Chemistry

T. Glass, Chair
College of Arts and Science
125 Chemistry Building
(573) 882-8374
chemistry@missouri.edu

The Department of Chemistry offers four undergraduate degree tracks, three leading to a Bachelor of Science and one leading to a Bachelor of Arts. A minor in chemistry and a Bachelor of Science degree with departmental honors also are offered.

At the graduate level, the department offers MS and PhD degrees in Chemistry.

Faculty

Curators Professor J. L. Atwood**
Rabjohn Professor M. Harmata**
Schlundt Professor K. S. Gates**
Assistant Professor G. A. Baker**, S. N. Baker**, M. Lee**
Assistant Teaching Professor B. C. Ganley
Instructor L. P. Silverman

• Graduate Faculty Member - membership is required to teach graduate-level courses, chair master's thesis committees, and serve on doctoral examination and dissertation committees.
• Doctoral Faculty Member - membership is required to chair doctoral examination or dissertation committees. Graduate faculty membership is a prerequisite for Doctoral faculty membership.

Undergraduate

• Department Level Requirements (http://catalog.missouri.edu/undergraduategraduate/collegeofartsandscience/chemistry/departmentlevelrequirements)
• BA in Chemistry (http://catalog.missouri.edu/undergraduategraduate/collegeofartsandscience/chemistry/bs-chemistry)
• BS in Chemistry (http://catalog.missouri.edu/undergraduategraduate/collegeofartsandscience/chemistry/bs-chemistry)
• Minor in Chemistry (http://catalog.missouri.edu/undergraduategraduate/collegeofartsandscience/chemistry/minor-chemistry)

Graduate

• MS in Chemistry (http://catalog.missouri.edu/undergraduategraduate/collegeofartsandscience/chemistry/ms-chemistry)
• PhD in Chemistry (http://catalog.missouri.edu/undergraduategraduate/collegeofartsandscience/chemistry/phd-chemistry)

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Director of Graduate Studies: Kent Gates
The Department of Chemistry offers graduate degrees in all areas of modern chemistry, including analytical, biological, computational, inorganic, organic, physical and radiochemistry.

Resources and Facilities
The department has well-equipped laboratories that contain state-of-the-art instrumentation and computing facilities for research. Major instrumentation includes NMR, X-ray diffraction and mass spectrometry centers, as well as a nuclear/radiochemistry lab. Other campus facilities widely used by the department include a central instrument shop, electronics shop, campus computing center and a 10-megawatt nuclear reactor. The latter provides a high neutron flux for radioisotope production, neutron activation analysis and neutron diffraction studies.

Internal Funding
Fellowships and teaching and research assistantships are available for highly qualified applicants. Application forms are available on the department’s website and should be submitted by February 1.

Graduate Degree Requirements
Students are strongly encouraged to visit the Department of Chemistry site (http://chemistry.missouri.edu) for the most up-to-date information.

Entrance Criteria
An applicant for graduate work in chemistry should have either a Bachelor of Arts or Bachelor of Science degree in chemistry, essentially equivalent to those awarded at MU, with at least a B average or a score at the 70th percentile on the GRE general test.

Examinations
All new graduate students in chemistry are required to take Departmental placement/qualifying examinations in all core areas (analytical, inorganic, organic and physical) prior to registration. Students must qualify in two areas. A student who performs well on an exam, as determined by the department’s Graduate Program Committee, will be considered to have qualified in that area. Students who do not qualify in particular areas, via the placement examinations, must pass appropriate advanced-level courses in those areas to qualify. An A or B grade is required in these courses for qualification.

Research, Advising, and the Committee
Affiliation with research advisor must be made by the end of the first year. All students who wish to remain in the program must pass the annual Departmental Research Progress Report to their committee for consideration. All students are expected to attend Departmental Colloquium and Organic/DyNAMITE seminars.

