

# CHEMISTRY

The undergraduate degree in chemistry emphasizes knowledge and awareness of:

- The basic principles of chemistry—atomic and molecular theory, reactivities and properties of chemical substances and the states of matter.
- The basic subfields of chemistry—organic, physical, analytical and inorganic.
- Mathematics sufficient to facilitate the understanding and derivation of fundamental relationships and to analyze and manipulate experimental data.
- The basic principles of physics.
- Safe chemical practices, including waste handling and safety equipment.

In addition, students completing a degree in chemistry are expected to acquire the ability and skills to:

- Read, evaluate and interpret information on a numerical, chemical and general scientific level.
- Assemble experimental chemical apparatus, design experiments and use appropriate apparatus to measure chemical composition and properties.
- Communicate results of scientific inquiries verbally and in writing.

Course code for this program is CHEM.

## Bachelor's Degree

- Chemistry - Bachelor of Arts (BA) (<https://catalog.colorado.edu/undergraduate/colleges-schools/arts-sciences/programs-study/chemistry/chemistry-bachelor-arts-ba/>)

## Minor

- Chemistry - Minor (<https://catalog.colorado.edu/undergraduate/colleges-schools/arts-sciences/programs-study/chemistry/chemistry-minor/>)

## Faculty

While many faculty teach both undergraduate and graduate students, some instruct students at the undergraduate level only. For more information, contact the faculty member's home department.

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Birks, John  
Professor Emeritus

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## Courses

### CHEM 1011 (3) Environmental Chemistry 1

Introduces basic principles of chemistry with applications to current environmental issues including toxic chemicals, air and water pollution, energy sources and their environmental impact, and climate change resulting from the greenhouse effect. No credit given to chemistry or biochemistry majors for this course if students already have credit in any college-level chemistry course numbered 1113/1114 or higher.

**Additional Information:** GT Pathways: GT-SC2 -Natural Physical Sci:Lec Crse w/o Req Lab

Arts Sci Core Curr: Natural Science Sequence

Arts Sci Core Curr: Natural Science Non-Sequence

Arts Sci Gen Ed: Distribution-Natural Sciences

MAPS Course: Chemistry

MAPS Course: Natural Science

MAPS Course: Physics

### CHEM 1021 (4) Introductory Chemistry

For students with no high school chemistry or a very weak chemistry background. Remedies a deficiency in natural science MAPS requirements and prepares students for CHEM 1113 and CHEM 1114 or CHEM 1400 and CHEM 1401. No credit given to chemistry or biochemistry majors for this course if students already have credit in any college-level chemistry course numbered 1113/1114 or higher. Department enforced prerequisite: one year high school algebra or concurrent enrollment in MATH 1011.

**Additional Information:** GT Pathways: GT-SC1 - Natural Physical Sci:Lec Crse w/ Req Lab

Arts Sci Core Curr: Natural Science Non-Sequence

Arts Sci Core Curr: Natural Science Lab

Arts Sci Gen Ed: Distribution-Natural Sci Lab

Arts Sci Gen Ed: Distribution-Natural Sciences

MAPS Course: Natural Science Lab or Lab/Lec

**CHEM 1031 (4) Environmental Chemistry 2**

Applications of chemical principles to current environmental issues including acid rain, stratospheric ozone depletion, the Antarctic ozone hole, solar energy conversion and fuel cells, and the environmental consequences of nuclear war. Laboratory experience is included. No credit given to chemistry or biochemistry majors this course if students already have credit in any college-level chemistry course numbered 1113/1114 or higher.

