

CHEMISTRY (CHEM)

Courses primarily for undergraduates:

CHEM 0500: Preparation for College Chemistry

Credits: 0. Contact Hours: Lecture 2, Discussion 1.

An in-depth active learning experience designed to impart the fundamental concepts and principles of chemistry, with an emphasis on mathematics skills and logical thinking. For students intending to enroll in general chemistry and who have not taken high school chemistry or who have not had a high school college preparatory chemistry course who need a review of chemical problem solving and chemical concepts. 1-year high school algebra recommended. Graduation Restriction: Credit for CHEM 0500 does not count toward graduation. (Typically Offered: Fall, Spring)

CHEM 1010A: Chemistry Learning Community Orientation: On-Campus Orientation

Credits: 1. Contact Hours: Lecture 1.

Integration of first year and transfer students into the chemistry program. Introduction and overview of degree requirements and support services on campus, assistance with transition to college and community life, and team-building and leadership activities. Offered on a satisfactory-fail basis only. (Typically Offered: Fall)

CHEM 1010B: Chemistry Learning Community Orientation: Professional Development Opportunities

Credits: 1. Contact Hours: Lecture 1.

Integration of first year and transfer students into the chemistry program. Introduction and overview of degree requirements and support services on campus, assistance with transition to college and community life, and team-building and leadership activities. Offered on a satisfactory-fail basis only. (Typically Offered: Spring)

CHEM 1020L: Physical Sciences for Elementary Education

(Cross-listed with PHYS 1020L).

Credits: 3. Contact Hours: Lecture 1, Laboratory 4.

Prereq: Credit or concurrent enrollment in MATH 1950 OR Permission of Instructor

Physical science principles for future elementary teachers. Emphasis on experiments that address current elementary science education standards and that are appropriate for their future students to do, such as measurements of mass, length, time, light from atoms, charge and current, motion due to forces, energy and work, heat, waves, optics, building bridges and making musical instruments, studying states of matter and chemical reactions. (Typically Offered: Fall, Spring)

CHEM 1100: Cutting-Edge Chemistry: Research and Career Opportunities

Credits: 1. Contact Hours: Lecture 1.

Overview of careers in chemistry: industrial, governmental, and academic careers; literature and compound search instruction; professional ethics; and an introduction to joining a research lab. For students majoring or minoring in chemistry or chemistry-related fields. Offered on a satisfactory-fail basis only. (Typically Offered: Fall)

CHEM 1600: Chemistry in Modern Society

Credits: 3. Contact Hours: Lecture 3.

Aspects of chemistry visible to a non-scientist in our society. A survey of selected areas of chemistry with emphasis on the interface between chemistry and other fields of human activity. (Typically Offered: Fall, Spring)

CHEM 1630: College Chemistry

Credits: 4. Contact Hours: Lecture 3, Discussion 1.

Prereq: Credit or concurrent enrollment in CHEM 1630L

A general survey of chemistry with an emphasis on conceptual problems for those who are not physical and biological science or engineering majors. Nomenclature, chemical reactions, stoichiometry, atomic structure, periodic properties, chemical bonding, states of matter, solutions, thermochemistry, acid-base theory, oxidation-reduction reactions, basic chemical kinetics, and chemical equilibrium. 1 year of high school algebra and geometry and CHEM 0500 or 1 year of high school chemistry necessary. Graduation Restriction: Only one of CHEM 1630, 1670, 1770, or 2010 may count toward graduation. (Typically Offered: Fall, Spring, Summer)

CHEM 1630L: Laboratory in College Chemistry

Credits: 1. Contact Hours: Laboratory 3.

Prereq: Credit or enrollment for credit in CHEM 1630

Laboratory to accompany CHEM 1630. Must be taken with CHEM 1630. Graduation Restriction: Only one of CHEM 1630L, 1670L, and 1770L may count toward graduation. (Typically Offered: Fall, Spring, Summer)

CHEM 1670: General Chemistry for Engineering Students

Credits: 4. Contact Hours: Lecture 3, Discussion 1.

