Chemistry

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Courses

CHEM 1020 Topics in General Chemistry
This course is designed to help students successfully transition from high school AP chemistry to the college level. It provides a general introduction to topics that entering freshmen typically find among the most difficult to master in a first-semester general chemistry course, including the nature and structure of the atom, quantum chemistry, and the nature of bonding. Students gain familiarity with the way in which a rigorous college chemistry course is taught and receive a realistic exposure to the nature of quizzes and exams. Problem sets, selected readings, and group problem-solving strengthen skills and facilitate learning. Prerequisites: two years of high school mathematics (including some familiarity with calculus nomenclature), one year each of high school chemistry and physics.
Credit 3 units. A&S IQ: NSM BU: SCI
Typical periods offered: Summer

CHEM 1030 Advanced Placement Chemistry I
The course permits the award of academic credit for advanced placement scores of 4 or 5.
Credit 3 units.

CHEM 1040 Advanced Placement Chemistry II
The course permits the award of academic credit for advanced placement score of 5.
Credit 3 units.

CHEM 1101 First-Year Opportunity: Why is Chemistry Called The Central Science?
In this course, we seek to answer that question by showing how chemistry is a thread that runs through many disciplines, including biology, physics, astronomy, geology, medicine and environmental science. We will learn about the many types of chemistry-oriented research that are conducted at WashU, along with presentations by several chemists who have gone on to use their chemistry degree in industry or in other adjacent fields. This is a terrific way to gain exposure about how to prepare your own academic pathway through many diverse fields, through using chemistry as a platform. In this first year opportunity seminar style course, we rely on active dialogue in the classroom, through questions and discussion. You can expect to learn about science communication tools and gain some practice with translating difficult science concepts to a broader audience. This will include short written assignments, but also can include graphical depictions of information and data (tools that may be understood well for science outreach or for professional uses of social media.)
Credit 1 unit. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

CHEM 1102 Chemistry for Concerned Citizens: Topics in Energy, the Environment, and More
This course is designed to provide an overview of chemistry as it relates to problems in environmental science, energy, and related topics. It is constructed such that all students, irrespective of their major area of study, can learn about chemistry in these contexts. The course is intended to be highly interdisciplinary; therefore, it will cover subjects including chemistry, physics, engineering, geology, biology, environmental policy, and others.
Credit 3 units. A&S IQ: NSM, AN Art: NSM

CHEM 1103 First-Year Opportunity: Chemistry and Energy
This seminar is intended for first-year undergraduates to learn about the role that chemistry can play in addressing one of the greatest challenges we face: climate change. Chemistry has played a vital role in providing the energy needs of society, and advances in chemistry can help to develop abundant and economically viable energy technologies that do not have adverse consequences on the environment. Chemistry has long been central to the use of fossil fuel, and there remain opportunities to improve the efficiency of fossil energy resources, thereby contributing to lower carbon dioxide emission per unit of energy generated. Chemistry is critical to the development of renewable energy resources, especially solar energy for the generation of electricity and fuels. Material covered will include the challenges associated with meeting the world's increasing energy needs while reducing the emission of carbon dioxide. This class will cover the role of chemistry in energy technologies, including the storage of energy.
Credit 1 unit.
Typical periods offered: Fall

CHEM 1600 Topics in General Chemistry
This course is designed to help students successfully transition from high school AP chemistry to the college level. It provides a general introduction to topics that entering freshmen typically find among the most difficult to master in a first-semester general chemistry course, including the nature and structure of the atom, quantum chemistry, and the nature of bonding. Students gain familiarity with the way in which a rigorous college chemistry course is taught and receive a realistic exposure to the nature of quizzes and exams. Problem sets, selected readings, and group problem-solving strengthen skills and facilitate learning. Prerequisites: one year of high school chemistry, 2 years of highschool algebra.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

CHEM 1601 Principles of General Chemistry I
This course traces the development of chemistry from early atomic theory to modern descriptions of structure, bonding, and intermolecular interactions. Over the course of the semester, the students learn how macroscopic observations of stoichiometry, chemical reactions, the properties of elements and compounds, and chemical periodicity developed into the microscopic understanding of molecular structure and bonding. The semester begins with fundamentals related to stoichiometry, chemical reactions, solution chemistry, and gas properties, with an emphasis on quantitative problem solving. The octet rule, Lewis structures, and valence-shell-electron-pair repulsion (VSEPR) theory are then introduced as early efforts to describe the stability and structures of molecules. The localized electron model (LEM) and molecular-orbital theory (MOT) are next described as modern descriptions of chemical bonding. The course concludes with intermolecular forces such as hydrogen bonding and van der Waals interactions. This course will be a serious introductory series that requires and develops algebraic-computation and problem-solving skills.
Credit 3 units. A&S IQ: NSM, AN Art: NSM BU: SCI
Typical periods offered: Fall, Summer

CHEM 1602 Principles of General Chemistry II
This course covers chemical equilibrium, thermodynamics, and kinetics at a fundamental level, with an emphasis on in-class problem solving. Gas-phase reactions, heterogeneous (multi-phase) reactions, acid-base reactions, and solubility equilibria are introduced first. Chemical thermodynamics is then taught in its relation to chemical equilibrium. The course finishes with chemical kinetics and rate laws. The content is similar to that of Chem 1702, but advanced applications are omitted.
Credit 3 units. A&S IQ: NSM, AN BU: SCI
Typical periods offered: Spring, Summer

