

CHEMISTRY (CHEM)

CHEM 1000 - Foundations for General Chemistry (3 Credits)

This is a lecture- only course intended for students pursuing a degree in science or a health-related field. The course is designed for students who have never had a chemistry course or who have not taken general chemistry in 5+ years. Topics include the classification of matter, the Metric system, dimensional analysis, atomic theory and the structure of atoms, periodic relationships, energy and temperature, gas laws and the kinetic molecular theory, compounds and nomenclature of inorganic compounds, the mole, stoichiometry, types of chemical reactions, balancing equations, electron configurations, and chemical bonding. Enrollment in this course is strongly encouraged prior to enrollment in Chem 2031 if the student does not have a strong and recent background in general chemistry. Note: College Algebra or the equivalent is strongly recommended for optimal student success. Students may not receive credit for this course if they have already received credit for CHEM 2031 and CHEM 2061. Term offered: fall, spring, summer. Max hours: 3 Credits. Grading Basis: Letter Grade

CHEM 1115 - Chemistry Content (1-3 Credits)

Covers content areas of undergraduate chemistry. Topics include periodicity; the mole and chemical bonding; the kinetic theory and states of matter; chemical reactions; solutions and chemical equilibria. Note: Students may not receive credit for this course if they have already received credit for CHEM 2031 and CHEM 2061. Max hours: 3 Credits. Grading Basis: Letter Grade

CHEM 1130 - Engineering General Chemistry (5 Credits)

A one-semester non-laboratory version of general chemistry for engineers and those science majors who do not require laboratory credit and do not plan to take a second semester of chemistry. Prereq: One year of high school chemistry or CHEM 1000 and MATH 1110 (or high school equivalent) are strongly recommended for optimal student success. Note: Students may not receive credit for this course if they have already received credit for CHEM 2031 and CHEM 2061. Max hours: 5 Credits. Grading Basis: Letter Grade

CHEM 1474 - Core Chemistry: Chemistry for Everyday (4 Credits)

Focuses on the common household chemicals that affect us on a daily basis. Students explore current topics in chemistry and the underlying chemistry of nuclear power, plastics, sunscreens, food, acid rain, etc. Home-based laboratory experiments with safe, common substances. No co-credit: Students may not receive credit for this course if they have already received credit for CHEM 2031 and CHEM 2061. Term offered: fall, spring, summer. Max hours: 4 Credits. GT: Course is approved by the Colorado Dept of Higher Education for statewide guaranteed transfer, GT-SC1.

Grading Basis: Letter Grade

Additional Information: Denver Core Requirement, Biol Phys Sci - Lec/Lab; GT courses GT Pathways, GT-SC1, Nat Phy Sci:Course w/Req Lab.

CHEM 1494 - Forensic Chemistry (4 Credits)

This one semester chemistry lecture and laboratory course is designed to engage a non-science major through the high-interest topic: criminal investigations. In this course, using the theme of forensic science students will be introduced to a basic understanding of chemistry, the physical and chemical properties of matter, simple types of chemical reactions and equations, and molecular structure of drugs and biomolecules. Note: Two years of high school science and one year of high school algebra are strongly recommended for optimal success. Students will not receive credit for this course if they have already received credit for CHEM 2031 and CHEM 2061. Term offered: spring, summer. Max Hours: 4 Credits.

Grading Basis: Letter Grade

Additional Information: Denver Core Requirement, Biol Phys Sci - Lec/Lab. Typically Offered: Spring, Summer.

CHEM 1575 - Chemistry: History and Policies (4 Credits)

A study of the building blocks of all matter: chemicals. A focus on how the study of chemistry began and how it has changed over the course of history. The course explores how chemistry has impacted man from the earliest times: from the Bronze Age to the present and beyond. Students learn about the first use of manufactured chemical substances in history and the progression of chemical knowledge throughout history. Students also study how certain substances introduced into the environment throughout history have affected the environment and what policies have been put in place to control or remediate the release of these substances. Eight home-based laboratory experiments will be performed during the semester. High school algebra is strongly recommended preparation for this course. Math concepts critical for this course include basic operations#addition, subtraction, multiplication and division#, order of operations, exponents, square roots and the ability to rearrange and solve algebraic equations. Term offered: fall. Max Hours: 4 Credits.

Grading Basis: Letter Grade

Typically Offered: Fall.

CHEM 2031 - General Chemistry I (3 Credits)

This is the first of a two semester sequence designed for students pursuing a degree in science or a health related field. Chem 2031 is designed for students who have recently completed high school chemistry or Chem 1000 with a C- or better. Note: Non- science majors should review the course description for Chem 1474 as an alternative, non-majors science CU Denver Undergraduate Core course, with lab credit. Topics covered include the classification of matter, the Metric system, dimensional analysis, atomic theory and the structure of atoms, periodic relationships, empirical formulas, thermochemistry, gas laws and the kinetic molecular theory, compounds and nomenclature of inorganic compounds, the mole, balancing equations, stoichiometry, types of chemical reactions, solution stoichiometry and dilutions, electron configurations, chemical bonding, Lewis Dot Theory, Valence Shell Electron Pair repulsion Theory, and other topics as time allows. This course is a prerequisite or co-requisite for General Chemistry 1 Lab, Chem 2038. No co-credit with CHEM 2081. Note: a beginning course for science majors, medical technologists, pre-medical and pre-dental students. It is strongly recommended that students have taken CHEM 1000 and MATH 1110 or their high school equivalents to be adequately prepared to succeed in this course. Term offered: fall, spring, summer. Max hours: 3 Credits. GT: Course is approved by the Colorado Dept of Higher Education for statewide guaranteed transfer, GT-SC2.