Principles of chemistry and properties of matter explained in terms of modern chemical theory with emphasis on topics of general interest to the engineer. MATH 1400 or 2 years of high school algebra and 1 year of high school geometry and CHEM 0500 or 1 year of high school chemistry necessary. Graduation Restriction: Only one of CHEM 1630, 1670, 1770, or 2010 may count toward graduation. (Typically Offered: Fall, Spring)

CHEM 1670L: Laboratory in General Chemistry for Engineering

Credits: 1. Contact Hours: Laboratory 3.

Prereq: Credit or enrollment for credit in CHEM 1670

Laboratory to accompany 1670. Graduation Restriction: Only one of CHEM 1630L, 1670L, and 1770L may count toward graduation. (Typically Offered: Fall, Spring)

CHEM 1770: General Chemistry I

Credits: 4. Contact Hours: Lecture 3, Discussion 1.

Prereq: Credit or concurrent enrollment in CHEM 1770L

The first semester of a two-semester sequence which explores chemistry at a greater depth and with more emphasis on concepts, problems, and calculations than 1630. Recommended for physical and biological science majors, chemical engineering majors, and all others intending to take 3000-level chemistry courses. Principles and quantitative relationships, stoichiometry, chemical equilibrium, acid-base chemistry, thermochemistry, rates and mechanism of reactions, changes of state, solution behavior, atomic structure, periodic relationships, chemical bonding. Chemistry and Biochemistry majors may consider taking CHEM 2010. MATH 1400 or 2 years of high school algebra and 1 year of high school geometry and CHEM 0500 or 1 year of high school chemistry necessary. Graduation Restriction: Only one of CHEM 1630, 1670, 1770, or 2010 may count toward graduation. (Typically Offered: Fall, Spring, Summer)

CHEM 1770L: Laboratory in General Chemistry I

Credits: 1. Contact Hours: Laboratory 3.

Prereq: Credit or enrollment for credit in CHEM 1770

Laboratory to accompany 1770. 1770L must be taken with 1770. Graduation Restriction: Only one of CHEM 1630L, 1670L, and 1770L may count toward graduation. (Typically Offered: Fall, Spring, Summer)

CHEM 1770N: Laboratory in General Chemistry I

Credits: 1. Contact Hours: Laboratory 3.

Prereq: Credit or enrollment for credit in CHEM 1770

Laboratory to accompany CHEM 1770. CHEM 1770N must be taken with CHEM 1770. For Chemistry and Biochemistry majors. Laboratory to accompany CHEM 1770. CHEM 1770N must be taken with CHEM 1770. Graduation Restriction: Only one of CHEM 1630, 1670, 1770, or 2010 may count toward graduation. (Typically Offered: Fall)

CHEM 1780: General Chemistry II

Credits: 3. Contact Hours: Lecture 2, Discussion 1.

Prereq: CHEM 1630 or CHEM 1670 or (CHEM 1770; CHEM 1770L)

Continuation of 1770. Recommended for physical or biological science majors, chemical engineering majors, and all others intending to take 3000-level chemistry courses. (Typically Offered: Fall, Spring, Summer)

CHEM 1780L: Laboratory in College Chemistry II

Credits: 1. Contact Hours: Laboratory 3.

Prereq: CHEM 1770L and Credit or concurrent enrollment in CHEM 1780

Laboratory to accompany 1780. 1780L is not a necessary co-requisite with 1780. (Typically Offered: Fall, Spring, Summer)

CHEM 2010: Advanced General Chemistry

Credits: 5. Contact Hours: Lecture 4, Discussion 1.

Prereq: Credit or concurrent enrollment in MATH 1650 or MATH 1660 or MATH 2650; concurrent enrollment in CHEM 2010L

A one-semester course in general chemistry designed to give students an in-depth, broad-based view of modern chemistry, and, in part, to facilitate participation in independent undergraduate research. Topics include stoichiometry, atomic and molecular structure, chemical bonding, kinetics, chemical equilibria, and thermodynamics. Discussion of current trends in various chemical disciplines, which may be given by guest experts in chemistry, biochemistry, and chemical engineering, will help the student appreciate the scope of the chemical sciences and how research is carried out. One year HS chemistry and one year HS physics, or advanced chemistry necessary. Graduation Restriction: Only one of CHEM 1630L, 1670L, and 1770L may count toward graduation. (Typically Offered: Fall)

CHEM 2010L: Laboratory in Advanced General Chemistry

Credits: 1. Contact Hours: Laboratory 3.