CHEM 1611 Peer-Led Team-Learning: Principles of General Chemistry I
This is an elective one-credit course that can only be taken concurrently with L07 Chem 105 Introductory General Chemistry I. The purpose of the course is to encourage students to work in small groups, supervised by a trained peer leader, on problems from the course that are designed to require a collaborative effort and to enhance understanding. PLTL sessions guide students to become conscious of the problem-solving process and to rigorously evaluate and revise those processes in light of the reasonableness of their results rather than an answer key. In this course, student groups facilitated by a peer leader meet weekly and work together on a problem set building on topics covered in the parent course, with the aim of developing problem-solving, critical-thinking, and collaboration skills. Sign-ups for PLTL begin in Week 1 of the semester, with meetings beginning on the weekend of Week 2. Students must attend at least nine sessions during the semester to earn credit; those who do not reach the attendance threshold will be dropped from the course, and the course will be removed from their transcript. To receive credit for PLTL, a student must remain enrolled in the parent course. Please note the following exceptions to the enrollment and drop policy: (1) Students will not be able to enroll in PLTL if doing so would bring them above 21 credit units, but they will still be able to participate. (2) Students who wish to participate in PLTL but want to opt-out of receiving credit should contact their course's program manager. (3) If dropping PLTL would bring a student below 12 credit units, the drop will be entered as a withdrawal instead.
Credit 1 unit.
Typical periods offered: Fall

CHEM 1612 Peer-Led Team-Learning: Introductory General Chemistry II
This is an elective 1-credit course that can only be taken concurrently with Chem 106 Introductory General Chemistry II. The purpose of the course is to encourage students to work in small groups, supervised by a trained peer leader, on problems from the course that are designed to require a collaborative effort and to enhance understanding. Peer-led team learning sessions guide students to become conscious of the problem-solving process and to rigorously evaluate and revise that process in light of the reasonableness of their results rather than an answer key. In this course, student groups facilitated by a peer leader meet weekly and work together on a problem set building on topics covered in the parent course, with the aim of developing problem-solving, critical-thinking, and collaboration skills. Sign-ups for PLTL begin in Week 1 of the semester, with meetings beginning on the weekend of Week 2. Students must attend at least nine sessions during the semester to earn credit; those who do not reach the attendance threshold will be dropped from the course, and the course will be removed from their transcript. To receive credit for PLTL, a student must remain enrolled in the parent course. Please note the following exceptions to the enrollment and drop policy: (1) Students will not be able to enroll in PLTL if doing so would bring them above 21 credit units, but they will still be able to participate. (2) Students who wish to participate in PLTL but want to opt-out of receiving credit should contact their course's program manager. (3) If dropping PLTL would bring a student below 12 credit units, the drop will be entered as a withdrawal instead.
Credit 1 unit.
Typical periods offered: Spring

CHEM 1701 General Chemistry I
Systematic treatment of fundamental chemical and physical principles and their applications to the properties and transformations of materials, including the concept of energy and its uses, atomic and molecular structure, periodic classification of the elements, chemical bonding, gas laws, and laws of chemical combination. Pre-requisite: AP Chemistry, or two years of high-school chemistry, or one school of high school chemistry and one year of high school physics. Students can also enroll by permission of the instructors.
Credit 3 units. A&S IQ: NSM, AN Art: NSM BU: SCI
Typical periods offered: Fall

CHEM 1702 General Chemistry II
An introduction to the principles of chemical equilibrium and chemical change. Topics include chemical equilibria, acid/base chemistry, and other ionic equilibria, electrochemistry, elementary chemical thermodynamics and kinetics. Three lecture hours and a problem-solving subsection.
Credit 3 units. A&S IQ: NSM, AN Art: NSM BU: SCI
Typical periods offered: Spring

CHEM 1711 Peer-Led Team-Learning: General Chemistry I
This is an elective one-credit course that can only be taken concurrently with L07 Chem 111A General Chemistry I. The purpose of the course is to encourage students to work in small groups, supervised by a trained peer leader, on problems from the course that are designed to require a collaborative effort and to enhance understanding. PLTL sessions guide students to become conscious of the problem-solving process and to rigorously evaluate and revise those processes in light of the reasonableness of their results rather than an answer key. In this course, student groups facilitated by a peer leader meet weekly and work together on a problem set building on topics covered in the parent course, with the aim of developing problem-solving, critical-thinking, and collaboration skills. Sign-ups for PLTL begin in Week 1 of the semester, with meetings beginning on the weekend of Week 2. Students must attend at least nine sessions during the semester to earn credit; those who do not reach the attendance threshold will be dropped from the course, and the course will be removed from their transcript. To receive credit for PLTL, a student must remain enrolled in the parent course. Please note the following exceptions to the enrollment and drop policy: (1) Students will not be able to enroll in PLTL if doing so would bring them above 21 credit units, but they will still be able to participate. (2) Students who wish to participate in PLTL but want to opt-out of receiving credit should contact their course's program manager. (3) If dropping PLTL would bring a student below 12 credit units, the drop will be entered as a withdrawal instead.
Credit 1 unit.
Typical periods offered: Fall

CHEM 1712 Peer-Led Team-Learning: General Chemistry II
This is an elective one-credit course that can only be taken concurrently with Chem 112A General Chemistry II. The purpose of the course is to encourage students to work in small groups, supervised by a trained peer leader, on problems from the course that are designed to require a collaborative effort and to enhance understanding. Peer-led team learning sessions guide students to become conscious of the problem-solving process and to rigorously evaluate and revise that process in light of the reasonableness of their results rather than an answer key.