Grading Basis: Letter Grade

Additional Information: Denver Core Requirement, Biol Phys Sci - Lec; GT courses GT Pathways, GT-SC2, Nat Phy Sci:Lec w/o Req Lab.

CHEM 2038 - General Chemistry Laboratory I (1 Credit)

Laboratory course designed to accompany Chem 2031. Topics include gravimetric analysis, statistical analysis, stoichiometry, Avogadro's number, thermochemistry, atomic spectroscopy, paper chromatography, and gas laws. No co-credit with CHEM 2088. Coreq: CHEM 2031 or CHEM 2081. Term offered: fall, spring, summer. Max hours: 1 Credit.

GT: Course is approved by the Colorado Dept of Higher Education for statewide guaranteed transfer, GT-SC1.

Grading Basis: Letter Grade

Coreq: CHEM 2031 or CHEM 2081

Additional Information: Denver Core Requirement, Biol Phys Sci - Lab; GT courses GT Pathways, GT-SC1, Nat Phy Sci:Course w/Req Lab.

CHEM 2061 - General Chemistry II (3 Credits)

This is a continuation of Chem 2031 and is the second course of a two semester sequence designed for students pursuing a degree in science or a health related field. CHEM 2061 builds upon the understanding of chemistry rooted in the molecular nature of matter and change from General Chemistry I and expands to include topics such as intermolecular forces, solution chemistry, kinetics, chemical equilibrium, acid-base chemistry, buffer chemistry, solubility, thermodynamics and time permitting, electrochemistry. Specific topics include: the use of bonding theories to explain the relationships between atomic structure, molecular shape, and macroscopic properties of matter including boiling point, vapor pressure, surface tension, viscosity, and capillarity; the understanding of molecular structure to explain the energetics of solution formation as well as vapor pressures of pure liquids and solutions; the application of rates of reactions to define the state of equilibrium; the application of problem solving techniques for systems at equilibrium to acid/base and solubility chemistry; and the thermodynamic underpinnings of chemical reaction rates and the spontaneous conversion of chemical species to attain a state of dynamic equilibrium. This course is a prerequisite or co-requisite for General Chemistry II Lab, Chem 2068. Prereq: CHEM 2031 or 2081 with a C- or higher. No co-credit with CHEM 2091. Term offered: fall, spring, summer. Max hours: 3 Credits. GT: Course is approved by the Colorado Dept of Higher Education for statewide guaranteed transfer, GT-SC2.

Grading Basis: Letter Grade

Prereq: CHEM 2031 or 2081 with a C- or higher

Additional Information: Denver Core Requirement, Biol Phys Sci - Lec; GT courses GT Pathways, GT-SC2, Nat Phy Sci:Lec w/o Req Lab.

CHEM 2068 - General Chemistry Laboratory II (2 Credits)

Laboratory course designed to accompany Chem 2061. Topics include colligative properties, spectroscopic analysis, kinetics, equilibrium, acid-base chemistry, titrations, and qualitative analysis of metal cations. No co-credit with CHEM 2098. Prereq: CHEM 2038 or 2088 with a C- or higher. Coreq: CHEM 2061 or 2091. Term offered: fall, spring, summer.

Max hours: 2 Credits. GT: Course is approved by the Colorado Dept of Higher Education for statewide guaranteed transfer, GT-SC1.

Grading Basis: Letter Grade

Prereq: CHEM 2038 or 2088 with a C- or higher Coreq: CHEM 2061 or 2091

Additional Information: Denver Core Requirement, Biol Phys Sci - Lab; GT courses GT Pathways, GT-SC1, Nat Phy Sci:Course w/Req Lab.

CHEM 2081 - Honors General Chemistry I (3 Credits)

Topics include gas laws, thermochemistry, the quantum mechanical model of the atom, periodic properties, bonding and molecular geometry and intermolecular forces. Prepares students to take upper division chemistry courses. Honors section: Course assumes knowledge of stoichiometry and basic atomic structure. Note: Students may not receive credit for this course if they have already received credit for CHEM 2031.

Prereq: Admission into specific CU Denver program or consent of instructor is required to enroll. Working knowledge of high school algebra and advanced high school chemistry are required. Restriction: Restricted to Chemistry Honors students (CH01). Term offered: fall. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to Chemistry Honors students.

