

List of Approved Advanced Electives for the Chemistry Degree*:

Pay careful attention to prerequisites when choosing Advanced Electives.

Chemistry Courses:

CH 410. Application of Quantum Chemistry. 4 Credits. This course provides an overview of contemporary computational chemistry techniques used to model both single molecule and extended solids. Computations will be conducted on the new University of Oregon super computer, Talapas.

CH 410 Cellular Biochemistry. 4 credits. Given the complexity of cellular systems, scientists face challenges trying to visualize, quantify, and interpret the input-output relationships of individual and functionally redundant signaling pathways. In this course, we will discuss the major technological advances over the past 30 years that have contributed to scientific discovery at the interface between cell biology and biochemistry. Emphasis will be placed on defining the relationships between protein structure, function, and emergent properties of complex biological systems. This course is designed to teach students how to read, interpret, and discuss primary scientific research articles in biochemistry and cell biology.

CH 410. Design Principles of Dynamic Biological Systems. 4 Credits. In this course, we will discuss major technological advances over the past 30 years that accelerated scientific discovery at the interface between cell biology and biochemistry. Emphasis will be placed on defining the relationships between protein structure, function, and emergent properties in complex biological systems. Pre req CH 461; MATH 253.

CH 410. Materials Chemistry. 4 Credits.

CH 410. Science/Policy Interface. 4 Credits. This interdisciplinary (PHYS/CH) course has been developed around the use of science and scientific principles to produce better public policy outcomes on real world issues such as climate change, resource management, energy policy, environmental pollution, medical ethics, etc. Strong focus on improving skills for effectively communicating science to the policy world.

CH 410 Scientific Computing. 4 Credits. Programming skills are increasingly integral to all aspects of biochemical research. Programming competency enables new science because a researcher is not limited to “canned” analyses and approaches. Rather, a scientific programmer can flexibly learn, apply and tweak existing software as needed to answer scientific questions. In this course, students will learn how to think like a programmer when approaching real problems in biochemistry. For this, we will exclusively use the powerful and extensible Python programming language.

CH 410. Single-Molecule Methods. 4 Credits. In this course, students will learn about a variety of approaches used to interrogate single molecules, including techniques based on fluorescence, force, and current, and methods that utilize single molecules as raw materials for devices. We will discuss the theory behind these techniques as well as practical considerations for applying them hands-on. In addition, we will discuss specific studies that utilized single-molecule methods to probe systems ranging from model systems designed to investigate fundamental physical processes, to complex and dynamic biological machines. By studying both the fundamentals and applications of single-molecule methods, students will gain the ability to determine when such methods may be of use in their own research.

CH 420. Physical Organic Chemistry I. 4 Credits. Modern physical organic chemistry including chemical bonding, acid-base chemistry, thermochemistry, noncovalent interactions, and introduction to computational chemistry. Sequence with CH 421/521. Prereq: CH 336 or CH 341.

CH 421. Physical Organic Chemistry II. 4 Credits. Modern physical organic chemistry including tools to study reaction mechanisms, kinetic analysis, isotope effects, and qualitative molecular orbital theory. Sequence with CH 420/520. Prereq: CH 420.

CH 431. Inorganic Chemistry. 4 Credits. Introduction to group theory for molecular symmetry; syntheses, structures, reactions, and reaction mechanisms of coordination complexes and organometallic complexes.

CH 432. Inorganic Chemistry. 4 Credits. Bioinorganic chemistry: metals in biological systems; coordination chemistry, reactions, spectroscopy, metalloclusters, and synthetic modeling. Prereq: CH 431.

CH 433. Inorganic Chemistry. 4 Credits. Solid-state inorganic chemistry: solid-state structure and its determination; the electrical, magnetic, and mechanical properties of materials and their physical description. Prereq: CH 431.

CH 441. Quantum Chemistry. 4 Credits. The principles of time-independent quantum mechanics and their application to model atomic and molecular systems. Prereq: CH 413.

CH 442. Quantum Chemistry and Spectroscopy. 4 Credits. Molecular structure theory, perturbation theory, time-dependent quantum mechanics, theory of spectra, selection rules. Prereq: CH 441.

CH 443. Quantum Chemistry and Spectroscopy. 4 Credits. Experimental spectra of atomic and molecular systems and surfaces. Prereq: CH 442.

CH 444. Chemical Thermodynamics. 4 Credits. The laws of thermodynamics and their applications, including those to nonideal chemical systems. Prereq: CH 413.

CH 445. Statistical Mechanics. 4 Credits. Molecular basis of thermodynamics. Applications to the calculation of the properties of noninteracting and weakly interacting systems. Prereq: CH 413.

CH 446. Chemical Kinetics: [Topic]. 4 Credits. Repeatable. Description and interpretation of the time evolution of chemical systems. Prereq: CH 413.

CH 447. Computational Chemistry. 4 Credits. Introduction to modern computational methods used to understand the properties of molecules. Prereq: CH 411, 412; or PHYS 353.

CH 451. Advanced Organic-Inorganic Chemistry. 4 Credits. Principles of organic-inorganic reaction dynamics; kinetics and mechanisms, linear free-energy relationships, isotope effects, substitution reactions, dynamic behavior of reactive intermediates, electron transfer chemistry. Prereq: CH 336 or CH 341.

CH 452. Advanced Organic Chemistry—Stereochemistry and Reactions. 4 Credits. Principles and applications of stereochemistry; reagents and reactions, with mechanisms, used in contemporary organic synthesis; examples taken from the current literature.

CH 454. Advanced Electrochemistry 4 Credits. Advanced topics in electrochemistry including fundamental concepts (thermodynamics, kinetics, transport) and applications (analytical techniques, electrolysis, batteries).Prereq: CH 411.

