COURSE MASTER CATALOG

CHEM

Graduate courses in Chemistry are listed as, 7000-, or 8000- and 9000-level courses. Students in the PhD program are required to take the three “core courses”, 7021, 7022 and 7023, as well as two P/F-graded courses on Scientific Writing and Scientific Ethics, 7011 and 7012, respectively. After completing the core courses, they will take at least 9 credits of "post-qualification courses" at the 8000-level. This is usually the equivalent of three full-semester courses but may include shorter, half-semester courses. 9000-level courses are those that can be taken multiple times for credit, including Research and Seminar courses. Note that not all of the 8000-level courses are offered annually.

Course Descriptions provide specifics about each class offered. Most listings also show prerequisites for the class. For a reference list of courses organized by college, visit the **UC website**.

CHEM7011
Scientific Writing for Chemists

Scientific Writing is intended to provide the chemistry graduate student with the tools necessary to be able to write scientific documents that are clear, simple and direct, and defy using complex, awkward, and confusing constructs and language. Tasks, for example, to do this will include critiquing and re-writing published professional works, including, in particular, those produced by the students. Such works are therefore likely to include scientific papers and posters, meeting abstracts, and reviews, i.e. those formats most often to be encountered by the students in their professional lives.

CHEM7012
Scientific Ethics

The course is intended to familiarize graduate students with the multiple aspects of scientific ethics ranging from the treatment of living subjects, ownership of scientific data and the acceptable limits of signal processing and data manipulation to plagiarism and simple fraud. Case studies will be used to investigate the boundaries of ethical behavior.

CHEM7021
Modern Spectroscopy

A graduate level course covering basic theoretical concepts of spectroscopy, various spectroscopic methods, and applications of these methods to the characterization, quantitation, and bonding of molecules. This course is a required course for the PhD program in Chemistry.

CHEM7022
Molecular Interactions

A graduate level course covering the practical application of thermodynamics, statistical mechanics, and kinetics to chemical problems. Examples from modern chemical and biochemical research will be covered to illustrate the basic concepts covered in the course. This course is a required course for the PhD program in Chemistry.

CHEM7023
Chemical Reactivity

A graduate level course covering the fundamentals of chemical kinetics, including rates, rate laws, the relationship of rate laws to reaction mechanism, and chemical catalysis. The reactivity of organic and inorganic molecules, complexes and functional groups is discussed, and applications of kinetics concepts to biochemical systems are explored. This course is a required course for the PhD program in Chemistry.

CHEM7071
Introduction to Graduate Research

Initiation of thesis (M.S.) or dissertation (Ph.D.) research project, including experimental work and communication of the background, rationale and progress on the project to the thesis or dissertation committee.

CHEM8021
Separations

The course is designed to advance the student's understanding of the underlying principles of separation science (e.g., distillation, liquid-liquid extraction, chromatography, electrophoresis). Theoretical as well as practical considerations will be covered. Emphasis will be placed on the applications, advantages and limitations of the various techniques. Comparisons will be made with alternate available techniques. In the exams, students will be expected to apply the knowledge gained to explain the underlying principles and design separation protocols for a variety of analytical or bulk scale separation problems posed in the exam, including selection of appropriate specific methods, justifying the choice of the method selected and critiquing alternative methods that were not chosen.

CHEM8022
Electroanalytical Chemistry

The fundamentals of electroanalytical chemistry are covered. Topics include commonly used electroanalytical techniques (potentiometry, voltammetry, thin layer electrochemistry, coulometry, spectroelectrochemistry, conductometric methods), instrumentation, and applications in areas such as health care, environmental monitoring, industry, and military. Articles from the current literature are discussed. Active student participation is an integral part of the course.

CHEM8023
Introduction to Analytical Spectroscopy

The fundamentals of analytical optical and mass spectrometry are covered. Topics include commonly utilized UV/Visible/X-ray optical methods of analysis and elemental and molecular mass spectrometry with applications beyond quantification and into probing physical-chemical properties of materials - solid, liquid or gas. Highlights of state-of-the-art methods also will be included. Discussion will include achieving the lowest detection, highest sensitivity and best selectivities and the necessary compromises to achieve the overall best of the three. This course will include applications in biomedical, clinical, environmental, industry, and government laboratory areas. Articles from the current literature will be discussed. Active student participation is expected as an integral part of the course including student presentations on appropriate articles.