In this course, student groups facilitated by a peer leader meet weekly and work together on a problem set building on topics covered in the parent course, with the aim of developing problem-solving, critical-thinking, and collaboration skills. Sign-ups for PLTL begin in Week 1 of the semester, with meetings beginning on the weekend of Week 2. Students must attend at least nine sessions during the semester to earn credit; those who do not reach the attendance threshold will be dropped from the course, and the course will be removed from their transcript. To receive credit for PLTL, a student must remain enrolled in the parent course. Please note the following exceptions to the enrollment and drop policy: (1) Students will not be able to enroll in PLTL if doing so would bring them above 21 credit units, but they will still be able to participate. (2) Students who wish to participate in PLTL but want to opt-out of receiving credit should contact their course's program manager. (3) If dropping PLTL would bring a student below 12 credit units, the drop will be entered as a withdrawal instead.

Credit 1 unit. BU: SCI

Typical periods offered: Spring

CHEM 1751 General Chemistry Laboratory I

This course provides an introduction to basic laboratory techniques, the experimental method, and the presentation of scientific data, as well as direct experience with chemical principles and the properties and reactions of substances. The topics and experiments in this course complement the material covered in the first semester General Chemistry lecture courses.

Credit 2 units. A&S IQ: NSM Art: NSM

Typical periods offered: Fall, Summer

CHEM 1752 General Chemistry Laboratory II

Continuation of General Chemistry Laboratory I. The topics and experiments in this course complement the material covered in the second semester General Chemistry lecture courses.

Credit 2 units. A&S IQ: NSM Art: NSM

Typical periods offered: Spring, Summer

CHEM 1801 Introductory General Chemistry I PB

This course covers the systematic treatment of fundamental chemical principles and their applications. Emphasis is on atomic and molecular theories, laws of chemical combination, periodic classification of the elements, and properties of gases, liquids, solids, and solutions. Prerequisites: Math U20 141 and Math U20 142 or equivalent, one year of high school chemistry, or permission of department. This course is restricted to students admitted to the Post-Baccalaureate Premedical Program or in University College. All other students should enroll in Chem 105 or Chem 111.

Credit 3 units. BU: SCI

Typical periods offered: Fall

CHEM 1802 Introductory General Chemistry II PB

Continuation of L07-125 General Chemistry I PB. Considers oxidation-reduction, chemical equilibria, electro-chemical cells, and the chemistry of representative elements. Prerequisite: L07-125. Students desiring to satisfy lab science requirements must also enroll in L07-156. This course is restricted to students admitted to the Post-Baccalaureate Premedical program or the School of Continuing & Professional Studies. Others may register with instructor permission, and on a space available basis.

Credit 3 units. BU: SCI

Typical periods offered: Spring

CHEM 1851 General Chemistry Laboratory I PB

This course provides an introduction to basic laboratory techniques and the experimental method as well as direct experience with chemical principles and the properties and reactions of substances. The topics and experiments in this course complement the material covered in Chem 125. Prerequisite: Concurrent enrollment in Chem 125 or permission of instructor. The first two lab lectures will be longer than the regular lectures, but without lab session. The lab sessions will convene for the first time beginning with the third class meeting. This course is restricted to students admitted to the Post-Baccalaureate Premedical program or in the School of Continuing & Professional Studies. All other students should enroll in Chem 151.

Credit 2 units. Art: NSM

Typical periods offered: Fall

CHEM 1852 General Chemistry Laboratory II PB

Continuation of L07-155 Chem Lab I PB. Topics and experiments complement the material covered in the L07-126 lecture course. Students attend a three-hour laboratory session and a one-hour laboratory lecture. Prerequisite: concurrent enrollment in L07-126, or permission of the instructor. This course is restricted to students admitted to the Post-Baccalaureate Premedical program or the School of Continuing & Professional Studies. Others may register with instructor permission, and on a space available basis.

Credit 2 units.

Typical periods offered: Spring

CHEM 1900 First-Year Research

This course presents an introduction to research for first- and second-year students. Students are mentored by a faculty advisor. Prerequisite: Permission of the sponsor and the Department of Chemistry. Credit/no credit only.

Credit 0.5-3 units. A&S IQ: NSM Art: NSM

Typical periods offered: Fall, Spring

CHEM 1996 Chemistry Elective: 100-Level

Course used for transcribing 1000-level elective CHEM units.

Credit 3 units.

Typical periods offered: Fall, Spring, Summer

CHEM 2501 Organic Chemistry I

Code for transfer credit equivalent to lecture portion of Organic Chemistry I

Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

Typical periods offered: Fall, Summer

CHEM 2502 Organic Chemistry II

Code for transfer credit equivalent to lecture portion of Organic Chemistry II

Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

Typical periods offered: Spring, Summer

CHEM 2551 Organic Chemistry Laboratory I

Code for transfer credit equivalent to lab portion of Organic Chemistry I

Credit 1 unit. A&S IQ: NSM

Typical periods offered: Fall

CHEM 2552 Organic Chemistry Laboratory II

Code for transfer credit equivalent to lab portion of Organic Chemistry II

Credit 1 unit.