CH 461. Biochemistry. 4 Credits. Structure and function of macromolecules. Exposure to calculus and physical chemistry recommended. Prereq: CH 336 or CH 343.

CH 462. Biochemistry. 4 Credits. Metabolism and metabolic control processes. Energy and sensory transduction mechanisms. Prereq: CH 461.

CH 463. Biochemistry. 4 Credits. Mechanisms and regulation of nucleic acid and protein biosynthesis. Other current topics in biochemical genetics. Prereq: CH 461/561; or CH 360 with a grade of B- or better.

CH 464. RNA Biochemistry. 4 Credits. Introduction to the diverse field of RNA biochemistry. Prereq: CH 463 or BI 320.

CH 465. Physical Biochemistry. 4 Credits. Physical chemical properties of biological macromolecules; forces and interactions to establish and maintain macromolecular conformations; physical bases of spectroscopic, hydrodynamic, and rapid-reaction investigative techniques. Offered alternate years. Prereq: CH 461.

CH 466. Structural Biochemistry. 4 Credits. Protein and nucleic acid structures and energetics. Structure determination by x-ray crystallography and nuclear magnetic resonance. Computational methods for structural analysis. Offered alternate years. Prereq: CH 461.

CH 467. Biochemistry Laboratory. 4 Credits. Methods of modern molecular biology and protein purification. Prereq: CH 461

Geology courses:

GEOL 471. Thermodynamic Geochemistry. 4 Credits. Introduction to geologic application of classical chemical thermodynamics. Gibbs free energy and its temperature, pressure, and composition derivatives; fugacity, activity, and chemical potential. Solutions, ideal and nonideal. Prereq: GEOL 311 or 332, CH 223, MATH 253.

GEOL 472. Aqueous-Mineral-Gas Equilibria. 4 Credits. Aqueous chemistry applied to natural waters (geothermal, diagenetic, continental brines). Equilibrium calculations applied to aqueous-mineral-gas systems. Prereq: CH 223; MATH 252.

GEOL 473. Isotope Geochemistry. 4 Credits. Introduction to nuclear physics and isotope systematics; techniques of isotope analysis; applications of stable and radioactive isotopes in geochronology and as tracers of geological processes.

Please note: Be careful when choosing non-Chemistry 410 courses. Only the 410 course with the title below has been approved as an advanced elective for the Chemistry degree.

Physics courses:

PHYS 410. Math Methods II. 4 Credits. The primary goal of the course is provide the mathematical background necessary for a 400-level or graduate course in quantum mechanics. We will start by covering linear algebra of finite spaces. We will then move to the heart of the course: Vector spaces of functions and how a certain class of differential equations - those often appearing in physics - are connected to the function spaces. If time permits, we will also do a quick overview of complex analysis. Pre-requisite: Vector calculus, ordinary differential equations.

PHYS 410. Modern Optics Lab. 4 Credits. Physics 410/510 is a laboratory only course designed to familiarize students with many aspects of modern optics, laboratory electronics, and instrumentation. Each student, working as part of a team, will work through four of the experiments available in the laboratory. Teams will therefore have four 2-hour laboratory sessions to complete the work on each experiment.

PHYS 410. Scientific Computation. 4 Credits. The goal of this course is to build a strong foundation for scientific computation. With a particular emphasis on data science applications, we will cover tools and techniques useful for conducting computationally demanding science.

PHYS 410 Writing Science. 4 Credits. In Writing Science, you will learn to make your science come alive through vivid storytelling. The course will help you develop practical and structured writing skills useful for publishing in peer-reviewed journals, undergraduate and PhD theses, popular scientific reporting, scholarships and grants (e.g. NSF GRFP), and any situation where it is vital to communicate an idea. Furthermore, Writing Science will help you integrate science writing into well-motivated, inspired science. The techniques developed in Writing Science will also be applied to other areas of communication, like oral presentations, posters, and nonscientific writing. Although Writing Science is most appropriate for undergraduate and graduate students who are actively engaged in scientific research, all students are welcome and will benefit from the course. Prereq: none

PHYS 411. Mechanics, Electricity, and Magnetism. 4 Credits. Fundamental principles of Newtonian mechanics, conservation laws, small oscillations, planetary motion, systems of particles. Electromagnetic phenomena. Series. Prereq: MATH 282.

PHYS 412. Mechanics, Electricity, and Magnetism. 4 Credits. Fundamental principles of Newtonian mechanics, conservation laws, small oscillations, planetary motion, systems of particles. Electromagnetic phenomena. Series. Prereq: MATH 281.

PHYS 413. Mechanics, Electricity, and Magnetism. 4 Credits. Fundamental principles of Newtonian mechanics, conservation laws, small oscillations, planetary motion, systems of particles. Electromagnetic phenomena. Series. Prereq: PHYS 412.

PHYS 414. Quantum Physics. 4 Credits. Planck's and de Broglie's postulates, the uncertainty principle, Bohr's model of the atom, the Schroedinger equation in one dimension, the harmonic oscillator, the hydrogen atom, molecules and solids, nuclei and elementary particles. Sequence. Prereq: PHYS 413.

PHYS 415. Quantum Physics. 4 Credits. Planck's and de Broglie's postulates, the uncertainty principle, Bohr's model of the atom, the Schroedinger equation in one dimension, the harmonic oscillator, the hydrogen atom, molecules and solids, nuclei and elementary particles. Sequence. Prereq: PHYS 414

Note: Check with the appropriate department to determine when any specific course will be offered.

* Other courses may be submitted for consideration and approval by the department