Prereq: Credit or concurrent enrollment in CHEM 2010

Laboratory to accompany 2010. Introductory lab experience in synthesis and analysis to prepare students for research activities. 2010L must be taken with 2010. Graduation Restriction: Only one of 1630L, 1670L, 1770L, 1770N or 2010L may count toward graduation. (Typically Offered: Fall)

CHEM 2110: Quantitative and Environmental Analysis

Credits: 2. Contact Hours: Lecture 2.

Prereq: (CHEM 1630 and CHEM 1630L) or (CHEM 1780) or (CHEM 2010 and CHEM 2010L); concurrent enrollment in CHEM 2110L

Theory and practice of elementary volumetric, chromatographic, electrochemical and spectrometric methods of analysis. Chemical equilibrium, sampling, and data evaluation. Emphasis on environmental analytical chemistry; the same methods are widely used in biological and materials sciences as well. (Typically Offered: Fall, Spring)

CHEM 2110L: Quantitative and Environmental Analysis Laboratory

Credits: 2. Contact Hours: Laboratory 6.

Prereq: Credit or enrollment for credit in CHEM 2110

Introductory laboratory experience in volumetric, spectrometric, electrochemical and chromatographic methods of chemical analysis. (Typically Offered: Fall, Spring)

CHEM 2310: Elementary Organic Chemistry

Credits: 3. Contact Hours: Lecture 3.

Prereq: (CHEM 1630; CHEM 1630L) or (CHEM 1770; CHEM 1770L) or CHEM 1670; *credit or concurrent enrollment in* CHEM 2310L

A survey of modern organic chemistry including nomenclature, structure and bonding, and reactions of hydrocarbons and important classes of natural and synthetic organic compounds. For students desiring only an elementary course in organic chemistry. Students in physical or biological sciences and premedical or pre-veterinary curricula should take the full year sequence 3310 and 3320 (with the accompanying laboratories 3310L and 3320L). Graduation Restriction: Only one of CHEM 2310 and 3310 or BBMB 2210 may count toward graduation. (Typically Offered: Fall, Spring, Summer)

CHEM 2310L: Laboratory in Elementary Organic Chemistry

Credits: 1. Contact Hours: Laboratory 3.

Prereq: *Credit or concurrent enrollment in* CHEM 2310; (CHEM 1630L or CHEM 1770L)

Laboratory to accompany 2310. 2310L must be taken with 2310. Graduation Restriction: Only one of CHEM 2310L and 3310L may count toward graduation. (Typically Offered: Fall, Spring, Summer)

CHEM 2980: Cooperative Education

Credits: Required. Repeatable.

Prereq: *Permission of the department cooperative education coordinator; sophomore classification*

Required of all cooperative education students. Students must register for this course prior to commencing each work period. (Typically Offered: Fall, Spring, Summer)

CHEM 2990: Undergraduate Research (for Freshmen and Sophomores)

Credits: 1-30. Repeatable, maximum of 6 credits.

Prereq: *Instructor Permission for Course*

CHEM 3010: Inorganic Chemistry

Credits: 2. Contact Hours: Lecture 2.

Prereq: CHEM 3240

Atomic and molecular structure and bonding principles; molecular shapes and symmetry; acids and bases; solid-state structures and properties; inorganic chemistry of H, B, C. (Typically Offered: Spring)

CHEM 3160: Instrumental Methods of Chemical Analysis

Credits: 2. Contact Hours: Lecture 2.

Prereq: CHEM 2110, CHEM 2110L, MATH 1660, *and concurrent enrollment in* CHEM 3160L

Quantitative and qualitative instrumental analysis. Operational theory of instruments, atomic and molecular absorption and emission spectroscopy, electroanalysis, mass spectrometry, liquid and gas chromatography, electrophoresis, literature of chemical analysis. PHYS 2320 recommended. (Typically Offered: Fall)

CHEM 3160L: Instrumental Analysis Laboratory

Credits: 2. Contact Hours: Laboratory 6.