Typical periods offered: Spring

CHEM 2561 Organic Chemistry I With Lab
This is the first part of a two-semester survey of organic chemistry. The course will include an introduction to organic structures, reactions, and reaction mechanisms. The laboratory will meet on alternate weeks and include an introduction to laboratory methods in organic chemistry, including separation and methods of purification of organic compounds. Prerequisites: Chem 106 or Chem 112 and Chem 152.
Credit 4 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall, Summer

CHEM 2562 Organic Chemistry II With Lab
A course covering certain areas of organic chemistry in more detail than the prerequisite course, with special emphasis on the mechanisms and the synthetic applications of organic reactions and on the organic chemistry of biological compounds. The laboratory will meet eight times and include organic synthesis and spectroscopic techniques. Required course for chemistry majors.
Credit 4 units. A&S IQ: NSM Art: NSM
Typical periods offered: Spring, Summer

CHEM 2566 Organic Chemistry Problem Solving Workshops II
The workshops for Organic Chemistry II, CHEM 262, aim at helping students master the fundamental key concepts, following the lecture schedule, in a collaborative learning enrollment. The focus of the workshops is problem solving and creative/critical thinking. The workshop problem sets are designed based on the topics discussed in the lecture. Corequisite: Concurrent enrollment in CHEM 262
Credit 1 unit.
Typical periods offered: Spring

CHEM 2811 Organic Chemistry I PB (Lecture Only)
This is the lecture-only version of the first part of a two-semester survey of organic chemistry. The course will include an introduction to organic structures, reactions, and reaction mechanisms. Prerequisites: Chem 126 and Chem 156. This course is restricted to students admitted to the Post-Baccalaureate Premedical program or in University College.
Credit 3 units. Art: NSM BU: SCI
Typical periods offered: Fall

CHEM 2812 Organic Chemistry II PB (Lecture Only)
This course is the lecture-only version of Chem 266, covering certain areas of organic chemistry in more detail than the prerequisite course, with special emphasis on the mechanisms and synthetic applications of organic reactions and on the organic chemistry of biological compounds. Prerequisites: Chem 265 or Chem 2651. This course is restricted to students admitted to the Post-Baccalaureate Premedical Program or in University College.
Credit 3 units. BU: SCI
Typical periods offered: Spring

CHEM 2821 Introduction to Medicinal Chemistry PB
This is an introductory course covering the basic concepts of drug structure, interactions and metabolism relevant to medicinal chemistry. The course will provide an understanding of the structure and physicochemical properties of drugs and their targets and how these determine the drug's mechanism of action and the body's response. In addition, basic concepts of drug design and development will be covered. Prerequisites: A background in general chemistry is required. Knowledge of organic or biochemistry is not required. Organic and biochemistry concepts needed for an understanding of the material will be taught as part of the course. Priority given to students enrolled in the Post-Baccalaureate Premedical program or in the School of Continuing & Professional Studies.
Credit 3 units. BU: SCI
Typical periods offered: Fall, Spring

CHEM 2851 Organic Chemistry I With Lab PB
This is the first part of a two-semester survey of organic chemistry. The course will include an introduction to organic structures, reactions, and reaction mechanisms. The laboratory portion of the course will have eight experiments and include an introduction to laboratory methods in organic chemistry, including separation and methods of purification of organic compounds. Prerequisites: Chem 126 and Chem 156. This course is restricted to students admitted to the Post-Baccalaureate Premedical program or in University College. All other students should enroll in Chem 261.
Credit 4 units. Art: NSM BU: SCI
Typical periods offered: Fall

CHEM 2852 Organic Chemistry II W/ Lab PB
A course covering certain areas of organic chemistry in more detail than the prerequisite course, with special emphasis on the mechanisms and synthetic applications of organic reactions and on the organic chemistry of biological compounds. The laboratory meets eight times and includes organic synthesis and spectroscopic techniques. Prerequisite: Chem 265. This course is restricted to students admitted to the Post-Baccalaureate Premedical Program or in University College. All other students should enroll in Chem 262.
Credit 4 units. BU: SCI
Typical periods offered: Spring

CHEM 2991 Chemical Laboratory Safety
This course presents an overview of current laboratory safety, regulatory, and compliance practices. Safety and compliance issues that impact chemical, biological, and materials research will be covered.
Credit 0.5 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

CHEM 2996 Chemistry Elective: 200-Level
Credit 3 units.

CHEM 3996 Chemistry Elective: 300-Level
Credit 3 units.

