

# CHEM - CHEMISTRY

## CHEM401 Inorganic Chemistry (3 Credits)

An overview of basic concepts of the electronic structure of the elements, chemical bonding and reactivity, from simple diatomic molecules to coordination compounds. These are viewed from simple (Lewis) to the most comprehensive molecular orbital theory. Symmetry and group theory are used throughout the course.

**Prerequisite:** CHEM276 or CHEM271; and (CHEM247 or CHEM241).

## CHEM403 Radiochemistry (3 Credits)

Radioactive decay; introduction to properties of atomic nuclei; nuclear processes in cosmology; chemical, biomedical and environmental applications of radioactivity; nuclear processes as chemical tools; interaction of radiation with matter.

**Prerequisite:** Must have completed one year of college chemistry and one year of college physics.

## CHEM425 Instrumental Methods of Analysis (4 Credits)

Modern instrumentation in analytical chemistry. Electronics, spectroscopy, chromatography and electrochemistry.

**Prerequisite:** CHEM272 and CHEM271; or (CHEM276 and CHEM277).

## CHEM433 Atmospheric Chemistry and Climate (3 Credits)

The effects of human activity on atmospheric composition, focused on global warming, the carbon cycle, air pollution, and the ozone layer. Fundamentals of atmospheric chemistry (spectroscopy, kinetics, isotopic analysis, and biogeochemical cycles) are related to the modern understanding of climate change, air quality, and ozone depletion, based on resources such as satellite missions, field campaigns, and scientific assessments published by international agencies. We also examine how society's energy needs could be met, in the future, in a manner with less impact on atmospheric composition than the present heavy reliance on combustion of fossil fuels.

**Prerequisite:** CHEM131, CHEM135, or CHEM146. And MATH241; or permission of CMNS-Atmospheric & Oceanic Science department; or permission of CMNS-Chemistry & Biochemistry department. Cross-listed with AOSC433.

**Credit Only Granted for:** AOSC433, AOSC633, CHEM433, or CHEM633.

**Formerly:** CHEM434.

## CHEM441 Advanced Organic Chemistry (3 Credits)

An advanced study of the compounds of carbon, with special emphasis on molecular orbital theory and organic reaction mechanisms.

**Prerequisite:** Must have completed or be concurrently enrolled in CHEM480 or CHEM481; and 1 course with a minimum grade of C- from (CHEM241, CHEM247).

**Jointly offered with:** CHEM641.

## CHEM460 Structure Determination Using Spectroscopic Methods (3 Credits)

The use of infrared, ultraviolet-visible, proton and carbon-13 nuclear magnetic resonance and mass spectroscopy for structure determination in organic chemistry.

**Prerequisite:** Must have completed CHEM243; or CHEM247; or (CHEM241 and CHEM242).

**Formerly:** CHEM660.

## CHEM471 Techniques in Pulse NMR (1 Credit)

NMR techniques to operate, adjust, and calibrate the spectrometers and acquire and process NMR data in one and two dimensional NMR applications.

**Prerequisite:** CHEM241 and CHEM242; or CHEM247.

**Recommended:** CHEM460.

**Restriction:** Senior standing or higher.

**Additional Information:** Persons with heart pacemakers and/or metal implants cannot take the course due to potential health hazards.

## CHEM480 Principles of Physical Chemistry (3 Credits)

Covers elementary thermodynamics, principles of kinetics and catalysis and selected topics in molecular quantum mechanics, spectroscopy and statistical mechanics. Topics will emphasize core subjects along with applications to biosciences, materials science, environmental science and related areas.

**Prerequisite:** (CHEM276 or CHEM271); and (CHEM277 or CHEM272); and (MATH140 or MATH136); and (PHYS260 and PHYS261) or PHYS132.

**Credit Only Granted for:** CHEM480 or CHEM481; CHEM480, BCHM485 or CHEM482.

## CHEM481 Physical Chemistry I (3 Credits)

Thermodynamics and kinetics of chemical and molecular systems.

Topics may include internal energy, heat, work, enthalpy, entropy, free energy, and spontaneity as well as reaction order, differential rate laws, integrated rate laws, and rate laws for multi-step processes.

**Prerequisite:** Minimum grade of C- in CHEM135; or minimum grade of C- in CHEM271 and CHEM272; or minimum grade of C- in CHEM276 and CHEM277. And minimum grade of C- in MATH141. And minimum grade of C- in PHYS260 and PHYS261; or minimum grade of C- in PHYS141.