CHEM 2088 - Honors General Chemistry I Laboratory (2 Credits)

Laboratory experiments on topics covered in CHEM 2031 or CHEM 2081, gaining experience in observing, recording, and interpreting physical and chemical phenomena. Offers smaller sections and greater access to specialized techniques, open ended experiments, and instrumentation, requiring a faster pace and more sophisticated work. Note: Students may not receive credit for this course if they have already received credit for CHEM 2038. Prereq: Admission into specific CU Denver program or consent of instructor is required to enroll. Coreq: CHEM 2031 or CHEM 2081. No co-credit with CHEM 2038. Term offered: fall. Max hours: 2 Credits.

Grading Basis: Letter Grade

Coreq: CHEM 2031 or CHEM 2081. Restriction: Restricted to Chemistry Honors students.

CHEM 2091 - Honors General Chemistry II Lecture (3 Credits)

Continuation of CHEM 2081. Additional topics may include kinetics, equilibria and thermodynamics. Note: Students may not receive credit for this course if they have already received credit for CHEM 2061. Note: Admission into specific CU Denver program or consent of the instructor is required. Prereq: CHEM 2081 or 2031 with a C- or higher. Restriction: Restricted to Chemistry Honors students (CH01). No co-credit with CHEM 2061. Term offered: spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 2081 or 2031 with a C- or higher Restriction: Restricted to Chemistry Honors students (CH01)

CHEM 2098 - Honors General Chemistry II Laboratory (2 Credits)

Students perform laboratory experiments on topics covered in General Chemistry II (CHEM 2061) or the companion Honors General Chemistry II course. Students gain experience in observing, recording, and interpreting physical and chemical phenomena. Honors General Chemistry II Laboratory is distinguished from the regular General Chemistry Laboratory by smaller sections, and greater access to specialized techniques, open ended experiments, and instrumentation. Students use the laboratory skills they developed in Honors General Chemistry I Laboratory to work independently with a special emphasis on recording, interpreting, and expressing data, chemical safety, the scientific literature, innovation in the laboratory, and presentation of scientific information in oral and poster formats. Prereq: Admission into specific CU Denver program or consent of instructor is required to enroll. Prereq: CHEM 2038 or CHEM 2088. Coreq: CHEM 2091 or CHEM 2061. Restriction: Restricted to Chemistry Honors Students. No co-credit with CHEM 2068. Term offered: spring. Max hours: 2 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 2038 or CHEM 2088 Coreq: CHEM 2091 or CHEM 2061 Restriction: Restricted to Chemistry Honors Students

CHEM 2300 - Nutritional Chemistry (3 Credits)

Introduces nutrition intended primarily for majors in nursing, physical therapy, physical education. Topics include structure and metabolism of carbohydrates, lipids and proteins, functions of vitamins and minerals and food constituents. Prereq: CHEM 1000 or CHEM 1474 or CHEM 2031 or CHEM 2081 with a C- or better. Term offered: spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 1000 or CHEM 1474 or CHEM 2031 or CHEM 2081 with a C- or better.

CHEM 2600 - Introductory Topics in Chemistry (1-3 Credits)

This course is designed primarily for non-chemistry majors. Students will explore a special topic related to chemistry or biochemistry. A description of topics to be covered in the current semester is maintained on the Chemistry department website. Max hours: 6 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 6.

CHEM 2840 - Independent Study: CHEM (1-3 Credits)

Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS undergraduate advising office for approval. Term offered: fall, spring, summer. Repeatable. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 3.

CHEM 2939 - Internship (1-3 Credits)

Experiences involving application of specific, relevant concepts and skills in supervised employment situations. Prereq: 15 hours of 2.75 GPA. Repeatable. Max Hours: 9 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 9.

CHEM 3011 - Inorganic Chemistry (3 Credits)

The fundamentals of inorganic chemistry, including: atomic, molecular and crystal structures; the energetics of reactions, acid-base interactions; and the chemistry of main group and transition metal elements, including coordination and organometallic chemistry. Prereq or Coreq: CHEM 3421 or 3491 with a C- or higher. Term offered: spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq or Coreq: CHEM 3421 or CHEM 3491 with a C- or higher

CHEM 3018 - Inorganic Chemistry Laboratory (2 Credits)

Combines theoretical concepts with hands-on laboratory experience and introduces students to modern inorganic chemistry. Experiments cover both main group and transition metal chemistry with an emphasis on synthesis, characterization, and application of inorganic compounds.

Prereq or Coreq: CHEM 3011 with a C- or higher. Term offered: spring. Max hours: 2 Credits.

Grading Basis: Letter Grade

Prereq or Coreq: CHEM 3011 with a C- or higher

CHEM 3111 - Analytical Chemistry (3 Credits)

Topics include sampling, volumetric analyses, instrumental analyses and statistical treatment of data. Note: Lecture course for chemistry, biology, medical technology and environmental students. Prereq: CHEM 2061 or CHEM 2091 with a C- or higher. Term offered: fall. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 2061 or CHEM 2091 with a C- or higher

Typically Offered: Fall.