CHEM 4001 Physical Science in 12 Problems
Exercises related to general chemistry, classical mechanics, quantum mechanics, statistical mechanics, thermodynamics, and kinetics, will be solved with numerical software. Each exercise will be accompanied by a lecture, a software template solving a problem and presenting a related take-home problem. The software will allow us to focus on, and treat in a transparent fashion, physical problems without the unworldly idealizations and contrivances found in textbooks.
Credit 1 unit. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

CHEM 4010 Physical Chemistry I
Introduction to quantum chemistry with applications to electronic structure and elementary spectroscopy. Prerequisites: Chem 106/112A and Math 233; prior completion of Physics 191 and 192 is strongly encouraged (but concurrent enrollment in Physics I will be accepted); or permission of instructor. Required course for all Chemistry majors.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall

CHEM 4020 Physical Chemistry II
This course presents an introduction to chemical thermodynamics, statistical mechanics, and transport phenomena, and it is a required course for all Chemistry majors. Prerequisites: Chem 401, and Math 233; or permission of instructor. Prior completion of Physics 192/194 is strongly encouraged, but prior completion of Physics 191/193 and concurrent enrollment in Physics 192/194 will be accepted.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Spring

CHEM 4030 Chemical Kinetics
This lecture course will provide an introduction to the kinetics of chemical reactions for graduate and upper-level undergraduate science and engineering students. Bulk and molecular-level considerations will be discussed and provide a foundation for the understanding of chemical reaction mechanisms and the techniques used for their study. Students will gain an understanding of the importance and significance of the rate laws of reactions and in particular the reaction rate constant. Details of how the environment in which reactions occur (i.e., gas phase, solution phase, and surface reactions) and molecular structure are reflected in the rate constant will be discussed. Examples such as catalytic loss cycles in the atmosphere, enzyme catalysis, combustion systems, chain reactions, and explosions are presented in detail to illustrate how the fundamental principles of chemical kinetics can be applied to predict reaction rates, chemical reactivity, and the outcomes of particular processes. Prerequisites: Chem 106/112A and/or permission of instructor.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall, Spring

CHEM 4035 Nuclear and Radiochemistry Lab
Application of radiochemistry to problems in chemistry, physics, and nuclear medicine, with emphasis on particle detectors and experimental techniques. Prerequisites: 3 units of physical chemistry or quantum mechanics, or permission of instructor. Five hours of laboratory a week.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall, Spring

CHEM 4036 Introduction to the Atomic Nucleus
Introduction to the interaction of radiation with matter, the production and decay of radioactive nuclides, the structure and properties of nuclei, and various applications of nuclear science (including nuclear power) are all presented. Lectures will be in-person but a complete set of taped lectures will also be available. A weekly, in-person or remote, help session will be scheduled at a mutually agreed to time. There will be about 6 timed quizzes, one midterm and one final, all of which must be taken in-person on mutually agreed dates.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall, Spring

CHEM 4050 Computational Problem Solving in the Chemical Sciences
Have you ever wondered how molecular interactions shape the world around us? Why do certain materials exhibit unique properties? How can we predict and manipulate chemical reactions at the atomic level? These are the mysteries at the heart of chemistry, where understanding the unseen world of atoms and molecules can unlock groundbreaking advances in science and technology. However, one needs specialized numerical methods and computational chemistry skills to explore these questions. This course is designed to bridge this gap. It provides a comprehensive introduction to the mathematical and computational skills necessary to model chemical phenomena at the atomic level. We start by building a strong foundation in mathematical representations of chemical problems, utilizing open-source software tools for problem-solving, data interpretation, and visualization of materials and molecular structures. In the second part of the course, we delve into the fascinating world of atomic-level computer modeling. You'll learn various methodologies, such as Monte Carlo and molecular dynamics. We'll analyze static (thermodynamic and structural) and dynamic properties and their statistical errors. Don't worry if you're new to coding - we'll cover the basics of Python programming in the first few lectures, setting you up for success. By the end of this course, you will be proficient in using computational tools, understanding atomic interactions, and approaching chemical problems with a structured and strategic thought process. Join us to unlock the secrets of the molecular world and transform the way you see chemistry!
Credit 3 units. A&S IQ: NSM
Typical periods offered: Fall

CHEM 4079 Instrumental Methods: Physical Chemistry
A course providing direct hands-on experience with the principles of physical chemistry (thermodynamics, quantum, kinetics) and associated experimental methods and instrumentation, including optical, infrared, and nuclear and electron spin resonance, electrochemistry, calorimetry, laser kinetics, and basic electronics. Prerequisite: Chem 401 or concurrent enrollment in Chem 402.
Credit 3 units. A&S IQ: NSM, WI Art: NSM
Typical periods offered: Spring

CHEM 4101 Special Topics in Physical Chemistry
This course is an overview of instrumentation and techniques that are found in modern chemistry laboratories. We shall cover the design of experiments, including basic electronics, signal-to-noise considerations and signal handling. We shall also discuss the applications of a wide variety of spectroscopies, imaging techniques, surface analytical techniques, mass spectrometry and NMR. This course will be of interest to students who expect to pursue chemical research involving modern physical measurements and who wish to understand the fundamental principles behind complex analytical instrumentation. In detail, topics covered will be: 1. Physical Chemistry for Spectroscopy: Electromagnetic Spectrum; Molecular Energy Levels. 2. Signal-to-Noise: Different sources e.g. Shotky, Flicker, Johnson, interference, background radiation. 3. Basic Electronics: Kirchoff's Laws, impedance, capacitance, diodes, op-amps, filters, oscilloscopes. 4. Experimental Considerations: Light sources, magnetic fields, detectors, signal handling, vacuums. 5. CW Spectroscopies: IRS, Raman, Rayleigh Scattering, flourescence, UV-Vis. 6. Lasers: types, Q-switching, laser spectroscopies. 7. Imaging: SEM, TEM, NSOm. 8. Surface techniques: AES, WPS, RAIRS, HREELS, STM, AFM. 9. Mass Spectrometry. 10. NMR.
Credit 3 units. Art: NSM
Typical periods offered: Fall, Spring