**Requisites:** Requires prerequisite course of CHEM 1011 (minimum grade C-).

**Additional Information:** Arts Sci Core Curr: Natural Science Sequence  
Arts Sci Core Curr: Natural Science Lab  
Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 1113 (4) General Chemistry 1**

Intended for first-semester students whose academic plans require advanced work in chemistry. Subjects: components of matter, stoichiometry, classes of reactions, gases, thermochemistry, atomic structure, electron configuration, chemical bonding, molecular shapes, covalent bonding, organic compounds, intermolecular forces, equilibrium. Department enforced prerequisites: one year high school chemistry or CHEM 1021 (min grade C-); high school math through pre-calculus. Not recommended for students with grades below B- in CHEM 1021. Department enforced corequisite: CHEM 1114. Not open to engineering students with exception of EPEN majors.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 1400 or CHEN 1211

**Requisites:** AMEN, AREN, ASEN, CHEN, CSEN, CVEN, ECEN, EEEN, EVEN, MCEN, OPEN or CBEN majors are not allowed to take this class.

**Additional Information:** GT Pathways: GT-SC2 -Natural Physicl Sci:Lec Crse w/o Req Lab

Arts Sci Core Curr: Natural Science Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 1114 (1) Laboratory in General Chemistry 1**

Lab. Intended for first-semester students whose academic plans require advanced work in chemistry. Instruction in experimental techniques which coordinate with lecture topics in CHEM 1113. Department enforced prerequisites: one year high school chemistry or CHEM 1021 (min grade C-); high school math through pre-calculus. Not recommended for students with grades below B- in CHEM 1021. Department enforced corequisites: CHEM 1113 or CHEN 1201.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 1401 or CHEM 1221

**Requisites:** ASEN, ECEN, EEEN, EVEN, and MCEN majors may not enroll in this course.

**Additional Information:** GT Pathways: GT-SC1 - Natural Physcal Sci:Lec Crse w/ Req Lab

Arts Sci Core Curr: Natural Science Lab  
Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 1133 (4) General Chemistry 2**

Intended for second-semester students whose academic plans require advanced work in chemistry. Subjects: acid-base equilibria, buffers and titrations, thermodynamics, redox reactions, electrochemistry, transition elements and their coordination compounds, solubility/solubility equilibria, crystal field theory, kinetics, nuclear chemistry. Department enforced corequisite: CHEM 1134.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 2100

**Requisites:** Requires prerequisite courses of CHEM 1113 and CHEM 1114 or CHEM 1400 and CHEM 1401 or CHEN 1211 and CHEM 1221 or CHEN 1201 and CHEM 1114 or CHEN 1203 and CHEM 1221 (all minimum grade C-).

**Additional Information:** GT Pathways: GT-SC2 -Natural Physicl Sci:Lec Crse w/o Req Lab

Arts Sci Core Curr: Natural Science Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 1134 (1) Laboratory in General Chemistry 2**

Intended for second-semester students whose academic plans require advanced work in chemistry. Instruction in experimental techniques which coordinate with lecture topics in CHEM 1133. Department enforced corequisite: CHEM 1133.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 2101

**Requisites:** Requires prerequisite courses of CHEM 1113 and CHEM 1114 or CHEM 1400 and CHEM 1401 or CHEN 1211 and CHEM 1221 or CHEN 1201 and CHEM 1114 or CHEN 1203 and CHEM 1221 (all minimum grade C-).

**Additional Information:** GT Pathways: GT-SC1 - Natural Physcal Sci:Lec Crse w/ Req Lab

Arts Sci Core Curr: Natural Science Lab  
Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 1221 (1) Engineering General Chemistry Lab**

Meets general chemistry laboratory requirement for engineering students. Designed to illustrate chemical concepts and introduce basic techniques in chemical measurement and synthesis. Department enforced prerequisites: one year of high school chemistry or CHEM 1021 (min. grade C-) and high school algebra; B- in CHEM 1021 recommended.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 1114 or CHEM 1401

**Requisites:** Requires prerequisite course of CHEN 1211 or CHEM 1133 (minimum grade C-), or corequisite course of CHEN 1211 or CHEM 1133. Restricted to undergraduate engineering students and IUT On Track applicants.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 1400 (4) Foundations of Chemistry**