CHEM8029
Special Topics in Analytical Chemistry

An advanced topic within the broad area of Analytical Chemistry will be explored, led by a faculty member with special expertise in the topic. Topics offered will vary with faculty availability and student interest.

CHEM8031
Advanced Biochemistry I: Proteins

Advanced Biochemistry I: Proteins is a lecture core course in the Graduate Biochemistry Program, and focuses on the structures, folding, dynamics, and interactions of proteins, and includes modern methods used to study these phenomena. Active student participation is expected as an integral part of the course.

CHEM8032
Advanced Biochemistry II: Nucleic Acids

Advanced Biochemistry II: Nucleic Acids is a lecture course in the Graduate Biochemistry Program, which focuses on the structures, biosynthesis, dynamics, and interactions of nucleic acids, and includes modern methods used to study these phenomena. This course is an elective in the Biochemistry curriculum.

CHEM8033
Advanced Biochemistry III: Carbohydrates and Lipids

Advanced Biochemistry III: Carbohydrates and Lipids is a lecture course in the Graduate Biochemistry Program, which focuses on the structures, biosynthesis, dynamics, and interactions of carbohydrates and lipids, and includes modern methods used to study these phenomena. This course is an elective in the Biochemistry curriculum.

CHEM8034
Advanced Biochemistry IV: Metabolism

Advanced Biochemistry IV: Metabolism is a lecture course in the Graduate Biochemistry Program. Topics covered include the bioenergetics of respiration and photosynthesis, and the chemistry and intermediary metabolism of carbohydrates, lipids, proteins and nucleic acids. This course is an elective in the Biochemistry curriculum.

CHEM8036
Advanced Biophysical Chemistry

Advanced Biophysical Chemistry is a lecture course in the Graduate Biochemistry Program, which explores the principles of biophysical methods used to study the structure, thermodynamics and folding of proteins and nucleic acids. Selected topics may include: Structural classification of proteins, non-covalent interactions, thermodynamic parameters, protein stability, dominant forces in protein folding, structural principles of DNA, RNA folds and ribozymes, macromolecular crowding. Selected methods may include macromolecular x-ray crystallography, hydrogen exchange experiments, calorimetry, single molecule fluorescence, atomic force microscopy, and cryo-electron microscopy. This course is an elective in the Biochemistry curriculum.

CHEM8039
Special Topics in Biochemistry

An advanced topic within the broad area of Biochemistry will be explored, led by a faculty member with special expertise in the topic. Topics offered will vary with faculty availability and student interest.

CHEM8041
Spectroscopic Methods for Transition Metal Complexes

This course will describe spectroscopic and magnetic methods used for the investigation of transition metal complexes, including small molecule metal complexes and metal-containing biomolecules. Spectroscopic methods to be discussed will include UV/vis absorption, fluorescence, circular dichroism and magnetic circular dichroism, IR and Raman, resonance Raman, x-ray absorption, nuclear magnetic resonance, and electron paramagnetic resonance. The kind of transition observed, selection rules, information content, instrumentation, experimental aspects and applications of each method will be covered in a manner that will leave the student with an awareness of the spectroscopic tools available for application to scientific problems involving transition metals.

CHEM8042
Structure and Reactivity of Transition Metal Compounds

This course will examine the structure and bonding in transition metal compounds, with an emphasis on the properties of the ligands and metal-ligand interactions. Topics will include the bonding modes and electronic properties of common ligands (dative or covalent), electron counting, metal-metal bonding, isolobal analogies, and molecular orbitals for transition metal complexes. The synthesis, spectroscopic characterization, and basic reaction mechanisms will also be discussed. This course aims to help students with interests in inorganic chemistry to gain a good understanding of the structure-reactivity relationship for transition metal compounds.

