM:1200 Chemical Science Laboratory
- GE: Natural Sciences Lab only.

### CHEM:2021 Fundamentals of Chemical Measurements
- 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:110. Requirements: chemistry major.

### CHEM:2210 Organic Chemistry I
- 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
- 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
- Carbon-containing compounds; structure, stereochemistry, physical properties, reactivity, reaction mechanisms, synthesis; emphasis on alkanes, alkenes, alkynes, ethers, alcohols, alkyl halides, aromatics. Prerequisites: CHEM:1120. Requirements: chemistry, biochemistry, or chemical engineering major.

### CHEM:2240 Organic Chemistry II for Majors
- Continuation of CHEM:2230; use of spectroscopic techniques to determine chemical structures; chemistry of carbonyl compounds, amines, ethers, amino acids, carbohydrates, nucleosides. Prerequisites: CHEM:2210 or CHEM:2230. Requirements: chemistry, biochemistry, or chemical engineering major.

### CHEM:2410 Organic Chemistry Laboratory
- 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
- 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. Requirements: chemistry, biochemistry, or chemical engineering major.

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

### CHEM:3120 Analytical Chemistry II
- Modern theory and practice; emphasis on atomic and molecular spectroscopy, mass spectrometry, chemical separations. Prerequisites: CHEM:1120 and (MATH:1460 or MATH:1850) and (PHYS:1511 or PHYS:1611).
CHEM:3250 Inorganic Chemistry 3 s.h.

CHEM:3430 Analytical Measurements 3 s.h.

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:4000 Scientists and Writers 1 s.h.
Scientists, writers, and business executives from different worlds need to work together in STEM industries and science journalism, and need to understand each other; interdisciplinary understanding and collaborative skills highly sought after by employers in STEM firms including pharmaceutical, biotech start-ups, and many others; skills essential for writers reporting on, writing about, or translating science in any medium. Requirements: STEM graduate standing in biological, chemical, physical, medical science, or engineering disciplines; or advanced undergraduate standing in journalism, creative writing, English, or any other writing-intensive major.

CHEM:4171 Advanced Analytical Chemistry 3 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:4372 Advanced Organic Chemistry 3 s.h.
Basic concepts from perspectives of structure, mechanism, synthesis, stereochemistry. Requirements: CHEM:2220 or CHEM:2240.

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. Requirements: CHEM:4432.

CHEM:4480 Radiochemistry: Energy, Medicine, and the Environment 3 s.h.
Fundamental theoretical concepts of radiochemistry and their application in energy, medicine, and environmental sectors. Requirements: CHEM:1120 and (CHEM:2210 or CHEM:2230).

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

CHEM:4875 Introduction to Polymer Chemistry 2-3 s.h.
Synthesis, structures, characterization, properties, and applications of polymers. Requirements: 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: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, instrumentation, modern techniques (extraction, 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 3 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  
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  
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  
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:5438 Surface Chemistry and Heterogeneous Processes  
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 BIOC: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:7270 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: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.