Covers core concepts in chemistry: nature of matter (atomic and molecular structure, bonding and macroscopic properties), transformations of matter (chemical reactivity), and quantifying chemical transformations (thermochemistry, thermodynamics and kinetics). Emphasizes critical thinking and cultivate core problem solving skills utilized by scientists. Intended for first semester CHEM/BCHM majors. Department enforced prerequisites: one year high school chemistry or CHEM 1021 (minimum grad C-) and high school math through pre-calculus. Not recommended for students with grades below B- in CHEM 1021. Department enforced corequisite: CHEM 1401.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 1113

**Requisites:** Restricted to Chemistry (CHEM) or Biochemistry (BCHM) majors only.

**Grading Basis:** Letter Grade

**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 1401 (1) Foundations of Chemistry Lab**

Coordinates with lecture topics in CHEM 1400. Intended for first-semester CHEM and BCHM majors. Emphasizes the development of hands-on practical laboratory skills, experimental design, data interpretation, problem solving and open inquiry. Department enforced prerequisites: one year high school chemistry or CHEM 1021 (minimum grad C-) and high school math through pre-calculus. Not recommended for students with grades below B- in CHEM 1021. Department enforced corequisite: CHEM 1400.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 1114 or CHEM 1221

**Requisites:** Restricted to Chemistry (CHEM) or Biochemistry (BCHM) majors only.

**Grading Basis:** Letter Grade

**Additional Information:** Arts Sci Core Curr: Natural Science Lab  
Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 2100 (4) Foundations of Chemistry 2**

Covers the energetic principles that determine when chemical reactions occur and the dynamic principles that determine how rapidly they will occur. Applications include ionic equilibria in solution (acids and bases, buffers and titrations), oxidation-reduction reactions, electrochemistry and chemical kinetics. These applications will be situated in a context of current research problems in areas such as renewable energy and atmospheric chemistry. Department enforced corequisite: CHEM 2101.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 1133

**Requisites:** Requires prerequisite courses of CHEM 1400 and CHEM 1401 (minimum grade C-) or CHEM 1113 and CHEM 1114 (minimum grade B) and prerequisite or corequisite of MATH 2300 or APPM 1360 (minimum grade C-).

**Additional Information:** Arts Sci Core Curr: Natural Science Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 2101 (1) Laboratory in Foundations of Chemistry 2**

Coordinates with the lectures topics in CHEM 2100. Emphasizes the acquisition of more advanced laboratory skills, experimental design, data interpretation and analysis. Department enforced corequisite: CHEM 2100.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 1134

**Requisites:** Requires prerequisite courses of CHEM 1400 and CHEM 1401 (minimum grade C-) or CHEM 1113 and CHEM 1114 (minimum grade B) and prerequisite or corequisite of MATH 2300 or APPM 1360 (minimum grade C-).

**Grading Basis:** Letter Grade

**Additional Information:** Arts Sci Core Curr: Natural Science Lab  
Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 3151 (3) Air Chemistry and Pollution**

Examines the composition of the atmosphere, and sources of gaseous and particulate pollutants: their chemistry, transport and removal from the atmosphere. Applies general principles to acid rain, smog and stratospheric ozone depletion. Department enforced prerequisite: two semesters of chemistry.

**Equivalent - Duplicate Degree Credit Not Granted:** ATOC 3500

**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 3251 (3) Sustainable Energy from a Chemistry Perspective**

Explores qualitative and quantitative chemical aspects of energy systems (production, transmission, storage, utilization) including fossil, wind, solar, nuclear and biomass energy. Applies chemical principles including composition, structure, bonding, physical properties, thermodynamics, equilibrium and kinetics to energy systems and sustainability, especially environmental implications. Describes the importance of energy to the chemical industries and society as a whole.

**Requisites:** Requires prerequisite course of CHEM 1133 and 1134 or CHEM 2100 and 2101 or CHEN 1211 and CHEM 1221 (all minimum grade C-).