CHEM 1000: Introductory Chemistry
Introductory course for students with no high school background in chemistry. Covers fundamental principles of scientific measurement, stoichiometry, solutions, basic atomic structure, gases. No credit if taken after CHEM 1100.
Chemistry

Credit Hours: 2
Prerequisites or Corequisites: MATH 1100 or MATH 1120

CHEM 1100: Atoms and Molecules with Lab
One-semester introduction for non-science majors to the basic concepts and important applications of chemistry. Satisfies A&S requirement for a laboratory science. No credit if taken after CHEM 1310.
Credit Hours: 3

CHEM 1100H: Atoms and Molecules with Laboratory - Honors
One-semester introduction for non-science majors to the basic concepts and important applications of chemistry. Satisfies A&S requirement for a laboratory science. No credit if taken after CHEM 1310.
Prerequisites: Honors eligibility required

CHEM 1320: College Chemistry I
First of two-course sequence emphasizing principles and applications of modern chemical sciences. Covers chemical nomenclature, stoichiometry, kinetic molecular theory, atomic structure, periodic properties, and molecular structure and bonding. Satisfies laboratory science requirement. Math Reasoning Proficiency Course.
Credit Hours: 4
Prerequisites: MATH 1100 or MATH 1120 or equivalent

CHEM 1320H: College Chemistry I - Honors
First of a two-course sequence emphasizing principles and applications of modern chemical sciences. Covers chemical nomenclature, stoichiometry, kinetic molecular theory, atomic structure, periodic properties, and molecular structure and bonding. Satisfies laboratory science requirement. Math Reasoning Proficiency Course.
Credit Hours: 4
Prerequisites: MATH 1100 or MATH 1120 or equivalent. Honors eligibility required

CHEM 1330: College Chemistry II
Continuation of CHEM 1320. Covers intermolecular forces, solutions, kinetics, acid-base chemistry, electrochemistry, nuclear chemistry, thermodynamics. Satisfies requirement for a laboratory science. May be taken concurrently with CHEM 2030 or CHEM 2100.
Credit Hours: 4
Prerequisites: grade of C- or better in CHEM 1320 or CHEM 1320H

CHEM 1330H: College Chemistry II- Honors
Continuation of CHEM 1320H. Covers equilibria, kinetics, electrochemistry, nuclear chemistry, thermodynamics. Satisfies requirement for a laboratory science. May be taken concurrently with CHEM 2030 or CHEM 2100.
Credit Hours: 4
Prerequisites: grade of C- or better in CHEM 1320 or CHEM 1320H. Honors eligibility required

CHEM 1500H: Honors Intensive General Chemistry with Lab - Honors
A one-semester, intensive introduction to chemistry for honors-eligible students that takes the place of CHEM 1320, CHEM 1330. Four lectures and one 3-hour lab period per week. Math Reasoning Proficiency Course.
Credit Hours: 5
Prerequisites: honors eligibility, college algebra and one year of high school chemistry or instructor's consent

CHEM 2030: Survey of Organic Chemistry
One-semester introduction to structure and bonding, functional group chemistry, principles of reactivity, reaction mechanisms, the molecules of life.
Credit Hours: 3
Prerequisites: Grade of C or better in CHEM 1320 or CHEM 1320H or equivalent. Recommended CHEM 1330, or CHEM 1330 concurrently

CHEM 2100: Organic Chemistry I
First course of a two-semester sequence. Structure and bonding; chemistry of hydrocarbons, alkyl halides, alcohols and ethers; reaction mechanisms; principles of reactivity and synthesis; IR and NMR spectroscopy. Only 1 hour credit if taken after CHEM 2030 or equivalent. Prerequisites: grade of C or better in CHEM 1320 or equivalent or CHEM 1330 concurrently.
Credit Hours: 3
Recommended: CHEM 1330

CHEM 2110: Organic Chemistry II
Continuation of CHEM 2100. Aromatic hydrocarbons, carbonyls, amines; chemistry of carbanions; reactions of polar double bonds; nucleic acids, proteins, carbohydrates and fats.
Credit Hours: 3
Prerequisites: grade of C or better in CHEM 2100 or equivalent, or departmental consent

CHEM 2130: Organic Laboratory I
Basic lab techniques, functional group manipulations, and short syntheses. Pre-lab and post-lab writing assignments. 1 hour recitation, 3 hours lab per week.
Credit Hours: 2
Recommended: Concurrent enrollment in CHEM 2110 or CHEM 2030. No credit for students who have previous organic laboratory credit

CHEM 2140: Organic Laboratory II
Continuation of CHEM 2130. Preparation and identification of organic compounds; application of instrumental techniques. 2 lab sessions, 1 recitation session per week.
Credit Hours: 2
Prerequisites: grade of C or better in CHEM 2110 and CHEM 2130 or equivalent

CHEM 2160H: Honors Organic Chemistry I - Honors
First course of a two-semester sequence. Similar to CHEM 2100 but with increased depth and breadth; emphasis on preparing science students
for research and professional careers. 3 lectures, 1 discussion session per week.