Prereq: *Credit or enrollment in* CHEM 3160

Advanced laboratory experience in UV-visible spectrophotometry, atomic absorption and emission spectrometry, electrochemistry, gas and liquid chromatography, electrophoresis, mass spectrometry, and other instrumental methods. (Typically Offered: Fall)

CHEM 3210L: Laboratory in Physical Chemistry

Credits: 2. Contact Hours: Lecture 1, Laboratory 3.

Prereq: *Credit or enrollment in* CHEM 3240 or CHEM 3250

Error analysis; use of computers for interfacing to experiments and for data analysis; thermodynamics, infrared and optical spectroscopy, lasers. Not applicable towards the B.S. degree in Chemistry. Graduation Restriction: Only one of CHEM 3210L and 3202L may count toward graduation. (Typically Offered: Spring)

CHEM 3220L: Laboratory in Physical Chemistry

Credits: 3. Contact Hours: Lecture 1, Laboratory 6.

Prereq: CHEM 3240 or CHEM 3250

Error analysis: use of computers for interfacing to experiments and for data analysis; thermodynamics, surface science, infrared and optical spectroscopy, lasers. Graduation Restriction: Only one of CHEM 3210L and 3220L may count toward graduation. (Typically Offered: Spring)

CHEM 3240: Introductory Quantum Mechanics

Credits: 3. Contact Hours: Lecture 3.

Prereq: CHEM 1780; MATH 1660; PHYS 2320

Quantum mechanics, atomic and molecular structure, spectroscopy, kinetic theory of gases, chemical kinetics. (Typically Offered: Fall, Spring)

CHEM 3250: Chemical Thermodynamics

Credits: 3. Contact Hours: Lecture 3.

Prereq: CHEM 1780; MATH 1660; PHYS 2320

Classical thermodynamics 1st, 2nd, and 3rd laws with applications to gases and interfacial systems, multicomponent, multiphase equilibrium of reacting systems, surface chemistry, and electrochemical cells. Students taking a two-semester physical chemistry sequence are advised to take 3240 first; in the spring semester, a molecular-based section of this course, stressing statistical thermodynamics, is offered for which knowledge of 3240 is useful. (Typically Offered: Fall, Spring)

CHEM 3260: Chemical Kinetics

Credits: 1. Contact Hours: Lecture 1.

Prereq: CHEM 1670, CHEM 1770, CHEM 1780 or CHEM 2010 and MATH 1660

Kinetic theory, rate laws, temperature dependence of rate constants, transition-state theory, reaction mechanisms, kinetic isotope effects, catalysts, Michaelis-Menten kinetics, and Marcus theory. CHEM 3240 and CHEM 3250 recommended. (Typically Offered: Spring)

CHEM 3310: Organic Chemistry I

Credits: 3. Contact Hours: Lecture 3.

Prereq: CHEM 1780 or CHEM 2010

The first half of a two-semester sequence. Modern organic chemistry including nomenclature, synthesis, structure and bonding, reaction mechanisms. For students majoring in physical and biological sciences, premedical and pre-veterinary curricula, chemistry and biochemistry. Students desiring only one semester of organic chemistry should take 2310 and 2310L, not 3310. (Typically Offered: Fall, Spring, Summer)

CHEM 3310L: Laboratory in Organic Chemistry I

Credits: 1. Contact Hours: Laboratory 3.

Prereq: CHEM 1770L or CHEM 2010L; *credit or enrollment for credit in CHEM 3310*

Laboratory to accompany 3310. Chemistry and biochemistry majors are encouraged to take 3330L. Graduation Restriction: Only one of CHEM 2310L and 3310L may count toward graduation. (Typically Offered: Fall, Spring, Summer)

CHEM 3320: Organic Chemistry II

Credits: 3. Contact Hours: Lecture 3.

Prereq: CHEM 3310

Continuation of 3310. Modern organic chemistry including nomenclature, synthesis, structure and bonding, reaction mechanisms, natural products, carbohydrates and proteins. For students majoring in physical and biological sciences, premedical and pre-veterinary curricula, chemistry and biochemistry. Enrollment in CHEM 3320L highly recommended. (Typically Offered: Fall, Spring, Summer)

CHEM 3320L: Laboratory in Organic Chemistry II

Credits: 1. Contact Hours: Laboratory 3.