CHEM 4510 Organic Chemistry III
A lecture course that builds on the material in the first two semesters of Organic Chemistry, covering in more detail certain topics in those courses while also introducing new topics. A transition to graduate-level study in organic chemistry; recommended for chemistry, biochemistry, and biology majors.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

CHEM 4511 Synthetic Polymer Chemistry
This course describes various methods for the synthesis and characterization of polymers. Copolymers, control of architecture, polymer reactivity, polymer properties, structure/property relationships, and applications of polymers will be discussed. Current topics of interest from the recent literature will also be covered.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Spring

CHEM 4521 Physical Organic Chemistry
The goal of physical organic chemistry is to understand the details of reaction mechanisms, and gain insight into structures and reactivity common to organic chemicals and of high-energy chemical intermediates. This course focuses on the structure of any intermediates, the extent of a reaction from the perspective of the transition state, and identifying the relative energies of reactants, products, intermediates, and transition states. Students will learn concepts needed to solve mechanistic organic problems encountered in research, covering common organic reaction mechanisms, experimental techniques, and theoretical approaches. After the course, students will be able to design experiments to probe mechanistic questions and propose reasonable mechanisms and intermediates to explain experimental observations.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall

CHEM 4523 Organic & Inorganic Reaction Mechanisms
This course covers the fundamentals of the study of the mechanisms of reactions of organic, organometallic, and inorganic molecular compounds, primarily in the solution phase, and it surveys examples through case studies. A basic knowledge of organic chemistry is assumed. Prerequisites: Grade of B- or better Chem 261 and Chem 262 or the equivalent.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Spring

CHEM 4530 Spectral Methods in Organic Chemistry
A detailed treatment of the structure and stereochemistry of organic compounds with particular emphasis on ultraviolet, visible, infrared, nuclear magnetic resonance, and mass spectroscopic techniques for structure determination. Prerequisite: Chem 262 or permission of instructor.
Credit 3 units.
Typical periods offered: Spring

CHEM 4531 Computational Chemistry and Molecular Modeling
Lectures will cover the background, practice and applications of computational chemistry to the modeling of the structures and chemical reactions of organic molecules. Different levels of calculation will be presented, from molecular mechanics calculations and Hhckel molecular orbital theory, through semi-empirical and ab initio self-consistent field calculations with correlation energy corrections, and density functional theory. Hands-on experience performing calculations is an important element in this course.
Credit 3 units. A&S IQ: NSM, WI Art: NSM

CHEM 4559 Advanced Organic Chemistry Laboratory
Initially, problem solving in organic chemistry is emphasized through an introduction to the methods of qualitative organic analysis, including the use of chromatographic and spectroscopic techniques. Each student then selects an independent synthetic project to perform. Prerequisite, Chem 262. Six laboratory hours per week. Lectures held three hours a week for the first half of the semester.
Credit 4 units. A&S IQ: NSM, WI Art: NSM
Typical periods offered: Fall

CHEM 4570 Synthetic Polymer Chemistry Laboratory
An upper-level undergraduate laboratory course that complements Chem 4511 Synthetic Polymer Chemistry. This twice-a-week lab provides hands-on training in the design, synthesis, and characterization of polymers and polymeric materials through four standard experiments (each one week) and one independent project (over five to six weeks). The independent project involves using an article from the literature as the basis for developing a short proposal. At the end of the course, students give oral presentations of their proposals, which are reviewed by their classmates.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Spring

CHEM 4579 Synthetic Polymer Chemistry Laboratory -- Writing Intensive
An upper-level undergraduate laboratory course that complements Chem 4511 Synthetic Polymer Chemistry. This twice-a-week lab provides hands-on training in the design, synthesis, and characterization of polymers and polymeric materials through four standard experiments (each one week) and one independent project (over five to six weeks). The independent project involves using an article from the literature as the basis for developing a short proposal. At the end of the course, students give oral presentations of their proposals, which are reviewed by their classmates. This course satisfies the writing-intensive requirement.
Credit 3 units. A&S IQ: NSM, WI BU: SCI
Typical periods offered: Spring

CHEM 4610 Inorganic Chemistry
Inorganic chemistry encompasses the structure, properties, and reactivity of inorganic molecules and solids and it is a required course for all Chemistry majors. This course will focus on the symmetry, bonding, electronic structure, spectroscopy, and reactivity of inorganic coordination complexes in which ligands are bound to one or more metal centers. The course will start with using group theory to classify molecules based on the symmetry elements they possess. A series of different bonding models including VSEPR, valence bond theory, molecular orbital theory, crystal field theory, and ligand field theory will be used to describe the structure and bonding of inorganic molecules, coordination complexes, and organometallic compounds. These models will serve as a basis for interpreting and predicting the electronic and vibrational spectra of inorganic compounds.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall, Spring

CHEM 4611 Organometallic Chemistry
Survey of organometallic compounds with discussion of their synthesis, structure, spectroscopy, and reactivity. Prerequisite: Chem 262.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

