

CHEMISTRY (CHEM)

CHEM-150 General Chemistry: Foundations

Fall and Spring. Credits: 4

Introduces fundamental principles of chemistry and prepares students to begin study in inorganic, organic, and analytical chemistry at the intermediate level. Topics include quantitative relations in chemical reactions, elementary thermodynamics, and atomic and molecular structure. Emphasizes and supports the development of quantitative reasoning and argumentation skills. Includes laboratory.

Applies to requirement(s): Math Sciences

W. Chen, M. Gomez, R. Hems

Coreq: CHEM-150L.

Notes: This course is offered in both fall and spring semesters.

CHEM-160 Integrated Introduction to Biology and Chemistry

Fall. Credits: 4

This 8-credit course serves as a gateway to both the biology and chemistry core curricula. The course introduces and develops fundamental concepts in chemistry while also exploring the diverse range of strategies adopted by living systems to survive in different environments. This course prepares students for further study in chemistry and/or biology (Biology 200). Students must register for both Biology 160 and Chemistry 160 as well as a single lab section (listed under Chemistry 160). Recommended for students interested in completing pre-health requirements or advanced study in biochemistry or neuroscience, and for those students seeking an intensive experience in chemistry and biology.

Applies to requirement(s): Math Sciences

A. van Giessen

Restrictions: This course is limited to first-year students.

Coreq: BIOL-160 and CHEM-160L.

Notes: Students must co-enroll in BIOL-160 and CHEM-160 for a total of 8 credits; three 50 minute lectures, three 75 minute lectures, and one three-hour laboratory per week.

CHEM-199 Introduction to Research

Spring. Credits: 4

This seminar is for first-year students who have a strong interest in the chemical sciences and will help to prepare them for scientific research. Students will be exposed to various research topics through reading, discussing, presenting, and writing about primary literature and attending selected department seminars. Throughout the semester students will carry out one research-style project in order to gain experience with the multifaceted nature of scientific inquiry. To jump start their research career on campus, each student will arrange meetings with at least two science faculty followed by a presentation and a written description on the faculty members' research topics.

Applies to requirement(s): Meets No Distribution Requirement

W. Chen

Restrictions: This course is limited to first-year students.

Instructor permission required.

Prereq: CHEM-150 or CHEM-160.

Advisory: Interested students should complete the online application.

CHEM-202 Organic Chemistry I

Fall. Credits: 4

This course introduces the core principles of the language of organic chemistry and extends their use to the description of the behavior and reactivity of carbonyl containing functional groups. Topics include representation and naming, the use of various spectroscopic approaches to probe molecular structure, an overview of bonding models and molecular geometry, the development of mechanistic drawing, and the application of this mechanistic approach to the reactions of a wide range of carbonyl compounds. The accompanying laboratory course emphasizes the connections between the observable behavior of organic substances and their molecular structures. The laboratory curriculum introduces the essential techniques of preparation, purification, and spectroscopic analysis of organic compounds, with emphasis on both physical manipulations and their underlying chemical rationale.

Applies to requirement(s): Math Sciences

K. Broaders, D. Hamilton

Prereq: CHEM-150, or CHEM-160, or CHEM-101 and CHEM-201. Coreq: CHEM-202L.

CHEM-223 Chemical Measurement and Analysis

Spring. Credits: 4

This course serves as an introduction to quantitative analytical chemistry and measurement. Topics to be covered include: aqueous statistical and error analysis, titrimetric and gravimetric analysis, and sample preparation techniques. In the laboratory, students will apply techniques covered in lecture to quantitation of a variety of analytes, and they will also learn the fundamentals of method development and optimization.

Applies to requirement(s): Math Sciences

R. Hems, A. van Giessen

Prereq: CHEM-150 or CHEM-160. Coreq: CHEM-223L.

CHEM-224AR Lab in Analytical Chemistry: 'Art Analysis'

Not Scheduled for This Year. Credits: 2

This course introduces concepts of analytical chemistry under the theme of "Chemistry in Art." The topics of quantitative/qualitative chemical analysis and instrumental analysis are discussed through hands-on observation-based experiments, in collaboration with the Mount Holyoke College Art Museum. Experimental techniques such as gas chromatography, mass spectrometry, X-ray fluorescence, UV visible spectroscopy, infrared spectroscopy, and scanning electron microscopy are incorporated for the analysis of paintings and art objects.

Applies to requirement(s): Meets No Distribution Requirement

H. Jayathilake

Prereq: CHEM-202.

CHEM-231 Inorganic Chemistry

Spring. Credits: 4

An introduction to the chemistry of elements. Topics include atomic structure and periodicity, symmetry, bonding theory, chemistry of the main-group elements and coordination chemistry. Laboratory introduces computational, preparative, and spectroscopic techniques.