CHEM8043
Organometallic Chemistry

This course examines the structure, bonding and reactivity of compounds containing metal-carbon bonds, with an emphasis on reaction mechanisms and synthetic applications. The first half of the course covers the elementary reactions of organotransition metal complexes including oxidative addition/reductive elimination, migratory insertion/beta-hydride elimination, electrophilic and nucleophilic attack on coordinated ligands, hapticity change, and the formation of metallacycles. The second half of the course focuses on the applications of organotransition metal complexes in homogenous catalysis, particularly for C-H/C-C bond activation, hydrogenation, hydroformylation, cross-coupling, olefin metathesis, and olefin polymerization.

CHEM8044
Electronic Structure, Photophysics and Photochemistry of Transition Metal Compounds

A description of the electronic structures of molecules will be developed with emphasis on transition metal complexes. The interaction of light with matter will be discussed in context of a classical model and subsequently described in detail using time-dependent quantum mechanics. Topics will include electron spin, angular momentum, terms and states, singlet-triplet splittings, rates of photophysical processes, Jablonski diagrams, electron transfer, Franck-Condon factors, bandshape analysis, common photochemical reactions, adiabatic and non-adiabatic processes, and factors governing surface crossing. Throughout the course, an emphasis will be placed on the different orbital characters of electronically excited states commonly encountered in organic and inorganic systems, as well as the influence of molecular geometry on the energies of these states. Orbital mixing and configuration interaction will be treated quantitively. Various methods and instrumentation used to investigate these phenomena will be discussed.

CHEM8045
Bioinorganic Chemistry

This course will examine the roles that metals play in biological systems. The chemical and functional roles of metals will be discussed in light of their binding to different sites in biological molecules, especially metal-dependent proteins. The descriptive chemistry of metalloproteins representative of the different biologically important metals will provide examples for understanding structure-function relationships in biological metal sites. Adverse biological roles of metals and examples of medical uses of metals will also be discussed.

CHEM8046
Introduction to X-ray Crystallography

This course focuses on single-crystal diffraction methods with emphasis on chemical crystallography. Topics include crystals, symmetry, geometry of diffraction, data collection and reduction methods, solutions to the phase problem, refinement, sources of error, and interpretation of modeled parameters. Students will gain hands-on experience manipulating single crystals, collecting & analyzing diffraction data and solving crystal structures.

CHEM8049
Special Topics in Inorganic Chemistry

An advanced topic within the broad area of Inorganic Chemistry will be explored, led by a faculty member with special expertise in the topic. Topics offered will vary with faculty availability and student interest.

CHEM8051
Advanced Organic Synthesis

This course builds on the foundations of organic chemistry to develop synthetic routes for a wide variety of molecules with emphasis on the natural chemical reactivities of functional groups, the properties and choices of reagents to obtain desired chemoselectivities, and implementation of methods to obtain defined spatial relationships in the construction of chiral compounds.

CHEM8052
Physical Organic Chemistry

This course covers physical organic chemistry and focuses on understanding the structure, physical properties and reactivity of organic molecules. Topics that can be covered include: valence bond theory, molecular orbital theory and aromaticity, stereochemistry and conformational analysis, radicals, carbenes, carbocations, anions, acidities, alkylations, kinetics, absolute rate theory, isotope effects, linear free energy relationships, addition reactions to carbonyls, unimolecular substitution reactions, ion pairs, salt effect, bimolecular substitution reactions, addition reactions to C-C double bonds, elimination reactions, electrocyclic reactions, Diels-Alder reactions, other cycloaddition reactions, Cope and Claisen rearrangements and sigmatropic shifts. In addition students may have the opportunity for hands-on experience with calculations relevant to modern physical organic chemistry.

CHEM8054
Polymer Chemistry

This graduate-level course surveys modern polymer chemistry with a focus on new synthesis techniques including controlled radical polymerization. Particular emphasis is given to kinetics and mechanism. Characterization and materials properties are covered in terms of macromolecular structure. Examples from current primary literature are provided.