Prereq: CHEM 3310L; *credit or concurrent enrollment in CHEM 3320*

Laboratory to accompany 3320. Chemistry and biochemistry majors are encouraged to take 3340L. (Typically Offered: Fall, Spring, Summer)

CHEM 3330L: Laboratory in Organic Chemistry I (for Chemistry and Biochemistry Majors)

Credits: 2. Contact Hours: Laboratory 6.

Prereq: *Credit or enrollment for credit in CHEM 3310*

Laboratory to accompany 3310 for chemistry and biochemistry majors. (Typically Offered: Fall)

CHEM 3340L: Laboratory in Organic Chemistry II (for Chemistry and Biochemistry Majors)

Credits: 2. Contact Hours: Laboratory 6.

Prereq: CHEM 3330L, *credit or enrollment for credit in CHEM 3320*

Laboratory to accompany 3320 for chemistry and biochemistry majors. (Typically Offered: Spring)

CHEM 3980: Cooperative Education

Credits: Required. Repeatable.

Prereq: *Permission of Department Cooperative Education Coordinator; Junior classification*

Required of all cooperative education students. Students must register for this course prior to commencing each work period. (Typically Offered: Fall, Spring, Summer)

CHEM 3990: Undergraduate Research

Credits: 1-30. Repeatable.

Prereq: *Permission of Instructor; Sophomore classification*

A comprehensive research report, describing the work performed, the justification or purpose of the research work, the results obtained, and including appropriate literature references/citations must be submitted to the undergraduate chemistry office and the research faculty member. Reports must contain a title, abstract, introduction, procedural details (experimental, computational, or theoretical), results, discussion, and references. Graduation Restriction: No more than six total credits of CHEM 3990 and CHEM 4990 may count toward graduation. Credits earned in 3990/4990/4900 may only be used to meet one of the advanced course requirements for the B.S. degree.

CHEM 4010L: Inorganic Chemistry Laboratory

Credits: 1. Contact Hours: Laboratory 3.

Prereq: CHEM 4020

Preparation and characterization of inorganic and organometallic compounds by modern techniques. For students majoring in chemistry or biochemistry. (Typically Offered: Spring)

CHEM 4020: Advanced Inorganic Chemistry

Credits: 3. Contact Hours: Lecture 3.

Prereq: CHEM 3010

Chemistry of the d and f metals. Structure, bonding, electronic spectra, and reaction mechanisms. Aspects of organometallic solid state and bioinorganic chemistry. CHEM 3310 recommended. (Typically Offered: Fall)

CHEM 4900: Independent Study

Credits: 1-30. Repeatable.

Prereq: *6 credits in CHEM at 3000 level or higher; Permission of Instructor*
Graduation Restriction: No more than 9 credits of CHEM 4900 may count toward graduation.

CHEM 4980: Cooperative Education

Credits: Required. Repeatable.

Prereq: *Permission of Department Cooperative Education Coordinator; Senior classification*

Required of all cooperative education students. Students must register for this course prior to commencing each work period. (Typically Offered: Fall, Spring, Summer)

CHEM 4990: Senior Research

Credits: 2-3. Repeatable, maximum of 6 credits.

Prereq: 3.0 GPA in CHEM, PHYS, and MATH courses; Permission of Instructor
 Research in chosen area of chemistry. This course should be elected for two consecutive semesters. For students majoring in chemistry. A comprehensive and formal research report/senior thesis, describing the work performed, the justification or purpose of the research work, the results obtained, and including appropriate literature references/citations must be submitted to the undergraduate chemistry office and the research faculty member. Reports must contain a title, abstract, introduction, procedural details (experimental, computational, or theoretical), results, discussion, and references. Graduation Restriction: No more than six total credits of CHEM 3990 and CHEM 4990 may count toward graduation.

Courses primarily for graduate students, open to qualified undergraduates:

CHEM 5010L: Inorganic Preparations

Credits: 1. Contact Hours: Laboratory 3.