**CHEM 2170H: Honors Organic Chemistry II with Lab - Honors**  
Continuation of CHEM 2160H; includes laboratory. Content and structure similar to CHEM 2110, but with increased depth and breadth.

**Credit Hours:** 5  
**Prerequisites:** honors eligibility, grade of B or better in CHEM 2160H or instructor's permission

**CHEM 2190H: Honors Organic Chemistry Laboratory - Honors**  
Preparation and identification of organic compounds; multistep syntheses; application of instrumental techniques, including NMR, FTIR, MS and HPLC. 2 lab sessions, 1 discussion session per week.

**Credit Hours:** 2  
**Prerequisites:** honors eligibility, grade of C or better in CHEM 2170H or equivalent

**CHEM 2400: Fundamentals of Inorganic Chemistry with Lab**  
A systematic introduction with laboratory to inorganic and organometallic compounds, reactions, and periodic properties.

**Credit Hours:** 3  
**Prerequisites:** grade of C or better in CHEM 1330

**CHEM 2950: Undergraduate Research in Chemistry**  
A laboratory research project and/or preparation of compounds with a written final report. Cannot be substituted for other chemistry courses required for a B.S. or B.A. degree. No more than 6 hrs. total credit.

**Credit Hour:** 1-3  
**Prerequisites:** sophomore standing, 2.75 GPA and/or instructor's consent

**CHEM 3200: Quantitative Methods of Analysis with Lab**  
Principles and practice of quantitative analysis, including the basic principles of modern instrumental methods.

**Credit Hours:** 4  
**Prerequisites:** CHEM 1330 or CHEM 1500H

**CHEM 3300: Fundamentals of Physical Chemistry**  
Survey of physical chemistry. Satisfies physical chemistry prerequisite for BIOCHM 8430.

**Credit Hours:** 3  
**Prerequisites:** MATH 1700, a course in organic chemistry; PHYSCS 1210 and PHYSCS 1220 or PHYSCS 2175, or PHYSCS 2176 concurrently

**CHEM 3310: Physical Chemistry I**  
Lecture only. Topics include the kinetic theory of gases, chemical kinetics, thermodynamics and chemical equilibrium.

**Credit Hours:** 3

**Prerequisites:** one semester organic chemistry and PHYSCS 2175, PHYSCS 2176 and MATH 2300, or MATH 2300 concurrently

**CHEM 3330: Physical Chemistry II**  
Continuation of CHEM 3310. Lecture only. Covers wave mechanics, bonding, molecular spectroscopy and statistical mechanics.

**Credit Hours:** 3

**CHEM 3340: Physical Chemistry Laboratory**  
**Credit Hours:** 3  
**Prerequisites:** Grade of C or better in CHEM 3200; CHEM 3330 or CHEM 3330 concurrently

**CHEM 3700: Undergraduate Seminar in Chemistry**  
Methods for locating and presenting chemical information, data analysis techniques, professional issues.

**Credit Hours:** 3  
**Prerequisites:** CHEM 1330 or CHEM 1500H; CHEM 2100 or CHEM 2160H

**CHEM 3700W: Undergraduate Seminar in Chemistry - Writing Intensive**  
Methods for locating and presenting chemical information, data analysis techniques, professional issues.

**Credit Hours:** 3  
**Prerequisites:** CHEM 1330 or CHEM 1500H; CHEM 2100 or CHEM 2160H

**CHEM 3800: Internship in Chemistry**  
Cannot be substituted for other chemistry courses required for B.S. or B.A. degree.

**Credit Hour:** 1-6  
**Prerequisites:** departmental consent

**CHEM 3940: Service-Learning in Chemistry**  
A service-learning community outreach program affording chemistry students with an opportunity to enhance their problem-solving skills. May be repeated once for credit. Satisfies no specific chemistry degree requirements, nor Arts and Science general education requirements. Graded on a S/U basis only.

**Credit Hours:** 2  
**Prerequisites:** departmental consent

**CHEM 4001: Topics in Chemistry - General**  
Organized study designed to broaden the knowledge base of students. Subjects on analytical, inorganic, organic and physical chemistry covered.

**Credit Hour:** 1-99  
**Prerequisites:** departmental consent

**CHEM 4003: Topics in Chemistry- Natural Science**  
Organized study designed to broaden the knowledge base of students. Subjects on analytical, inorganic, organic and physical chemistry covered.