CHEM 3118 - Analytical Chemistry Laboratory (2 Credits)

CHEM 3118 provides a strong background in those chemical principles that are particularly important to analytical chemistry, such as the ability to obtain high-quality analytical data. Students gain experience with techniques of sampling and analysis, including an introduction to instrumental methods. Additionally, students develop the skills needed to solve analytical problems in a quantitative manner, with the aid of spreadsheet tools. The post laboratory assignments demonstrate a writing process that follows the guidelines of the American Chemical Society. Note: Laboratory course to be taken concurrently with CHEM 3111. Prereq: CHEM 2068 or CHEM 2098 with a C- or higher. Coreq: CHEM 3111 or CHEM 3481. Term offered: fall. Max hours: 2 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 2068 or CHEM 2098 with a C- or higher. Coreq: CHEM 3111 or CHEM 3481.

Typically Offered: Fall.

CHEM 3411 - Organic Chemistry I (4 Credits)

Lecture course for science majors. Topics covered include Structure and Bonding, Stereochemistry, Alkanes, reactions of alkenes, alkyl halides, alcohols and other functional groups, reaction mechanism and spectroscopy. Prereq: CHEM 2061 or 2091 with a C- or higher. No co-credit with CHEM 3481. Term offered: fall, spring, summer. Max hours: 4 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 2061 or CHEM 2091 with a C- or higher

CHEM 3418 - Organic Chemistry Lab I (1 Credit)

Laboratory course for science majors. Topics include methods of purification, separation and analysis of organic compounds; organic reactions and workups and spectroscopy. Emphasis on scientific writing. Prereq: CHEM 2068 or 2098 with a C- or higher. Coreq: CHEM 3411 or CHEM 3481. No co-credit with CHEM 3488. Term offered: fall, spring, summer. Max hours: 1 Credit.

Grading Basis: Letter Grade

Prereq: CHEM 2068 or 2098 with a C- or higher Coreq: CHEM 3411 or CHEM 3481

CHEM 3421 - Organic Chemistry II (4 Credits)

Lecture course for science majors. A continuation of Chem 3411. Topics covered include spectroscopy, aromaticity, reactions of alkynes, conjugated dienes, benzene, benzene derivatives, aldehydes, ketone, carboxylic acids, carboxylic acid derivatives, enols, enolates and amines, reaction mechanisms and syntheses. Prereq: CHEM 3411 or 3481 with a C- or higher. No co-credit with CHEM 3491. Max hours: 4 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 3411 or 3481 with a C- or higher.

CHEM 3428 - Organic Chemistry Lab II (1 Credit)

Laboratory course for science majors. A continuation of CHEM 3418. Topics include analysis of organic unknowns, organic reactions and workups and spectroscopy. Emphasis on scientific writing. Prereq: CHEM 3418 or 3488 with a C- or higher; Coreq: CHEM 3421 or CHEM 3491. Note: Students will not receive credit for CHEM 3428 if they take it after successfully completing CHEM 3498. Term offered: fall, spring, summer. Max hours: 1 Credit.

Grading Basis: Letter Grade

Prereq: CHEM 3418 or 3488 with a C- or higher Coreq: CHEM 3421 or 3491

CHEM 3481 - Majors Organic Chemistry I (4 Credits)

Lecture course for science majors. An accelerated and in-depth approach to organic chemistry. Intended for chemistry majors and advanced premedical, pre-dental, pre-pharmacy and other health related careers requiring a full year of organic chemistry. Instructor permission required. Topics covered include Structure and Bonding, Stereochemistry, Alkanes, reactions of alkenes, alkyl halides, alcohols and other functional groups, reaction mechanism and spectroscopy. Prereq: CHEM 2091 with a C- or higher and Coreq: CHEM 3418 or 3488 OR Prereq: CHEM-BS Majors or BICM-BS Majors and CHEM 2061 or CHEM 2091 with a C- or higher and Coreq: CHEM 3418 or CHEM 3488. No co-credit with CHEM 3411. Term offered: fall. Max hours: 4 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 2091 Coreq: CHEM 3418 or 3488 OR Prereq: (CHEM-BS/ADL or BICM-BS/ADL) and CHEM 2061 or CHEM 2091 Coreq: CHEM 3418 or CHEM 3488

CHEM 3488 - Majors Organic Chemistry Laboratory I (1 Credit)

Laboratory course for science majors. Honors laboratory class to accompany CHEM 3411 or CHEM 3481. Topics include methods of purification, separation and analysis of organic compounds through extended experiments; organic reactions and workups and spectroscopy. Emphasis on scientific writing. Prereq: CHEM 2068 or CHEM 2098 with a C- or higher. Coreq: CHEM 3411 or CHEM 3481. Instructor permission required to enroll. Note: No co-credit with CHEM 3418. Term offered: fall. Max hours: 1 Credit.