Preparation and characterization of inorganic and organometallic compounds by modern research techniques. (Typically Offered: Fall)

CHEM 5020: Advanced Inorganic Chemistry

Credits: 3. Contact Hours: Lecture 3.

Chemistry of the main group (s, p) and transition (d, f) metals. Structure, bonding, electronic spectra, and reaction mechanisms. Aspects of organometallic, solid state, bioinorganic, and nano chemistry. (Typically Offered: Fall)

CHEM 5050: Physical Inorganic Chemistry

Credits: 3. Contact Hours: Lecture 3.

Elementary group theory and molecular orbital theory applied to inorganic chemistry. Spectroscopic methods of characterization of inorganic compounds and organometallic compounds. (Typically Offered: Fall)

CHEM 5110: Advanced Analytical Chemistry

Credits: 3. Contact Hours: Lecture 3.

General methods of quantitative inorganic and organic analysis. Aqueous and nonaqueous titrimetry; selective reagents; sampling and sample dissolution; modern instrumentation; sensors; atomic and molecular microscopy; bioanalytical methods; data evaluation; chemometrics; and analytical literature. (Typically Offered: Fall)

CHEM 5120: Electrochemical Methods of Analysis

Credits: 3. Contact Hours: Lecture 3.

Principles of convective-diffusional mass transport in electroanalysis. Applications of potentiometry, voltammetry, and coulometry. Introduction to heterogeneous and homogeneous kinetics in electroanalysis. Analog and digital circuitry. Interfacing. (Typically Offered: Fall)

CHEM 5130: Analytical Molecular and Atomic Spectroscopy

Credits: 3. Contact Hours: Lecture 3.

Introduction to physical optics and design of photometric instruments. Principles of absorption, emission, fluorescence, and Raman spectroscopy. Error and precision of optical methods. Ultraviolet, visible, and infrared methods of qualitative and quantitative organic and inorganic analysis. (Typically Offered: Spring)

CHEM 5160: Analytical Separations

Credits: 3. Contact Hours: Lecture 3.

Principles and examples of inorganic and organic separation methods applied to analytical chemistry. Solvent extraction, volatilization, ion exchange, liquid and gas chromatography, and electrophoresis. (Typically Offered: Fall)

CHEM 5310: Organic Synthesis I

Credits: 3. Contact Hours: Lecture 3.

Survey of organic functional group transformations. (Typically Offered: Spring)

CHEM 5320: Organic Synthesis II

Credits: 2. Contact Hours: Lecture 2.

Synthesis of complex organic compounds including natural products. (Typically Offered: Fall)

CHEM 5370: Physical Organic Chemistry I

Credits: 3. Contact Hours: Lecture 3.

Survey of reactive intermediates including cations, anions, carbenes, and radicals. (Typically Offered: Fall)

CHEM 5380: Physical Organic Chemistry II

Credits: 3. Contact Hours: Lecture 3.

Molecular structure, stereochemistry, introduction to reaction mechanisms, thermodynamic and kinetic data, linear free energy relationships, isotope effects, orbital symmetry. (Typically Offered: Spring)

CHEM 5490: Nuclear Magnetic Resonance Spectroscopy

(Cross-listed with BBMB 5490).

Credits: 3. Contact Hours: Lecture 3.

Theoretical principles of NMR, practical aspects of experimental NMR, solution and solid state NMR, methodologies for molecule characterization, protein structure determination, NMR relaxation, and recent advances. (Typically Offered: Spring)

CHEM 5500: Safety in the Chemical Laboratory

Credits: 1. Contact Hours: Lecture 1.

Introduction to laboratory safety and chemical hygiene. Use of engineering controls and personal protective equipment. Chemical storage and waste disposal practices. Handling hazardous chemicals. Radiation safety and laser safety. Offered on a satisfactory-fail basis only. (Typically Offered: Spring)

CHEM 5550: Teaching College Chemistry

Credits: 2. Contact Hours: Lecture 2.