**Credit Hour:** 1-99  
**Prerequisites:** departmental consent
CHEM 4010: Advanced Chemistry Laboratory
Advanced methods for the synthesis and characterization of organic, inorganic, and organometallic compounds.
Credit Hours: 3
Prerequisites: CHEM 2400, CHEM 2140, or CHEM 2190H, CHEM 3200, CHEM 3330 (or CHEM 3330 corequisite)

CHEM 4050: Problems in Chemistry
Individual study under the direction of a faculty member that supplements regular course work.
Credit Hour: 1-99
Prerequisites: instructor's consent

CHEM 4160: Intermediate Organic Chemistry
Stresses synthetic organic chemistry at an intermediate level.
Credit Hours: 3
Prerequisites: at least one year organic chemistry

CHEM 4170: Medicinal Chemistry
Chemical mechanisms of drug action. Topics include drug metabolism and action, chemical toxicology and medicines, enzyme activity, and specific drug case studies.
Credit Hours: 3
Prerequisites: CHEM 2110, or CHEM 2170H, CHEM 3300 or CHEM 3310 or instructor's consent

CHEM 4200: Instrumental Methods of Analysis with Lab
(cross-leveled with CHEM 7200). Chemical instrumentation methods including electrochemistry, spectroscopy, and advanced separations techniques.
Credit Hours: 3
Prerequisites: CHEM 3200, a semester of physical chemistry

CHEM 4280: Environmental Chemistry
Surveys the chemistry of air and water environments; discusses the chemistry of waste treatment.
Credit Hours: 3
Prerequisites: 8 hours chemistry including organic and analytical

CHEM 4290: Environmental-Toxicological Chemistry
In-depth study of the chemical aspects of current issues dealing with environmental pollutants and toxic chemical substances.
Credit Hours: 3
Prerequisites: CHEM 4280

CHEM 4400: Inorganic Chemistry
(cross-leveled with CHEM 7400). Atomic and molecular structure, bonding, kinetics and mechanism, ligand field theory, coordination compounds, acids and bases.
Credit Hours: 3
Prerequisites: one semester Physical Chemistry, second semester concurrently

CHEM 4490: Physics and Chemistry of Materials
(same as NU_ENG 4319, PHYSCS 4190 and BIOL_EN 4480; cross-leveled with CHEM 7490, NU_ENG 7319, PHYSCS 7190, BIOL_EN 7480). Undergraduate/graduate level course offered every spring semester for students from Physics, Chemistry, Engineering and Medical Departments and consists of lectures, laboratory demonstrations, two midterm and one final exam. Graduate students will submit a term paper.
Credit Hours: 3
Prerequisites: PHYSCS 2760 and CHEM 1320

CHEM 4600: Introduction to Radiochemistry with Lab
(same as NU_ENG 4391). Introduces application of radio-tracer techniques to chemical research.
Credit Hours: 3
Prerequisites: CHEM 1330 or CHEM 1500H; and one semester of physical chemistry, or instructor's consent

CHEM 4800: Chemistry Teaching Practicum
Provides practical experience teaching introductory chemistry in discussion and laboratory settings. For students pursuing dual degrees in chemistry and secondary education. For students pursuing simultaneous dual degrees in chemistry and secondary education. Graded on S/U basis only.
Credit Hours: 3
Prerequisites: senior standing; departmental consent required

CHEM 4950: Senior Research
A laboratory research project with approved written goals and a final written report. It may be taken twice.
Credit Hours: 3
Prerequisites: a 2.75 GPA, departmental consent

CHEM 4990H: Senior Honors Research I
A laboratory research experience with a student-instructor prepared outline approved by the Honors Director, a final written report and a final oral presentation and examination.
Credit Hours: 3
Prerequisites: a 3.33 GPA, departmental consent, approval of project outline. Honors eligibility required

CHEM 4991H: Senior Honors Research II
A laboratory research experience with a student-instructor prepared outline approved by the Honors Director, a final written report and a final oral presentation and examination.
Credit Hours: 3
Prerequisites: a 3.33 GPA, departmental consent, approval of project outline. Honors eligibility required