**Credit Only Granted for:** CHEM481 or CHEM480.

## CHEM482 Physical Chemistry II (3 Credits)

Quantum mechanical nature of atoms and molecules. Topics may include model systems for electronic, vibrational, rotational and translational energies as well as connections to molecular spectroscopy and thermal distributions.

**Prerequisite:** Minimum grade of C- in CHEM135; or minimum grade of C- in CHEM271 and CHEM272; or minimum grade of C- in CHEM276 and CHEM277. And minimum grade of C- in MATH141. And minimum grade of C- in PHYS260 and PHYS261; or minimum grade of C- in PHYS141.

**Credit Only Granted for:** CHEM482, BCHM485 or CHEM480.

## CHEM483 Physical Chemistry Laboratory I (2 Credits)

An introduction to the principles and application of quantitative techniques in physical chemical measurements. Experiments will be coordinated with topics in CHEM481.

**Prerequisite:** Must have completed or be concurrently enrolled in CHEM481.

## CHEM484 Physical Chemistry Laboratory II (2 Credits)

Advanced quantitative techniques necessary in physical chemical measurements. Experiments will be coordinated with topics in CHEM482.

**Prerequisite:** Must have completed or be concurrently enrolled in CHEM482.

## CHEM498 Special Topics in Chemistry (3 Credits)

**Prerequisite:** Prerequisite varies with the nature of the topic being considered.

**CHEM601 Structure and Bonding of Molecules and Materials (3 Credits)**

Development of the tools necessary to use the knowledge of structure and bonding of molecules and solids in the practice of synthetic inorganic and materials chemistry. Several bonding models are covered, from the simple valence bond and ligand field models to a quantitative group theoretical treatment of molecular orbital theory and band structure descriptions of solids. Concepts of electron counting and oxidation state and ligand characteristics are revisited in terms of the more sophisticated bonding models. Finally, these models are used to analyze the reactivity, magnetic and spectroscopic properties of inorganic coordination compounds. Prior advanced inorganic and/or advanced quantum chemistry courses are not prerequisites.

**CHEM602 Advanced Inorganic Chemistry II (3 Credits)**

A continuation of CHEM 601 with emphasis on the application of contemporary spectroscopic techniques to inorganic problems.

**Prerequisite:** CHEM601; or permission of instructor.

**CHEM608 Selected Topics in Inorganic Chemistry (1-3 Credits)**

Topics of special interest and current importance.

**Prerequisite:** CHEM602 and CHEM601; or students who have taken courses with comparable content may contact the department.

**Repeatable to:** 6 credits if content differs.

**CHEM611 Professional Skills for New Graduate Students (1 Credit)**

Covers a wide range of topics in professional development for new graduate students.

**Restriction:** Must be in one of the following programs (Chemistry (Master's); Biochemistry (Master's); Biochemistry (Doctoral); Chemistry (Doctoral)); and must be a new graduate student.

**CHEM612 Scientific Presentations (1 Credit)**

Workshops will cover all aspects of giving scientific presentations. Each student will give a presentation based on the topic of his/her final paper in CHEM611. Presentations will be critiqued by peers and faculty members.

**Prerequisite:** CHEM611.

**CHEM623 Optical Methods of Quantitative Analysis (3 Credits)**

The quantitative applications of various methods of optical spectroscopy.

**Prerequisite:** CHEM482; or students who have taken courses with comparable content may contact the department.

**CHEM624 Electrical Methods of Quantitative Analysis (3 Credits)**

The use of conductivity, potentiometry, polarography, voltammetry, amperometry, coulometry, and chronopotentiometry in quantitative analysis.

**Prerequisite:** CHEM482; or students who have taken courses with comparable content may contact the department.

**CHEM625 Separation Methods in Quantitative Analysis (3 Credits)**

The theory and application for quantitative analysis of various forms of chromatography, ion exchange, solvent extraction, distillation, and mass spectroscopy.

**Prerequisite:** CHEM482; or students who have taken courses with comparable content may contact the department.

**CHEM633 Atmospheric Chemistry and Climate (3 Credits)**

The effects of human activity on atmospheric composition, focused on global warming, the carbon cycle, air pollution, and the ozone layer. Fundamentals of atmospheric chemistry (spectroscopy, kinetics, isotopic analysis, and biogeochemical cycles) are related to the modern understanding of climate change, air quality, and ozone depletion, based on resources such as satellite missions, field campaigns, and scientific assessments published by international agencies. We also examine how society's energy needs could be met, in the future, in a manner with less impact on atmospheric composition than the present heavy reliance on combustion of fossil fuels.