**CHEM 3311 (4) Organic Chemistry 1**

Intended primarily for nonmajors. Topics include structure and reactions of alkanes, alkenes, alkynes, alkyl halides, and aromatic molecules; nomenclature of organic compounds; stereochemistry; reaction mechanisms and dynamics. Department enforced corequisite: CHEM 3321.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 3451

**Requisites:** Requires prerequisite course of (CHEM 1133 and CHEM 1134) or (CHEM 1400 and CHEM 1401) or (CHEM 2100 and CHEM 2101) or (CHEN 1211 and CHEM 1221) or (CHEN 1203 and CHEM 1221) (all minimum grade C-).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 3321 (1) Laboratory in Organic Chemistry 1**

Instruction in experimental techniques of modern organic chemistry emphasizing chemical separations and reactions of alkanes, alkenes, and aromatic compounds. Stereochemical modeling and the identification of organic unknowns by spectroscopic and chemical methods are also introduced. Department enforced corequisite: CHEM 3311 or CHEM 3451.

**Requisites:** Requires prerequisite course of (CHEM 1133 and CHEM 1134) or (CHEM 1400 and CHEM 1401) or (CHEM 2100 and CHEM 2101) or (CHEN 1211 and CHEM 1221) or (CHEN 1203 and CHEM 1221) (all minimum grade C-).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 3331 (4) Organic Chemistry 2**

Lect. and rec. Intended primarily for nonmajors. Topics include structure and reactions of alkyl halides, alcohols, ethers, carboxylic acids, aldehydes, ketones, and amines; introduction to the chemistry of heterocycles, carbohydrates, and amino acids; nomenclature of organic compounds; synthesis; and reaction mechanisms. Department enforced corequisite: CHEM 3341 or CHEM 3381.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 3471 or BCHM 3491

**Requisites:** Requires prerequisite courses of (CHEM 3311 or CHEM 3451) and CHEM 3321 (all minimum grade C-).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 3341 (1) Laboratory in Organic Chemistry 2**

Lab. Instruction in experimental techniques of modern organic chemistry emphasizing reactions involving alcohols, ketones, carboxylic acids, and their derivatives. Department enforced corequisite: CHEM 3331 or CHEM 3471 or BCHM 3491.

**Requisites:** Requires prerequisite courses of (CHEM 3311 or CHEM 3451) and CHEM 3321 (all minimum grade C-).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 3381 (2) Laboratory in Advanced Organic Chemistry**

Lab. Instruction in experimental techniques of modern organic chemistry, emphasizing chemical literature, advanced spectroscopy, and reactions involving organometallic compounds, microwave chemistry, and column chromatography. Multistep syntheses are also introduced, including an independent synthesis project.

**Requisites:** Requires prerequisite courses of (CHEM 3331 or CHEM 3471 or BCHM 3491) and CHEM 3341 (all minimum grade C-). Restricted to Chemistry (CHEM) or Biochemistry (BCHM) majors only.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 3451 (4) Organic Chemistry 1 for Chemistry and Biochemistry Majors**

Covers bonding, acidity, reaction mechanisms, nomenclature of organic compounds; stereochemistry; structure and reactions of aldehydes, ketones, and carboxylic acids and derivatives. Department enforced corequisite: CHEM 3321.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 3311

**Requisites:** Requires prerequisite courses of (CHEM 1133 and CHEM 1134) or (CHEM 1400 and CHEM 1401) or (CHEM 2100 and CHEM 2101) or (CHEM 1211 and CHEM 1221) or (CHEM 1203 and CHEM 1221) (all min grade C-). Restricted to Chemistry (CHEM) or Biochemistry (BCHM) majors

**Grading Basis:** Letter Grade

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 3471 (4) Organic Chemistry 2 for Chemistry Majors**

Covers Amines, alkylation reactions, additions to unsaturated C-C bonds, aromaticity, and aromatic reactivity, organic materials, biomolecules, nomenclature of organic compounds, reaction mechanisms. Department enforced corequisite: CHEM 3341.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 3331 or BCHM 3491