CHEM 4620 Solid-State and Materials Chemistry
A description of how the structures of crystalline solids at different length scales control their chemical and physical properties is critical for understanding how these materials are applied in a variety of technologies ranging from solar cells to lithium batteries. This course begins with basic crystallography and introduces common inorganic structure types as well as common defects in crystalline solids. With the aid of computer models, students will learn to analyze and index x-ray powder-diffraction patterns that provide a fingerprint to identify a crystal. The relation between the crystal structure of a solid and its resulting electronic structure, chemical reactivity, and physical properties (e.g., optical, electrical, and mechanical) will be discussed throughout the semester with an emphasis on how crystal defects alter these properties. The course will conclude with the use of phase diagrams to assess the composition and microstructure of metals and ceramics. Prerequisite: Chem 105/111A or permission of instructor
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall, Spring

CHEM 4630 Inorganic Electrochemistry and Photochemistry
An understanding of electrochemical processes is critical in describing the behavior of batteries, fuel cells, and other important devices used in energy conversion and environmental remediation. This course will cover modern inorganic electrochemistry, photochemistry, and photoelectrochemistry from a microscopic perspective of solid-electrolyte interfaces. The course material will start with the thermodynamics of solid-electrolyte interfaces and the kinetics of electron transfer across these interfaces. Electroanalytical techniques, including cyclic voltammetry and potential-step experiments, will be described to understand the mechanism of electrochemical and photochemical reactions. Lectures will include applications of electrochemical cells in catalysis, materials synthesis, and solar-fuel generation. Prerequisites: Chem 461, or Chem 465, or consent of instructor.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

CHEM 4631 Inorganic Biochemistry
A class in biological chemistry that emphasizes the role of metals in electron transfer and enzymatic catalysis. After a brief survey of essential concepts from biology, coordination chemistry, and spectroscopy, topics will include: electron transfer systems; oxygen transport and activation; metal ion acquisition, transport, and homeostasis; enzymes catalyzing atom transfer reactions and radical-mediated processes. Prerequisite: Chem 262; Chem 461 recommended but not required.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Spring

CHEM 4670 Inorganic Chemistry Laboratory
A laboratory course emphasizing both the synthesis of inorganic compounds and the study of their physical properties. Laboratory exercises will introduce novel synthetic techniques including high-temperature synthesis and vacuum-line manipulations. Compounds will be spectroscopically characterized by UV-visible absorption, gas-phase infrared, and multinuclear and dynamic NMR spectroscopies. Measurements of electrochemical behavior, magnetic susceptibility, and electrical conductivity will be performed.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Spring

CHEM 4679 Inorganic Chemistry Laboratory -- Writing Intensive
A laboratory course emphasizing both the synthesis of inorganic compounds and the study of their physical properties. Laboratory exercises will introduce novel synthetic techniques including high-temperature synthesis and vacuum-line manipulations. Compounds will be spectroscopically characterized by UV-visible absorption, gas-phase infrared, and multinuclear and dynamic NMR spectroscopies. Measurements of electrochemical behavior, magnetic susceptibility, and electrical conductivity will be performed. This course satisfies the Writing Intensive requirement.
Credit 3 units. A&S IQ: NSM, WI Art: NSM
Typical periods offered: Spring

CHEM 4810 General Biochemistry I
Topics include the properties and structures of biomolecules, including amino acids, nucleotides, lipids, carbohydrates, proteins and nucleic acids. Additional topics include enzyme kinetics and mechanisms, membrane structure and properties, protein folding, an introduction to metabolism, oxidative phosphorylation and photosynthesis. This course is the first semester of an integrated two-semester sequence.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

CHEM 4820 General Biochemistry II
Biochemistry explores the chemistry of life processes at the molecular level. This course is the second semester of a two-semester General Biochemistry sequence. The first semester of the Biochemistry sequence covered the basics of the topic with an emphasis on the structures, functions, and interactions of biomolecules including proteins, nucleic acids, carbohydrates, and lipids. This second semester course will emphasize metabolism, the biosynthetic (anabolism) and degradation (catabolism) pathways that provide the energy of life and define the molecules associated with healthy and disease states.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Spring

CHEM 4821 Chemical Biology
This course is a survey of modern chemical biology focusing on the application of a broad array of chemical tools to biological problems. The course is roughly divided into four sections; biopolymers, computational methods and bioinformatics, tools for chemical biology, and applications of chemical biology. A mandatory discussion section accompanies the course and is used to review current and classical literature in the field. Prereqs: Chem 262 and Biol 2970, or permission of the instructor.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

CHEM 4830 Bioorganic Chemistry
This course presents a molecule-centered perspective on the current state of the art in antibiotic drug discovery and natural products chemistry. The molecular mechanisms of antibiotic drug action and pathogen resistance will be covered along with the biosynthetic origins of antibiotics from plants and microbes. The course is taught from the perspective of understanding how organic chemistry plays out in biological systems, with an emphasis on small organic molecules and enzymes. Curved arrow mechanisms will be used frequently in learning activities and assignments. A working knowledge of protein structure and function is helpful. Students are encouraged (but not required) to take General Biochemistry I and/or General Biochemistry II in preparation for this course. Students will be responsible for writing a review article on an assigned antibiotic molecule and presenting their paper to the class.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