CHEM 7087: Seminar in Chemistry for Beginning Graduate Students
Seminar in Chemistry for Beginning Graduate Students
Credit Hour: 1
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
</tr>
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<tbody>
<tr>
<td>CHEM 7200</td>
<td>Instrumental Methods of Analysis with Lab (cross-leveled with CHEM 4200)</td>
<td>Chemical instrumentation methods including electrochemistry, spectroscopy, and advanced separations techniques.</td>
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<td><strong>Credit Hours:</strong> 3</td>
<td><strong>Prerequisites:</strong> CHEM 3200, a semester of physical chemistry</td>
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<tr>
<td>CHEM 7300</td>
<td>Intermediate Physical Chemistry</td>
<td>Treatment of atomic and molecular, structure and spectroscopy based on quantum concepts. Designed to provide a broad base of knowledge in these fundamental areas to beginning graduate students in chemistry.</td>
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<td><strong>Credit Hours:</strong> 3</td>
<td><strong>Prerequisites:</strong> departmental consent</td>
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<tr>
<td>CHEM 7400</td>
<td>Inorganic Chemistry (cross-leveled with CHEM 4400)</td>
<td>Atomic and molecular structure, bonding, kinetics and mechanism, ligand field theory, coordination compounds, acids and bases.</td>
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<td><strong>Credit Hours:</strong> 3</td>
<td><strong>Prerequisites:</strong> one semester Physical Chemistry, second semester concurrently</td>
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<tr>
<td>CHEM 7490</td>
<td>Physics and Chemistry of Materials (same as NU_ENG 7319, PHYSCS 7190, BIOL_EN 7480; cross-leveled with CHEM 4490, NU_ENG 4319, PHYSCS 4190, BIOL_EN 4480). Undergraduate/graduate level course offered every winter semester for students from Physics, Chemistry, Engineering and Medical Departments and consists of lectures, laboratory demonstrations, two midterm and one final exam. Graduate students will submit a term paper.</td>
<td><strong>Credit Hours:</strong> 3 <strong>Prerequisites:</strong> PHYSCS 2760 and CHEM 1320 or equivalent and instructor's consent</td>
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<tr>
<td>CHEM 8003</td>
<td>Topics in Chemistry - Natural Science</td>
<td>Organized study of selected topics. Subjects and earned credit may vary from semester to semester. Repeatable upon consent of department.</td>
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<td><strong>Credit Hour:</strong> 1-99</td>
<td><strong>Prerequisites:</strong> instructor's consent</td>
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<tr>
<td>CHEM 8020</td>
<td>Introduction to X-ray Crystallography</td>
<td>Designed for students in chemistry and related fields. Aimed at offering a practical understanding of single-crystal x-ray structural studies. Includes hands-on laboratory work (data collection and analysis).</td>
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<td><strong>Credit Hours:</strong> 3</td>
<td><strong>Prerequisites:</strong> instructor's consent</td>
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<tr>
<td>CHEM 8050</td>
<td>Non-Thesis Research in Chemistry</td>
<td>Does not lead to dissertation.</td>
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<td><strong>Credit Hour:</strong> 1-99</td>
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<tr>
<td>CHEM 8085</td>
<td>Topics in Chemistry</td>
<td>Organized study of selected topics. Subjects and earned credit may vary from semester to semester. Repeatable upon consent of department.</td>
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<td><strong>Credit Hour:</strong> 1-99</td>
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**CHEM 8087:** Seminar in Chemistry  
Seminar in Chemistry  
**Credit Hour:** 1  
**CHEM 8090:** Thesis/Dissertation (pre-candidacy) Research in Chemistry  
Research leading to thesis. Graded on a S/U basis only.  
**Credit Hour:** 1-99  
**CHEM 8120:** Physical Organic Chemistry I  
Bonding theory, physical methods, absorption spectroscopy, conformational analysis, mechanism of reactions.  
**Credit Hours:** 3  
**CHEM 8130:** Physical Organic Chemistry II  
Case studies and methods for determining organic reaction mechanisms.  
**Credit Hours:** 3  
**CHEM 8150:** Organic Reaction Mechanisms  
Organic reaction mechanisms are discussed within a framework of structure-reactivity relationships. Particular attention directed to the chemistry of reactive intermediates and the application of stereochemical and molecular orbital concepts.  
**Credit Hours:** 3 **Prerequisites:** 1 year of Organic Chemistry and Physical Chemistry  
**CHEM 8160:** Organic Spectroscopy  
Structural analysis of organic compounds involving problem solving using modern NMR, IR, UV-VIS, MS CD/ORD and other spectroscopic techniques.  
**Credit Hours:** 3 **Prerequisites:** CHEM 3330 or equivalent or instructor's consent  
**CHEM 8170:** Applications of the Reactions of Organic Chemistry  
**Credit Hours:** 3  
**CHEM 8210:** Analytical Measurement  
Fundamental and applied aspects of scientific measurements. Topics include: Statistics, signal-to-noise, frequency analysis, sources of noise, digital and analog filtering, time vs. frequency domain measurements, Fourier transformation, sampling, convolution/deconvolution, autocorrelation and cross-correlation. Directed toward entering graduate students.  
**Credit Hours:** 3  
**CHEM 8230:** Separations and Chromatography  
Classical and instrumental methods of separation: gas, paper, thin film, and column chromatography; ion exchange.  
**Credit Hours:** 3
### CHEM 8240: Mass Spectrometry
This course will cover various aspects of modern mass spectrometry. Topics will include instrumentation, theory, uses and interfaces to mass spectrometry. Graded on A-F basis only.