Grading Basis: Letter Grade

Prereq: CHEM 2068 or 2098 with a C- or higher Coreq: CHEM 3411 or CHEM 3481

CHEM 3491 - Majors Organic Chemistry II (4 Credits)

Lecture course for science majors. A continuation of Chem 3481. An accelerated and in-depth approach to organic chemistry. Intended for chemistry majors and advanced pre-medical, predental, pre-pharmacy and other health related careers requiring a full year of organic chemistry. Instructor permission required. Topics covered include spectroscopy, aromaticity, reactions of alkynes, conjugated dienes, benzene, benzene derivatives, aldehydes, ketone, carboxylic acids, carboxylic acid derivatives, enols, enolates and amines, reaction mechanisms and syntheses. Prereq: CHEM 3411 or CHEM 3481 and CHEM 3418 or CHEM 3488 with a C- or higher and instructor consent are required in order to enroll in this course. No co-credit with CHEM 3421. Term offered: spring. Max hours: 4 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 3411 or CHEM 3481 and CHEM 3418 or CHEM 3488 with a C- or higher

CHEM 3498 - Majors Organic Chemistry Laboratory II (2 Credits)

Laboratory course for science majors. A continuation of CHEM 3418 or CHEM 3488. Topics include multi-step organic reactions, workups and spectroscopy and an independent research project. Emphasis on use of the chemical literature, scientific writing and scientific presentation. Prereq: Students must be a Chemistry or Biochemistry major (CHEM-BS, CHEM-ADL, CHEM-BS2, BICM-BS or BICM-ADL). Students must have completed CHEM 3411 or CHEM 3481 and CHEM 3418 or CHEM 3488 with a C- or higher. Students must have completed CHEM 3421 or CHEM 3491 with a C- or higher or be co-enrolled. Others may be permitted by the instructor. Term offered: fall, spring. Max hours: 2 Credits.

Grading Basis: Letter Grade

Prereq: Chemistry or Biochemistry major (CHEM-BS, CHEM-ADL, CHEM-BS2, BICM-BS or BICM-ADL) and CHEM 3411 or 3481 and CHEM 3418 or 3488 with a C- or higher. And Pre/Coreq: CHEM 3421 or 3491 with a C- or higher.

CHEM 3810 - Biochemistry (4 Credits)

Introduces the principles of biochemistry for science and health science-oriented majors. This survey course covers the important aspects of modern biochemistry including macromolecular structure, enzymology, and metabolism in one semester. Prereq: BIOL 2061 or 2097 and CHEM 3411 or 3481 with a C- or higher. Term offered: fall, spring, summer. Max hours: 4 Credits.

Grading Basis: Letter Grade

Prereq: BIOL 2061 or 2097 and CHEM 3411 or 3481 with a C- or higher

CHEM 3840 - Independent Study (1-3 Credits)

Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS undergraduate advising office for approval. Term offered: fall, spring, summer. Repeatable. Max Hours: 6 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 6.

CHEM 3939 - Internship (1-3 Credits)

Designed experiences involving application of specific, relevant concepts and skills in supervised employment situations. Prereq: Students must have a junior standing and at least a 2.75 GPA and must work with the Experiential Learning Center advising to complete a course contract and gain approval. Term offered: fall, spring, summer. Repeatable. Max Hours: 9 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 9.

Prereq: Junior standing or higher and at least a 2.75 cumulative GPA

CHEM 4010 - Advanced Inorganic Chemistry (3 Credits)

Covers the fundamental principles of inorganic chemistry. Topics include atomic structure and periodicity, molecular symmetry, bonding, structural chemistry, main-group chemistry, coordination chemistry, and organometallic chemistry. Requisite knowledge in Undergraduate Inorganic and Physical Chemistry assumed. Cross-listed with CHEM 5010. Max Hours: 3 Credits.

Grading Basis: Letter Grade

CHEM 4110 - Advanced Analytical Chemistry (3 Credits)

Explores the fundamental principles of analytical chemistry. Topics will focus on meteorology (the science of making measurements), measurements based on energy transfer (e.g. spectroscopic analysis), and measurements based on mass transfer (e.g. chemical separations and electrochemistry). Requisite knowledge in Undergraduate Instrumental Analysis is assumed. Cross-listed with CHEM 5110. Max hours: 3 Credits.

Grading Basis: Letter Grade

CHEM 4121 - Instrumental Analysis (3 Credits)

Surveys instrumental methods of analysis, emphasizing atomic and molecular spectroscopy, mass spectrometry, surface characterization, and chromatography techniques. Students are introduced to a wide array of powerful and elegant tools for obtaining qualitative and quantitative information about the composition and structure of matter. Prereq: CHEM 3111 or CHEM 3481, CHEM 3421 or CHEM 3491, PHYS 2331 or PHYS 2020 and CHEM 4521 with a C- or higher. Term offered: spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 3111 or CHEM 3481, CHEM 3421 or CHEM 3491, PHYS 2331 or PHYS 2020 and CHEM 4521 with a C- or higher.

Typically Offered: Spring.

CHEM 4128 - Instrumental Analysis Laboratory (2 Credits)

CHEM 4128 demonstrates a wide array of powerful and elegant tools for obtaining qualitative and quantitative information about the composition and structure of matter. The post laboratory assignments demonstrate a writing process that follows the guidelines of the American Chemical Society. Note: Required of chemistry majors and open to other students in CHEM 4121. Prereq: CHEM 3118 and 4538 with a C- or higher. Coreq: CHEM 4121. Term offered: spring. Max hours: 2 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 3118 and 4538 with a C- or higher Coreq: CHEM 4121

Typically Offered: Spring.