**Prerequisite:** CHEM131, CHEM135, or CHEM146.

**Cross-listed with:** AOSC633.

**Credit Only Granted for:** AOSC433, AOSC633, CHEM433, or CHEM633.

**CHEM640 Problems in Organic Reaction Mechanisms (1 Credit)**

A tutorial type course dealing with the basic description of the fundamentals of writing organic reaction mechanisms.

**CHEM641 Organic Reaction Mechanisms (3 Credits)**

Jointly offered with CHEM441.

**CHEM647 Organic Synthesis (3 Credits)**

The use of new reagents in organic reactions; multistep syntheses leading to natural products of biological interest; stereospecific and regiospecific reactions and their use in total synthesis.

**CHEM648 Special Topics in Organic Chemistry (1-3 Credits)**

Topics of special interest and current importance.

**Repeatable to:** 9 credits if content differs.

**CHEM650 Problems in Organic Synthesis (1 Credit)**

A tutorial type course dealing with mechanistic problems from the current literature of organic synthesis.

**CHEM678 Special Topics in Environmental Chemistry (3 Credits)**

In-depth treatment of environmental chemistry problem areas of current research interest. The topics will vary somewhat from year to year.

**Prerequisite:** CHEM474.

**Repeatable to:** 6 credits if content differs.

**CHEM682 Chemical Kinetics and Dynamics (3 Credits)**

The dynamics of atoms and molecules as they undergo chemical and physical change. Topics will be developed from a fundamental perspective and modern applications will be discussed. Topics include: chemical kinetics rate equations, atomic and molecular collisions; rate theories; atomic, molecular and chemical lasers; control of matter with light.

**Prerequisite:** CHEM482; or permission of instructor.

**Restriction:** Restricted to graduate students or advanced undergraduates with prerequisites.

**CHEM684 Chemical Thermodynamics (3 Credits)**

**Prerequisite:** CHEM482; or students who have taken courses with comparable content may contact the department.

**CHEM687 Statistical Mechanics and Chemistry (3 Credits)**

**Prerequisite:** CHEM684; or students who have taken courses with comparable content may contact the department.

**CHEM688 Selected Topics in Physical Chemistry (2 Credits)**

**Repeatable to:** 6 credits if content differs.

**CHEM689 Special Topics in Physical Chemistry (3 Credits)**

**Repeatable to:** 9 credits if content differs.

**CHEM690 Quantum Chemistry I (3 Credits)****CHEM698 Literature Seminar in Chemistry (1 Credit)**

Students will prepare and present a departmental seminar based on a topic in the current research literature.

**Restriction:** Must be in a major within CMNS-Chemistry & Biochemistry department.

**CHEM699 Special Problems in Chemistry (1-6 Credits)**

Laboratory experience in a research environment.

**Prerequisite:** One semester of graduate study in chemistry.

**Restriction:** Restricted to students in the non-thesis M.S. option.

**Repeatable to:** 6 credits.

**CHEM703 Introduction to Nonequilibrium Statistical Physics (3 Credits)**

Analysis and microscopic modeling of systems away from thermal equilibrium. Linear response theory, ergodicity, Brownian motion, Monte Carlo modeling, thermal ratchets, far-from-equilibrium fluctuation relations. Introduction to the theoretical tools of nonequilibrium phenomena and their application to problems in physics, chemistry and biology.

**Prerequisite:** PHYS603 or CHEM687; or permission of instructor.

**Cross-listed with:** BIPH703, CHPH703, PHYS703.

**Credit Only Granted for:** BIPH703, CHEM703, CHPH703, or PHYS703.

**CHEM705 Nuclear Chemistry (3 Credits)**

Nuclear structure models, radioactive decay processes, nuclear reactions in complex nuclei, fission, nucleosynthesis and nuclear particle accelerators.

**CHEM729 Special Topics in Geochemistry (1-3 Credits)**

A discussion of current research problems.

**Repeatable to:** 6 credits if content differs.

**CHEM799 Master's Thesis Research (1-6 Credits)****CHEM889 Seminar (1 Credit)****CHEM898 Pre-Candidacy Research (1-8 Credits)****CHEM899 Doctoral Dissertation Research (1-8 Credits)**