**Requisites:** Requires prerequisite courses of (CHEM 3311 or CHEM 3451) and CHEM 3321 (all minimum grade C-). Restricted to Chemistry (CHEM) or Biochemistry (BCHM) majors only.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 4011 (3) Modern Inorganic Chemistry**

Required course for chemistry majors. Introduces modern inorganic chemistry for undergraduates. Includes atomic structure, chemical periodicity, structure and bonding in molecules and crystals, reaction mechanisms, chemistry of selected main group and transition elements, and emphasis on catalyst, materials, bioinorganic, and organometallic systems.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 5011

**Requisites:** Requires prerequisite course of CHEM 3331 or CHEM 3471 or CHEM 3491 (minimum grade C-).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 4021 (3) Inorganic Laboratory**

One lect. and two 3-hour labs per week. Instruction in experimental techniques of modern inorganic chemistry. Includes syntheses and spectroscopic characterizations of transition metal and main group compounds, experience in manipulation of air sensitive compounds, and techniques involving unusual conditions of pressure or temperature.

**Requisites:** Requires prerequisite course of CHEM 4011 (minimum grade C-). Restricted to Chemistry (CHEM) or Biochemistry (BCHM) majors only.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 4141 (3) Environmental Water and Soil Chemistry**

Application of basic chemical principles to understanding the processes that determine the chemical composition of oceans, lakes, rivers, soils and sediments. Topics include air-water exchange; acid-base, redox, coordination, precipitation and dissolution, ion exchange and sorption reactions; nutrient chemistry; and the use of simple equilibrium and kinetic models for describing the chemistry of inorganic and organic species in air-water-soil systems.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 5141

**Requisites:** Requires prerequisite course of CHEM 2100 and CHEM 2101 or CHEM 1133 and CHEM 1134 (minimum grade C-). Restricted to students with 57-180 credits (Juniors or Seniors).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 4171 (3) Instrumental Analysis - Lecture and Laboratory 1**

Two Lect. and 3 hours of lab per week. Instruction and experience in using instrumental methods of chemical analysis to address problems in chemistry, biochemistry, industrial chemistry and environmental chemistry.

**Requisites:** Requires prerequisite course of CHEM 3331 or CHEM 3471 or CHEM 3491 and CHEM 3341 or CHEM 3381 and PHYS 1140 or CHEM 4400 or CHEM 4511 (minimum grade C-). Restricted to Chemistry (CHEM) or Biochemistry (BCHM) majors only.

**Grading Basis:** Letter Grade

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 4181 (3) Instrumental Analysis - Lecture and Laboratory 2**

Two lect. and 3 hours of lab per week. Instruction and experience in using instrumental methods of chemical analysis. Builds on material learned in CHEM 4171.

**Requisites:** Requires prerequisite course of CHEM 4171 (minimum grade C-). Restricted to Chemistry (CHEM) or Biochemistry (BCHM) majors only.

**Grading Basis:** Letter Grade

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab  
Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 4251 (3) Materials Chemistry and Properties**

Lec. Understanding of materials from chemistry perspective including metals, oxides, semiconductors and polymers. Basic description of chemical preparation of materials. Overview of fundamental properties of materials including structural, chemical, mechanical, thermal, electrical, and optical properties. Description of behavior of materials and various applications in modern technology. Discussion of materials characterization methods.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 5251

**Requisites:** Requires prerequisite course of CHEM 3331 or CHEM 3471 or CHEM 3491 and CHEM 4521 or CHEM 4531 (all minimum grade C-).

**CHEM 4261 (3) Organic Materials: Structures and Functions**

Overview of the preparation and functioning mechanism of novel organic materials that have recently been developed, including conductive polymers, 2-D macrocyclic structures, 3-D molecular cages, molecular machines/muscles/switches, fullerene derivatives and carbon nanotube composites. Emphasizes the use of organic and physical chemistry as tools to develop novel materials and probe their structure-property relationship.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 5261

**Requisites:** Requires prerequisite courses of CHEM 3331 or CHEM 3471 or CHEM 3491 and CHEM 4531 (all minimum grade C-).