CHEM 4221 - Practical Applications of Spectroscopy (3 Credits)

This course surveys spectroscopic methods in order to deduce the structure of organic compounds from an examination of spectra, with an emphasis on infrared spectroscopy, mass spectrometry, nuclear magnetic resonance spectroscopy, and ultraviolet spectroscopy. Students will be introduced to a wide array of powerful and elegant tools for obtaining qualitative information about the structure of matter. This course will require a good amount of thought, yet all of the concepts and associated mathematical manipulations are within the reach of a student who has met the prerequisites. Prereq: CHEM 3411 or CHEM 3481 with a C- or higher. Cross-listed with CHEM 5221. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 3411 or 3481 with a C- or higher.

CHEM 4310 - Advanced Organic Chemistry (3 Credits)

An exploration of structure, bonding and reactivity in organic modules that includes extensive analysis of the chemical literature, culminating in written and seminar presentations of individual projects. Requisite knowledge in Undergraduate Organic Chemistry and Physical Chemistry is assumed. Restriction: Restricted to degree-granting Graduate programs. Cross-listed with CHEM 5310. Term offered: fall. Max hours: 3 Credits.

Grading Basis: Letter Grade

CHEM 4421 - Cannabis Chemistry (3 Credits)

An exploration of the terpene to cannabinoid compounds including biosynthesis pathways; human receptor structures and mechanism; current analytical methods for Quality Assurance and Quality Control and current research in medical applications. Prerequisite: Organic Chemistry I with a C- or higher (Chem 3411 or Chem 3481), and corequisite/ prerequisite: Organic Chemistry II (CHEM 3421 or CHEM 3491). Cross-listed with CHEM 5421. Term offered: spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prerequisite: Organic Chemistry I with a C- or higher (Chem 3411 or Chem 3481), and corequisite/prerequisite: Organic Chemistry II (CHEM 3421 or CHEM 3491).

CHEM 4500 - Foundations of Physical Chemistry (3 Credits)

This course prepares students for CHEM 4511 and/or 4521. The goal is to bridge the gap between algebra- and calculus-based physics courses and to introduce essential math concepts and skills in Calculus III that are relevant to the Physical Chemistry course sequence 4511/4521. Pre: PHYS 2020 or (prereq or coreq) PHYS 2331, CHEM 3421 or CHEM 3491 and MATH 2411 with a C- or higher. Term offered: fall, spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Pre: PHYS 2020 or (prereq or coreq) PHYS 2331, CHEM 3421 or CHEM 3491 and MATH 2411 with a C- or higher.

CHEM 4510 - Computational Chemistry (3 Credits)

Classical and ab initio molecular dynamics are covered from theory to application. Students have access to high-performance computational resources and cover current topics in the field. Requisite knowledge in Undergraduate Physical Chemistry is assumed. Cross-listed with CHEM 5510. Term offered: fall. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Typically Offered: Fall.

CHEM 4511 - Physical Chemistry: Thermodynamics and Kinetics (3 Credits)

Includes study of the laws of thermodynamics, thermochemistry, chemical equilibria, solutions and statistical mechanics. Prereq: PHYS 2020 or PHYS 2331 with C- or higher and either (pre-requisite MATH 2421 Calculus III -OR- CHEM 4500 Foundations for Physical Chemistry with a C- or higher) OR co-requisite/ pre-requisite MATH 3511 Mathematics of Chemistry with a C- or higher if completed before CHEM 4511. Term offered: spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: PHYS 2020 or PHYS 2331 with C- or higher and either (pre-requisite MATH 2421 -OR- CHEM 4500 with a C- or higher) OR co-requisite/pre-requisite MATH 3511 with a C- or higher.

Typically Offered: Fall.

CHEM 4518 - Physical Chemistry Laboratory: Reaction Analysis (2 Credits)

Instruction in the experimental techniques of physical chemistry with emphasis on the properties of gases, thermodynamics and chemical equilibrium. Pre- or Co-Requisite CHEM 4511 with a C- or higher if completed before CHEM 4518. Term offered: spring. Max hours: 2 Credits.

Grading Basis: Letter Grade

Pre- or Co-Requisite CHEM 4511 with a C- or higher if completed before CHEM 4518.

CHEM 4521 - Physical Chemistry: Quantum and Spectroscopy (3 Credits)

Continuation of CHEM 4511, with emphasis on chemical kinetics, quantum mechanics, molecular structure and spectroscopy. Prereq: PHYS 2020 or PHYS 2331 with C- or higher and either (pre-requisite MATH 2421 Calculus III -OR- CHEM 4500 Foundations for Physical Chemistry with a C- or higher) OR co-requisite/ pre-requisite MATH 3511 Mathematics of Chemistry with a C- or higher if completed before CHEM 4521. Term offered: fall. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: PHYS 2020 or PHYS 2331 with C- or higher and either (pre-requisite MATH 2421 -OR- CHEM 4500 with a C- or higher) OR co-requisite/pre-requisite MATH 3511 with a C- or higher.