CHEM8059
Special Topics in Organic or Polymer Chemistry

An advanced topic within the broad area of Organic or Polymer Chemistry will be explored, led by a faculty member with special expertise in the topic. Topics offered will vary with faculty availability and student interest.

CHEM8061
Quantum Mechanics and Spectroscopy

This course covers the foundations of quantum mechanics from a chemistry perspective, with applications to the quantitative description of the electronic structure and bonding of atoms and molecules, and the origins of atomic and molecular spectra.

CHEM8062
Thermodynamics, Statistical Mechanics and Dynamics

This course covers the foundations of thermodynamics and statistical mechanics with special emphasis on quantitative analysis of chemical reactions and solvation. Applications will encompass various areas of chemistry from small organic systems to large biochemical assemblies.

CHEM8063
Computational Chemistry I

This course will discuss modern methods of electronic structure calculations and molecular dynamics simulations and how they are applied to problems in chemistry and biophysics. The basic principles of electronic structure calculations will be reviewed. Numerical algorithms for solving electronic structure problems will be presented, and approximate combined classical/quantum approaches will be discussed. A wide range of applications in large-molecule spectroscopy and biophysics will be covered as a central focus of the course. The quantum modeling will serve as a foundation for the discussion of molecular dynamics simulations of proteins, which will comprise the final third of the course.

CHEM8064
Computational Chemistry II

This course will discuss modern methods of modeling large molecules with direct application to problems in biophysics such as structure-function relationships. The basic principles of implicit-solvent and coarse-grained descriptions of macromolecules together with the corresponding dynamics will be introduced and discussed. Numerical algorithms for integrating the equations of motion will be discussed, and a large array of bioinformatic tools and principles for studying evolutionary traits in biomolecules will be presented. A wide range of applications in large-molecule biophysics will be covered as a central focus of the course.

CHEM8069
Special Topics in Physical or Computational Chemistry

An advanced topic within the broad area of Physical or Computational Chemistry will be explored, led by a faculty member with special expertise in the topic. Topics offered will vary with faculty availability and student interest.

CHEM8071
Chemical Sensors I: Electrochemical and Optical Sensors

The fundamentals of chemical sensors based on electrochemistry and spectroscopy are covered. Topics include commonly used sensors, strategies for achieving selectivity and adequate limits of detection, design of devices, and applications in health care, environmental monitoring, industry, and military areas. Articles from the current literature are discussed. Active student participation is expected as an integral part of the course.

CHEM8072
Chemical Sensors II: Biosensors

'Biosensors' explores the rapidly evolving areas of devices, reagents, and protocols that are being developed to detect and facilely measure analytes at, usually, exquisitely low concentrations. Systems discussed may be taken from, for example, environmental, military, and physiological sensing, and may include sensors based on living systems, or DNA, or be reagent-free. Active student participation is expected as an integral part of the course.

CHEM8079
Special Topics in Sensor Science

An advanced topic within the broad area of Sensor Science will be explored, led by a faculty member with special expertise in the topic. Topics offered will vary with faculty availability and student interest.

CHEM9010
Graduate Research

Continuation of research at the graduate level in partial fulfillment of the requirements for the thesis (M.S.) or dissertation (Ph.D.).

CHEM9020
Chemistry Seminar

Attendance at seminars and colloquia given by research scientists from within and outside of the University of Cincinnati.

CHEM9030
Topics in Modern Biochemistry Research

Topics in Modern Biochemistry Research is a discussion course in the Graduate Biochemistry Program, which explores topics selected from emerging areas of biochemistry based primarily on current literature. Subject areas may include: genomics, proteomics, bioinformatics, protein-DNA interactions, molecular basis of diseases and aging, in vivo protein folding and misfolding, cellular trafficking and protein transport, structure and function of membrane proteins. This is an elective in the Biochemistry curriculum.

CHEM9083
Life After Graduate School

This course will examine careers for PhD chemists, teach some critical non-technical skills needed by PhD chemists in their first job, guide students in finding postdoctoral fellowships and full-time employment opportunities, and in general help prepare PhD chemists for academic, industrial, and/or government positions.