Applies to requirement(s): Math Sciences

D. Cotter, A. van Giessen

Prereq: CHEM-150 (or CHEM-160). Coreq: CHEM-231L.

Advisory: MATH-101 recommended.

CHEM-291 Scientific Illustration and Data Visualization*Fall. Credits: 4*

Doing experiments and gathering data are important, but far from the entirety of the scientific process. Understanding and communicating experimental outcomes often heavily rely on our ability to visually represent them. In this course, we will explore best practices for organizing and representing data, and learn how the choices we make influence the message our representations communicate. We will also develop a set of good design principles for scientific figures, and learn to prepare high quality plots and graphics for use in presentations, posters, reports, theses, and papers.

*Applies to requirement(s): Math Sciences**K. Broaders**Prereq: 8 credits in a STEM subject.***CHEM-295 Independent Study***Fall and Spring. Credits: 1 - 4*

In this class, students will acquire hands-on and/or applied experience in diverse aspects of the research process in any field of Chemistry under the direction and supervision of a faculty advisor. Typically, these projects are related to the research program of the advisor. Student experiences often include: familiarizing themselves with a research topic, generating interesting questions, designing experiments, acquiring technical and instrumentation skills, collecting and analyzing data, writing and/or presenting their results. To inquire about enrollment, students should fill out the application form available on the departmental website.

The application is generally available each semester with a deadline immediately following the advising period, and faculty meet before the end of the semester to place students in labs for the following semester. Enrollment into a research opportunity depends on lab capacity, often not all applications are able to be fulfilled. A single credit requires an average of 3 hours of work per week. (Note: Some faculty may require a set weekly meeting time for a portion of this class.)

*The department**Instructor permission required.*

Notes: Note: Students conducting an independent laboratory research project for course credit in a department, program, or laboratory covered by the College's chemical hygiene plan must participate in a safety training session before beginning research.

CHEM-302 Organic Chemistry II*Spring. Credits: 4*

This course provides a direct continuation of Organic Chemistry I (CHEM-202) and develops and extends many of the concepts and approaches developed therein. Topics include stereochemistry, substitution and elimination reactions, conformational analysis, addition reactions of multiple bonds, substitution reactions of aromatic systems, and a broad extension of the carbonyl chemistry introduced in the preceding class. Consideration will be given to the development of organic syntheses of specific materials and attendant issues of compatibility and selectivity in reaction choice. The scope and reach of the spectroscopic methods introduced in Organic Chemistry I will be extended and applied to structure determination. The accompanying laboratory course provides additional practice with the techniques of preparation, isolation, purification, and chemical and spectroscopic analysis of organic compounds. Mechanistic interpretation of results, in-depth analysis of spectroscopic data, and the development of synthetic protocols are areas of special emphasis.

*Applies to requirement(s): Math Sciences**D. Hamilton**Prereq: CHEM-202 with grade of C or better. Coreq: CHEM-302L.***CHEM-306 Analytical Chemistry***Not Scheduled for This Year. Credits: 4*

This course serves as an advanced course in analytical chemistry, with a combined emphasis on both classical analysis tools and commonly used instrumental techniques. Topics to be covered include figures of merit, statistical and error analysis, titrimetric and gravimetric analysis, and sample preparation techniques. Instrumental methods covered will include atomic/molecular spectroscopy, chromatography and mass spectrometry. In the laboratory, students will apply techniques covered in lecture to quantitation of analytes commonly seen in pharmaceutical, forensic, chemical and biological settings, and will also emphasize method development and optimization.

*Applies to requirement(s): Math Sciences**Other Attribute(s): Speaking-Intensive, Writing-Intensive**The department**Prereq: CHEM-231 and 4 credits in Mathematics. Coreq: CHEM-306L.***CHEM-308 Chemical Thermodynamics with Lab***Fall. Credits: 4*

A consideration of the contribution of thermodynamics to the understanding of the 'driving forces' for physical chemical changes and the nature of the equilibrium state. Topics will include statistical mechanics, thermodynamics, and kinetics.

*Applies to requirement(s): Math Sciences**M. Gomez**Prereq: MATH-203 or PHYS 205, and CHEM-223 or CHEM-231, all with grade of C or better. Coreq: CHEM-308L.***CHEM-309 Introduction to Materials***Fall. Credits: 4*

This integrated lecture/lab course provides an introduction to different types of materials, including metals, ceramics, polymers, and composites, emphasizing structure and property relationships. The principles behind the design and implementation of materials as well as advances in materials in the areas of nano-, bio-, and electronic technology will be presented. Class time is split among lecture, discussion, and laboratory.