Methods of instruction, strategies and techniques for effective teaching and learning along with practice teaching in undergraduate chemistry recitation and laboratory courses. Cooperative learning, guided-inquiry, learning cycles, conceptual change, models and modeling, concept maps, visualization, computer simulations, web-based delivery systems, and learning theories. Offered even-numbered years. (Typically Offered: Spring)

CHEM 5610: Fundamentals of Quantum Mechanics

Credits: 4. Contact Hours: Lecture 4.

Schrodinger equation and exact solutions; square wells and barriers; harmonic oscillator; the hydrogen atom; atomic orbitals; operators including angular momenta; time-independent and time-dependent perturbation theory; Schrodinger and Heisenberg representations; unitary operators; interaction picture, density matrix. (Typically Offered: Fall)

CHEM 5620: Fundamentals of Atomic and Molecular Quantum Mechanics

Credits: 3. Contact Hours: Lecture 3.

Variational method, many electron atoms; addition of angular momentum, self-consistent field method for open and closed shells, linear combinations of atomic orbitals, origin of chemical bonding, many-electron diatomic and polyatomic molecules, treatments of electron correlation, approximation methods. (Typically Offered: Spring)

CHEM 5630: Statistical Mechanics

Credits: 3. Contact Hours: Lecture 3.

Microscopic and macroscopic properties, laws of thermodynamics, ensembles and distribution functions, applications to gases, solids, and chemical equilibrium. (Typically Offered: Spring)

CHEM 5640: Molecular Spectroscopy and Structure

Credits: 3. Contact Hours: Lecture 3.

Maxwell's field equations, interaction of light with matter including time-dependent perturbation theory, microwave, vibrational (infra-red, Raman) and electronic spectroscopies, symmetry derived selection rules, special lineshapes and introduction to nonlinear and coherent laser spectroscopies. Offered even-numbered years. (Typically Offered: Spring)

CHEM 5710: Solid-State Chemistry

Credits: 2. Contact Hours: Lecture 2.

Structural principles, synthetic strategies, analytical methods, and chemical bonding issues applied to solids. Atomic packings and networks, short-range vs. long-range order, defects; phase diagrams, reactive fluxes, chemical transport; diffraction, spectroscopy; energy bands and their bonding interpretations. Offered even-numbered years. (Typically Offered: Spring)

CHEM 5720: Spectrometric Identification of Organic Compounds

Credits: 3. Contact Hours: Lecture 2, Laboratory 3.

Principles of infrared, ultraviolet, nuclear magnetic resonance, and mass spectroscopy as applied to organic chemistry. (Typically Offered: Fall)

CHEM 5730: Nanochemistry

Credits: 2. Contact Hours: Lecture 2.

Synthesis, characterization, properties and applications of nanoscale materials (≈ 0.5 -500 nm), relationship with molecular, meso and bulk compounds. Chemistry of solid surfaces, zero-, one- and two- dimensional (0D, 1D, 2D) nanostructures, semiconductor quantum dots, plasmonic nanoparticles, carbon nanomaterials, porous nanomaterials, potential health and safety impacts. Offered odd-numbered years. (Typically Offered: Spring)

CHEM 5740: Organometallic Chemistry of the Transition Metals

Credits: 2. Contact Hours: Lecture 2.

Transition metal complexes with ligands such as cyclopentadienyl, olefins, acetylenes, benzenes, and carbon monoxide. Coverage of structure, bonding, reactivity, fundamental mechanisms, and homogeneous catalysis. Offered odd-numbered years. (Typically Offered: Spring)

CHEM 5750: Diffraction and Crystal Structure

Credits: 3. Contact Hours: Lecture 3.

Fundamentals of structure determination for single crystals emphasizing symmetry, diffraction geometry and instrumentation, sample preparation and handling, data collection strategies, methods of structure solution and refinement, presentation of results, and crystallographic databases. Offered odd-numbered years. (Typically Offered: Spring)

CHEM 5760: Surface Chemistry

Credits: 3. Contact Hours: Lecture 3.