CHEM 4831 Nucleic Acids
This course presents the structure, synthesis, properties, and interactions of nucleic acids and the design and synthesis of nucleic acid-based and/or targeted drugs, probes, and tools. Topics include primary, secondary, and tertiary structure; topological and thermodynamic properties; biological and chemical synthesis; DNA chips; PCR; site-directed natural and unnatural mutagenesis; chemical evolution (SELEX); ribozymes; phage display; carcinogen, drug, and protein interactions; affinity cleaving; ultraviolet light and ionizing radiation damage; DNA repair of mutagenesis; and the design and synthesis of anti-sense and anti-gene probes and drugs. Extensive use is also made of molecular modeling and the protein databank of nucleic acid structures. Prerequisites: Chem 261 and Chem 262 or equivalents.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

CHEM 4833 Protein Biochemistry
The focus of this course is protein biochemistry, and is intended to build upon General Biochemistry I. In this course we will focus on protein structure, folding, and techniques to purify and characterize protein activity. We will progress from initial studies to first understand

protein fold and function to current efforts to better characterize protein structure-function relationships. We will also highlight human diseases that are underpinned by protein misfolding. This course will focus on reading and understanding primary literature, including landmark papers along with more recent work. During the second half of the semester, each student will select a paper and prepare a written analysis of that paper. The student will then present the paper and lead a journal club style discussion of the paper.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall, Spring

CHEM 4839 Bioorganic Chemistry-- Writing Intensive
This course presents a molecule-centered perspective on the current state of the art in antibiotic drug discovery and natural products chemistry. The molecular mechanisms of antibiotic drug action and pathogen resistance will be covered along with the biosynthetic origins of antibiotics from plants and microbes. The course is taught from the perspective of understanding how organic chemistry plays out in biological systems, with an emphasis on small organic molecules and enzymes. Curved arrow mechanisms will be used frequently in learning activities and assignments. A working knowledge of protein structure and function is helpful. Students are encouraged (but not required) to take General Biochemistry I and/or General Biochemistry II in preparation for this course. Students will be responsible for writing a review article on an assigned antibiotic molecule and presenting their paper to the class. This course satisfies the Writing Intensive requirement.
Credit 3 units. A&S IQ: NSM, WI Art: NSM BU: SCI
Typical periods offered: Fall

CHEM 4840 Simulation in Chemistry and Biochemistry
This course explores a wide range molecular modeling techniques and applications of computational chemistry to problems in chemistry and biochemistry. Topics include ab initio quantum mechanics, semi-empirical MO theory, molecular mechanics, molecular dynamics simulation, coarse-grained models, electrostatic methods and biomolecular structure prediction. A major component of the course is weekly laboratory sessions using common software programs in the field, including Spartan, Q-Chem, Gaussian, VMD, TINKER, APBS, AutoDock, SDA7 and others. Many of the lab exercises target proteins, nucleic acids and other biological structures. As a final lab experience, students will complete an independent project using tools covered in the course.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Spring

CHEM 4842 Modern Medicinal Chemistry
The focus of this course in an overview of Modern Medicinal Chemistry from the selection of a therapeutic target through the FDA-approval process. Each aspect will be exemplified by examples of drugs currently in clinical use, or in late-stage development. One aspect of particular interest to synthetic chemists is the underlying development chemistry that often determines the competitive success of a product. Topics to be covered include peptidomimetic HIV protease inhibitors, topoisomerase inhibitors, HMGCoA-reductase inhibitors (Lipitor, etc.), receptor tyrosine-kinase inhibitors (Gleevac, etc.), a synthetic mimetic of superoxide dismutase, and several others depending on the interests of the participants. Students will be responsible for presenting to the class the synthetic routes developed for the discovery and commercialization of these drugs focusing on development chemistry. Prerequisite: Chem 262 or permission of the instructor.
Credit 3 units. A&S IQ: NSM Art: NSM

CHEM 4900 Introduction to Research
Third- and fourth-year students register for this course to perform research on a selected topic in chemistry. A student planning to register with a Department of Chemistry research mentor MUST obtain approval from that faculty member before registering, but a formal proposal is not required. For research experiences with mentors outside of the chemistry department, the student must submit the Chem 4900 Project Proposal Form, which identifies the faculty mentor and includes a short description of the proposed chemical research. The Chem 4900 Project Proposal Form, which is available on the chemistry department website, should be submitted to the director of undergraduate studies in the chemistry department for approval. Pass/No Pass only.
Credit 0.5-6 units. A&S IQ: NSM
Typical periods offered: Fall, Spring

CHEM 4950 Advanced Undergraduate Research in Chemistry
Registration for this course allows for advanced research mentored by a Department of Chemistry faculty member. Chemical research with a faculty member outside of the chemistry department may be allowed with prior approval. At the end of the semester, the mentor will chair a faculty committee to evaluate an oral presentation by the student, and a letter grade will be assigned. A concise written report may also be requested by the mentor or committee in addition to the oral examination. Before registration can be allowed, the student must fill out the Chem 4950 Application Form, available on the chemistry department website, and submit it to the director of undergraduate studies. This form includes a short description of the proposed research and a list of the committee members. This course may provide a Capstone Experience, but it does not fulfill the Writing Intensive requirement. The units earned may be applied as elective advanced credits toward a chemistry major with Latin honors eligibility. The course may be taken only once for credit.
Credit 3 units. A&S IQ: NSM
Typical periods offered: Fall, Spring

CHEM 4995 Chemistry Coursework Completed Abroad
Credit 0 units.

CHEM 4996 Chemistry Elective: 400-Level
Credit 3 units.