*Applies to requirement(s): Math Sciences**W. Chen**Prereq: CHEM-231, CHEM-202, and MATH-101 Coreq: CHEM-309L.***CHEM-312 Chemistry of Biomolecules***Fall. Credits: 4*

An examination of the major ideas of biochemistry from the point of view of the chemical sciences rather than the life sciences. The focus will be on structure and reactivity of important biomolecules and the role of energetics and reaction dynamics in biochemical processes. Major metabolic pathways are covered, including those of proteins, carbohydrates, lipids, and nucleic acids.

*Crosslisted as: BIOCH-312**Applies to requirement(s): Math Sciences**K. Berry**Prereq: CHEM-202 with a grade of C or better.*

Advisory: This course is NOT intended for Biochemistry majors, who must take BIOCH-311 and BIOCH-314. CHEM-312 students may take BIOCH-318 concurrently.

CHEM-324 Atomic and Molecular Structure

Not Scheduled for This Year. Credits: 4

This course is an introduction to experimental and theoretical approaches to the determination of the structure of atoms, molecules, and chemical bonds. Classroom work provides background in the theory of atomic and molecular structure and an introduction to quantum mechanics and spectroscopy

Applies to requirement(s): Math Sciences

W. Chen

Prereq: MATH-203 or PHYS-205, and CHEM-231, all with grade of C or better.

CHEM-325 Atomic and Molecular Structure with Lab

Spring. Credits: 4

This course is an introduction to experimental and theoretical approaches to the determination of the structure of atoms, molecules, and chemical bonds. Classroom work provides background in the theory of atomic and molecular structure and an introduction to quantum mechanics and spectroscopy.

Applies to requirement(s): Math Sciences

W. Chen, A. van Giessen

Prereq: MATH-203 or PHYS-205, and CHEM-231, all with grade of C or better.

Coreq: CHEM-325L.

Advisory: MATH-203 is recommended.

CHEM-326 Poisons: Death by Chemistry

Spring. Credits: 4

This course uses a Problem-Based Learning approach to look at the effect of poisons at the molecular, cellular, and physiological levels from the chemistry and biochemistry perspective. We'll discuss: the classification of poisons and the common structural elements of the molecules within each class; the interaction of toxic molecules with proteins and nucleic acids present in the cell; the physiologic effect of toxins on different systems of the body; dosage effects and pharmacokinetics; the mechanisms by which antidotes work; and the analytical techniques that toxicologists use to determine which poisons are present in the body. The different classes of poisons will be discussed in the context of historical case studies.

Applies to requirement(s): Math Sciences

A. van Giessen

Prereq: Any 200-level Chemistry course.

CHEM-328 From Lilliput to Brobdingnag: Bridging the Scales Between Science and Engineering

Spring. Credits: 4

The performance of many engineered devices is dependent on macroscopic factors (pressure, temperature, flow, conductivity). As a result, engineers often model devices macroscopically considering atomistic level details only through fixed parameters. These parameters do not always capture the full atomistic level picture. More accurate multi-scale approaches for modeling macroscopic properties use basic atomistic level chemistry at key points in larger scale simulations. This course is an introduction to such approaches focusing on fuel cells as a concrete example. Through project/case studies, basic scientific principles will be developed along side of basic engineering principles.

Crosslisted as: PHYS-328

Applies to requirement(s): Math Sciences

Other Attribute(s): Writing-Intensive

M. Gomez

Prereq: MATH-102 and any chemistry or physics course.

CHEM-329 Cosmetic Chemistry

Spring. Credits: 4

This course will introduce the chemistry, formulation, and physical characteristics of personal care products. The topics will include basic skin physiology, hygiene products, adornment products for face, nail, and hair, as well as current trends and advances in cosmetic dermatology. An integral part of the course will involve hands-on experience in making and characterizing some common skincare and cosmetic products.

Applies to requirement(s): Math Sciences

W. Chen

Prereq: CHEM-302.

CHEM-330 Advanced Topics in Chemistry**CHEM-330RN Advanced Topics in Chemistry: 'The RNA World: The Origin of Life to Modern Cells'**

Fall. Credits: 4

RNA is believed by many to have been the first macromolecule to evolve. In a hypothesized "RNA world," RNA would have simultaneously served the roles of carrying genetic information and catalyzing chemical reactions within early cells. The past three decades have been a renaissance for RNA biology, as researchers have uncovered the critical role RNA plays in eukaryotic and bacterial gene regulation and defense, as well as the potential for RNAs to perform catalysis. This seminar will introduce students to modern approaches to study the structure and function of RNA and will explore the chemical and biological roles RNA plays in modern cells as well as its role in the origin of life.