Typically Offered: Spring.

CHEM 4530 - Advanced Physical Chemistry (3 Credits)

Explores fundamental properties of molecules (bond length and strength, the potential energy surface, reaction rates, etc.) and examines how these properties are measured, using original literature as the primary source, and culminating in written and seminar presentations of individual projects. Requisite knowledge in Undergraduate Physical Chemistry is assumed. Cross-listed with CHEM 5530. Max Hours: 3 Credits.

Grading Basis: Letter Grade

CHEM 4538 - Physical Chemistry Laboratory: Molecular Structure (2 Credits)

CHEM 4538 explores the central principles of physical chemistry, with emphasis on quantum chemistry, spectroscopy, and computational methods. The post laboratory assignments demonstrate a writing process that follows the guidelines of the American Chemical Society. Pre or Co-requisite CHEM 4511 or CHEM 4521 with a C- or higher if completed before CHEM 4538 Term offered: fall. Max hours: 2 Credits.

Grading Basis: Letter Grade

Pre or Co-Requisite CHEM 4511 or CHEM 4521 with a C- or higher.

CHEM 4548 - Physical Biochemistry Laboratory (2 Credits)

Experimental techniques of physical chemistry emphasizing thermodynamics, kinetics, and spectroscopy of biological molecules.

Fulfills the Physical Chemistry Lab requirement for Biochemistry

Emphasis majors. Prereq: CHEM 3498 or CHEM 4828. Prereq or

Coreq: CHEM 4511 or CHEM 4521 with a C- or higher. Recommended

Preparation: CHEM 4810. Term offered: spring. Max hours: 2 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 3498 or CHEM 4828. Pre or Coreq: CHEM 4511 or

CHEM 4521 with a C- or higher.

Typically Offered: Spring.

CHEM 4600 - Advanced Topics in Chemistry (1-3 Credits)

Upper-level majors in chemistry or a related discipline explore a special topic in chemistry or biochemistry. A description of topics to be covered in the current semester is maintained on the Chemistry department website. Max hours: 6 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 6.

CHEM 4610 - Understanding & Presenting Chemical Research (1-2 Credits)

This course will improve your ability to systematically search for chemical information, help you interpret the information you find, & improve your ability to summarize and present that information. Prereq: CHEM 2061 or CHEM 2091 with a C- or higher. Cross-listed with CHEM 5610. Term offered: fall, spring. Repeatable. Max Hours: 2 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 2.

Prereq: CHEM 2061 or CHEM 2091 with a C- or higher

CHEM 4630 - Programming for Data Analysis in the Physical Sciences (1 Credit)

This course will be taught using live coding format (the instructor will code live in the classroom with the students). In this course, you will learn to process data using python scripts that you will write. Data include for example absorption spectra, protein pdb files, coordinate files.

You will also learn how to use Python libraries and write functions (for example to create high resolution graphs). Finally, you will learn best coding practices, how to keep track of different versions of your code and share your code using Github. Prereq: CHEM 2061 or CHEM 2091 with a C- or higher. Having completed a semester of Organic Chemistry is recommended preparation for optimal student success. Cross-listed with CHEM 5630. Max hours: 1 Credit.

Grading Basis: Letter Grade

Prereq: CHEM 2061 or CHEM 2091 with a C- or higher

CHEM 4655 - Teaching Assistant Bootcamp (1 Credit)

This course is 4-5 8-hour days of intensive training in suitable pedagogy for general chemistry and organic chemistry laboratory classes, procedures for teaching laboratory sections, and laboratory techniques.

Students must have a teaching assistant contract with the Chemistry Department in order to take this course. Cross-listed with CHEM 5655.

Term offered: fall. Repeatable. Max Hours: 1 Credit.

Grading Basis: Letter Grade

Repeatable. Max Credits: 2.

CHEM 4700 - Environmental Chemistry (3 Credits)

A discussion of the sources, reactions, transport, effects, and fates

of chemical species in the water, soil, and air environments. Prereq:

CHEM 3111 or CHEM 3411 or CHEM 3481 with a C- or higher. Cross-listed with CHEM 5700. Term offered: spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 3111 or CHEM 3411 or CHEM 3481 with a C- or higher

CHEM 4810 - General Biochemistry I (3 Credits)

In-depth introductory course for chemistry, science and health science

majors. Topics include structure and energetics of proteins; mechanisms

and kinetics of enzymes; structure and function of carbohydrates, lipids

and nucleic acids. Prereq or Coreq: CHEM 3421 or CHEM 3491 with a

grade of C- or higher. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq or Coreq: CHEM 3421 or CHEM 3491 with a grade of C- or higher.

CHEM 4815 - Structural Biology of Neurodegenerative Diseases (3 Credits)

Advanced course in Biochemistry/Biophysics. Principles of Protein

Folding, Structure-Function Relationship, and spectroscopic

techniques related to characterization of these processes as applied to

neurodegenerative diseases such as Parkinson's and Alzheimer's.