Gas-surface interactions and techniques of characterization. Idealized surface lattices, surface tension, Wulff plots, work function, adsorbate-adsorbate interactions, 2D phase diagrams, diffusion, thin film growth, adsorption and desorption mechanisms/energetics/kinetics, adsorption isotherms, vacuum techniques, electron- and ion-based spectroscopies for surface analysis (including AES, FIM, XPS, UPS, EXAFS, EELS, SIMS, LEED and STM). Offered even-numbered years. (Typically Offered: Fall)

CHEM 5770: Mass Spectrometry

Credits: 3. Contact Hours: Lecture 3.

Basic physics, instrumentation, chemical and biological applications of mass spectrometry. (Typically Offered: Spring)

CHEM 5780: Chemical Kinetics and Mechanisms

Credits: 2. Contact Hours: Lecture 2.

Rates and mechanisms; reversible, consecutive, and competing reactions; chain mechanisms; kinetic isotope effects; very rapid reactions; acid-base catalysis, theories of unimolecular reactions; transition state and Marcus theories. Offered even-numbered years. (Typically Offered: Spring)

CHEM 5790: Introduction to Research in Chemistry

Credits: Required. Contact Hours: Lecture 1.

Introduction to the various areas of research in chemistry at Iowa State University. (Typically Offered: Fall)

CHEM 5800: Introduction to Computational Quantum Chemistry

Credits: 3. Contact Hours: Lecture 3.

Basic principles of quantum mechanics, schrodinger equation. Hartree-Fock/molecular orbital theory, introduction to group theory, introduction to modern methods of computational chemistry; applications include molecular structure, potential energy surfaces and their relation to chemical reactions; molecular spectroscopy, photochemistry, solvent effects and surface chemistry. Offered odd-numbered years. (Typically Offered: Fall)

CHEM 5830: Chemical Group Theory

Credits: 1. Contact Hours: Lecture 1.

Basic concepts and theorems, representation theory; point groups, molecular orbitals, molecular states, molecular vibrations, rotation group and angular momenta; space groups and crystals; permutation group, antisymmetry, and spin states. (Typically Offered: Fall)

CHEM 5990: Nonthesis Research

Credits: 1-30. Repeatable.

*Prereq: Instructor Permission for Course***Courses for graduate students:****CHEM 6000: Seminar in Inorganic Chemistry**

Credits: 1. Contact Hours: Lecture 1.

Repeatable, maximum of 3 times.

(Typically Offered: Fall, Spring)

CHEM 6010: Selected Topics in Inorganic Chemistry

Credits: 1-2. Contact Hours: Lecture 2.

Repeatable.

Topics such as molecular structure and bonding; organometallic compounds; physical techniques of structure determination; nonaqueous solutions; Zintl phases; transition-metal oxides; free-radical reactions; electron transfer reactions; metal-metal bonding; and bioinorganic chemistry of nucleic acids. (Typically Offered: Fall, Spring)

CHEM 6110: Seminar in Analytical Chemistry

Credits: 1. Contact Hours: Lecture 1.

Repeatable.

(Typically Offered: Fall, Spring)

CHEM 6190: Special Topics in Analytical Chemistry

Credits: 1-2. Contact Hours: Lecture 2.

Repeatable.

Raman spectroscopy, sensors, spectroelectrochemistry, capillary electrophoresis, analytical plasmas, chemometrics and bioanalytical chemistry. (Typically Offered: Fall, Spring)

CHEM 6310: Seminar in Organic Chemistry

Credits: 1. Contact Hours: Lecture 1.

Repeatable.

(Typically Offered: Fall, Spring)

CHEM 6320: Selected Topics in Organic Chemistry

Credits: 1-2. Contact Hours: Lecture 2.

Repeatable.

Topics of current interest in organic chemistry such as spectroscopy, physical organic chemistry, photochemistry, organometallic chemistry, mechanisms of oxidations and reductions, modern organic synthesis, reactive intermediates, bioorganic chemistry, and polymers. (Typically Offered: Fall, Spring)

CHEM 6600: Seminar in Physical Chemistry

Credits: 1. Contact Hours: Lecture 1.

Repeatable.

(Typically Offered: Spring)

CHEM 6670: Special Topics in Physical Chemistry

Credits: 1-2. Contact Hours: Lecture 2.

Advanced and recent developments in physical chemistry are selected for each offering. (Typically Offered: Fall, Spring)

CHEM 6990: Research

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course