Crosslisted as: BIOCH-330RN

Applies to requirement(s): Math Sciences

Other Attribute(s): Speaking-Intensive

K. Berry

Prereq: BIOCH-311, or BIOCH-314, or CHEM-312.

CHEM-334 Advanced Inorganic Chemistry

Not Scheduled for This Year. Credits: 4

The implications of molecular symmetry as expressed in the language of group theory are explored in some depth. Group theory provides the context for a discussion of the structural and spectroscopic properties of inorganic compounds, particularly those of the transition metals. Topics include molecular orbital theory, vibrational spectroscopy, and electronic spectroscopy.

Applies to requirement(s): Math Sciences

D. Cotter

Prereq: CHEM-231.

CHEM-336 Organic Synthesis

Spring. Credits: 4

This course emphasizes recent developments in synthetic organic chemistry and deals with general synthetic methods and specific examples of natural product synthesis. It covers such topics as new methods of oxidation and reduction, stereospecific olefin formation, ring-forming reactions, and methods of carbon-carbon bond formation. The application of these reactions to the synthesis of naturally occurring compounds is examined. A general strategy for the synthesis of complex molecules is also presented.

Applies to requirement(s): Math Sciences

K. Broaders

Prereq: CHEM-302.

CHEM-346 Physical Chemistry of Biochemical Systems With Lab

Not Scheduled for This Year. Credits: 4

This course provides an overview of the fundamental principles of physical chemistry with an emphasis on their application to the study of biological molecules and processes. Topics will include statistical mechanics, thermodynamics and enzyme kinetics. Discussion of applications will relate commonly used experimental techniques – such as spectroscopy and calorimetry – to the fundamental principles on which they are based. In addition, students will gain experience and confidence in the use of mathematical models to describe biochemical systems.

Applies to requirement(s): Math Sciences

W. Chen, A. van Giessen

Restrictions: This course is limited to Biochemistry and Chemistry majors only.

Prereq: MATH-203 or PHYS-205, and CHEM-231 or CHEM-306, all with a grade of C or better. Coreq: CHEM-346L.

CHEM-348 Using Data Science to Find Hidden Chemical Rules

Spring. Credits: 4

Chemists have always been interested in understanding patterns in their data. The scientific method uses observations to create theories and models to understand physical phenomena. Data science algorithms allow us to find unexpected patterns in chemical data. New chemical theories can be developed using a combination of data from either experiment or simulation, algorithms and physical insight. This class uses the case method providing three challenge problems to find hidden chemical rules from large chemical data sets through algorithms and physical insight. There will be lectures on the physical/chemical problems, the data sets, and the possible algorithms to consider before the teams of students tackle these problems. The teams will write papers on their findings and use the peer review process to improve their papers.

Applies to requirement(s): Math Sciences

Other Attribute(s): Writing-Intensive

M. Gomez

Prereq: MATH-102 and either any Chemistry or any Computer Science class.

CHEM-349 Food Chemistry: the Science of the Kitchen

Not Scheduled for This Year. Credits: 4

Food Chemistry is an integrated lecture/lab course that focuses on the molecular bases of chemical phenomena that dictate the behavior of foods. We will examine topics such as trans fats, baking soda as a leavening agent in baking, the chemical basis for ripening of fruit, pectin as a cellular glue, artificial sweeteners, GMOs, and enzymatic and non-enzymatic browning of foods. The emphasis is on the major food components (water, lipids, proteins, and carbohydrates) and their behavior under various conditions. Content will be discussed using a variety of contexts including primary scientific literature, mainstream media, and food blogs. Laboratories provide opportunities for students to observe, manipulate, and explore topics in food chemistry under conditions of particular relevance to food processing.

Applies to requirement(s): Math Sciences

K. McMenimen

Prereq: CHEM-302 with a grade of C or better.

CHEM-395 Independent Study

Fall and Spring. Credits: 1 - 8

In this class, students will acquire hands-on and/or applied experience in diverse aspects of the research process in any field of Chemistry under the direction and supervision of a faculty advisor. Typically, these projects are related to the research program of the advisor. Student experiences often include: familiarizing themselves with a research topic, generating interesting questions, designing experiments, acquiring technical and instrumentation skills, collecting and analyzing data, writing and/or presenting their results. To inquire about enrollment, students should fill out the application form available on the departmental website.

The application is generally available each semester with a deadline immediately following the advising period, and faculty meet before the end of the semester to place students in labs for the following semester. Enrollment into a research opportunity depends on lab capacity, often not all applications are able to be fulfilled. A single credit requires an average of 3 hours of work per week. (Note: Some faculty may require a set weekly meeting time for a portion of this class.)

The department

Instructor permission required.

Notes: See safety training restrictions in description of Chemistry 295