Prereq: 1) BIOL 2051 & BIOL 2071 or BIOL 2095 & BIOL 2096, and 2)

CHEM 3810 or CHEM 4810 or CHEM 5810 with a C- or higher. Prereq or

Coreq: PHYS 2020 or PHYS 2331 with a C- or higher. Cross-listed with

CHEM 5815, BIOL 4815, and BIOL 5815. Term offered: spring. Max hours:

3 Credits.

Grading Basis: Letter Grade

Prereq: 1) BIOL 2051 BIOL 2071 or BIOL 2095 BIOL 2096, and 2)

CHEM 3810 or CHEM 4810 or CHEM 5810 with a C- or higher Prereq or

Coreq: PHYS 2020 or PHYS 2331 with a C- or higher

CHEM 4820 - General Biochemistry II (3 Credits)

Advanced course for chemistry, science and health science

majors. Topics include energetics and pathways for metabolism of

carbohydrates, lipids, and amino acids. Prereq: CHEM 3810 or 4810 or

5810 with a C- or higher. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 3810 or 4810 or 5810 with a C- or higher

CHEM 4825 - Biochemistry of Metabolic Disease (3 Credits)

Advanced course in biochemistry. An expanded study of selected topics

in metabolism and how they relate to diseases, including inflammation,

diabetes, obesity, and rare genetic disorders. Prereq: 1) CHEM 3810 or

CHEM 4810 or CHEM 5810 with a C- or higher and 2) BIOL 2051 & BIOL

2071 or BIOL 2095 and BIOL 2096 with a C- or higher. Cross-listed with

CHEM 5825, BIOL 4825 and BIOL 5825. Term offered: fall. Max hours: 3

Credits.

Grading Basis: Letter Grade

Prereq: 1) CHEM 3810 or CHEM 4810 or CHEM 5810 and 2) BIOL 2051

BIOL 2071 or BIOL 2095 and BIOL 2096

CHEM 4828 - Biochemistry Lab (2 Credits)

Focuses on modern laboratory techniques for biochemical research, with an emphasis on methods for protein isolation, purification and characterization. Students perform experiments including chromatography, electrophoresis, molecular cloning, spectrophotometry, and enzyme activity assays. Prereq: CHEM 3810 or CHEM 4810 or CHEM 5810 with a C- or higher. Max hours: 2 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 3810 or 4810 or 5810 with a C- or higher

CHEM 4835 - Biochemistry of Gene Regulation and Cancer (3 Credits)

Explores the biochemical and molecular aspects of cancer biology. Topics include DNA mutations and repair, gene regulation, oncogenes and tumor suppressors, stem cells and differentiation, and cancer drug development. Prereq: 1) CHEM 3810 or CHEM 4810 or CHEM 5810 with a C- or higher and 2) BIOL 2051 & 2071 or BIOL 2095 & BIOL 2096 with a C- or higher. Cross-listed with CHEM 5835, BIOL 4835, and BIOL 5835. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: 1) CHEM 3810 or CHEM 4810 or CHEM 5810 and 2) BIOL 2051 BIOL 2071 or BIOL 2095 and BIOL 2096

CHEM 4840 - Independent Study: Chem (1-6 Credits)

Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS undergraduate advising office for approval. Prereq: Permission of instructor required. Term offered: fall, spring, summer. Repeatable. Max Hours: 12 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 12.

CHEM 4845 - Molecular Modeling and Drug Design (3 Credits)

Advanced course in biochemistry. An introductory course on modern molecular modeling techniques and their applications to computer-aided rational drug design. Prereq: CHEM 3411 with a C- or higher and either PHYS 2020 or PHYS 2331 with a C- or higher. Cross-listed with CHEM 5845. Term offered: fall. Max hours: 3 Credits.

Grading Basis: Letter Grade

CHEM 3411 with a C- or higher and either PHYS 2020 or PHYS 2331 with a C- or higher.

CHEM 4860 - Bioinorganic Chemistry: Bioinorganic compounds in medicine (3 Credits)

Explore the roles of metals in biochemistry and medicine by studying chemical/physical properties of metal coordinated compounds. The course focus on metal coordination resulting biopolymer folding and the function of macromolecules that is involved into iron cytochromes, zinc and copper enzymes, iron sulfur proteins, oxygen transport, iron storage, electron transfer, inorganic model compounds, metals in medicine, and toxicity of inorganic species. Topic is extended to biomedical application such as chemotherapy. Prereq: CHEM 3810 or CHEM 4810 or CHEM 5810 with a C- or higher. Cross-listed with CHEM 5860. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 3810 or 4810 or 5810 with a C- or higher

CHEM 4880 - Directed Research (1-6 Credits)

Students will engage in original research projects supervised and mentored by faculty. Students must work with faculty prior to registration to develop a proposal for their project and receive permission to take this course. Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS undergraduate advising office for approval. Term offered: fall, spring, summer. Repeatable. Max Hours: 6 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 6.