**CHEM 4271 (3) Chemistry of Solar Energy**

Chemical principles of conversion of solar energy into electricity and fuels in molecular and semiconductor-based systems. Overview of solid-state electronic structure of materials and interfaces, light-matter interactions, principles of harvesting photoexcited currents and useful chemical species. Description of processes utilized in established and emerging solar energy technologies.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 5271

**Requisites:** Requires prerequisite courses of CHEM 3331 or CHEM 3471 or CHEM 3491 and CHEM 4531 (all minimum grade C-).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 4511 (3) Physical Chemistry 1**

Chemical thermodynamics and kinetics. Includes study of laws of thermodynamics, thermochemistry, entropy, free energy, chemical potential, chemical equilibria, and the rates and mechanisms of chemical reactions. Department enforced prereq or coreq., PHYS 1120 (minimum grade C-).

**Equivalent - Duplicate Degree Credit Not Granted:** BCHM 4400 and BCHM 5400

**Requisites:** Requires prereq courses of CHEM 1133 CHEM 1134 or CHEM 2100 CHEM 2101 or CHEM 1211 CHEM 1221 and MATH 2400 or APPM 2350 and PHYS 1110 or PHYS 1115 or PHYS 2020 (all minimum grade C-). Restricted to Chemistry (CHEM) or Biochemistry (BCHM) majors.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 4531 (3) Physical Chemistry 2**

Lect. Introduces the quantum theory of atoms, molecules and chemical bonding, and statistical thermodynamics. Includes principles of quantum mechanics and their application to atomic structure, molecular spectroscopy, symmetry properties, and the determination of molecular structure. Also includes principles of statistical mechanics and their applications to properties of gases, liquids, and solids.

**Requisites:** Requires prerequisite courses of CHEM 4511 and PHYS 1120 or PHYS 2020, and MATH 2400 or APPM 2350 (all minimum grade C-). Restricted to Chemistry (CHEM) or Biochemistry (BCHM) majors only.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 4555 (4) Theoretical and Computational Chemistry**

Explores computational methods to understand chemical systems. Topics include: atomic and molecular electronic structure calculations, Monte Carlo and molecular dynamics simulations and thermodynamic calculations. Not recommended for students with a grade below B- in the prerequisite course.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEM 5555

**Requisites:** Requires prerequisite course of CHEM 4531 (minimum grade C-).

**Grading Basis:** Letter Grade

**CHEM 4581 (1) Physical Chemistry Lab 1**

One 3-hour lab per week. Instruction in experimental techniques of modern physical chemistry. Experiments illustrate the fundamental principles of thermodynamics and chemical kinetics. Illustrates the material discussed in CHEM 4511.

**Requisites:** Requires prerequisite or corequisite course of CHEM 4511 (minimum grade C-). Restricted to Chemistry (CHEM) or Biochemistry (BCHM) majors only.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab

Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 4591 (2) Physical Chemistry Lab 2**

One lect. and one 3-hour laboratory every two weeks. a continuation of CHEM 4581, but may be taken concurrently with CHEM 4531.

Experiments illustrate the principles of quantum chemistry and spectroscopy discussed in CHEM 4531.

**Requisites:** Requires prerequisite courses of CHEM 4511 and CHEM 4581 (all minimum grade C-). Requires prerequisite or corequisite course of CHEM 4531 (minimum grade C-). Restricted to Chemistry (CHEM) or Biochemistry (BCHM) majors only.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sci Lab

Arts Sci Gen Ed: Distribution-Natural Sciences

**CHEM 4901 (1-6) Independent Study in Chemistry**

For undergraduate study. Department consent required. Repeatable up to 8 total credit hours.

**Repeatable:** Repeatable for up to 8.00 total credit hours.