**Credit Hours:** 3

### CHEM 8250: Analytical Spectroscopy
Selected topics dealing with recent advances in analytical chemistry.

**Credit Hours:** 3

### CHEM 8260: Surface Analysis and Characterization
Covers various aspects of modern methods of surface analysis and characterization. Topics include instrumentation, theory, and data reduction methods. Major sections include electron spectroscopy, microscopy, and vibrational spectroscopy as applied to surfaces. Graded on A-F basis only.

**Credit Hours:** 3

### CHEM 8265: Fluorescence Spectroscopy
Advanced analytical chemistry course that explores the fundamental principles and uses of modern fluorescence spectroscopy in biology, materials science, chemistry, physics and engineering. Special emphasis is placed on the methodologies used to obtain specific information about a particular chemical system. Graded on A-F basis only.

**Credit Hours:** 3

### CHEM 8270: Advanced Analytical Chemistry
Continuation of CHEM 8250.

**Credit Hours:** 3

### CHEM 8280: Bioanalytical Chemistry
This course is aimed at introducing students to the instrumental and theoretical principles by which biological molecules are measured in vivo and in vitro. The course explores how protein, DNA and metabolite structures and quantities are determined in the laboratory with an emphasis on understanding historical methods up through cutting edge approaches in each field. The theory of measurement techniques, separation techniques and related instrumentation are explored in the context of understanding the chemical equilibria that govern each instance. Students will leave this course with a broad understanding for how many biological molecules are measured and what the limitations of various techniques may be. Graded on A-F basis only.

**Credit Hours:** 3

### CHEM 8285: Nanochemistry
Covers various aspects of nanochemistry. Topics include synthesis and characterization of nonmaterial, nanotoxicity, and catalysis. Graded on A-F basis only.

**Credit Hours:** 3

### CHEM 8300: Advanced Physical Chemistry
Advanced Physical Chemistry

**Credit Hours:** 3

### CHEM 8310: Quantum Chemistry
Introduction to formal quantum mechanical theory, quantum measurement, simple model problems having exact solutions, angular momenta, approximation methods (perturbation theory, variation principle, WKB), and the structure of many-electron atoms.

**Credit Hours:** 3

**Prerequisites:** CHEM 3300 or equivalent or instructor's consent

### CHEM 8320: Chemical Kinetics
Factors affecting rates, orders and mechanisms of chemical reactions, with emphasis on current theories and experimental techniques.

**Credit Hours:** 3

**Prerequisites:** CHEM 3300 or equivalent or instructor's consent

### CHEM 8330: Computational Chemistry
Theory and application of modern computational techniques (molecular mechanics, ab initio and semiempirical molecular orbital methods) for predicting the structures, energies, and properties of molecules and molecular systems.

**Credit Hours:** 3

**Prerequisites:** CHEM 3300 or equivalent or instructor's consent

### CHEM 8340: Statistical Mechanics
Principles of statistical mechanics and their application to chemical systems; ensemble theory; condensed phases.

**Credit Hours:** 3

**Prerequisites:** CHEM 3300 or equivalent or instructor's consent

### CHEM 8350: Magnetic Resonance
Basic principles of nuclear magnetic resonance (NMR) and electron spin resonance (ESR), nuclear spin relaxation, current experimental techniques and the application to studies of structures, dynamics and chemical analysis.

**Credit Hours:** 3

**Prerequisites:** One year of organic chemistry, CHEM 3300 or equivalent

### CHEM 8400: Inorganic Mechanisms
Experimental stoichiometry and rate law determination. Isotopic applications. Methods and results of fast reaction studies. Basic known inorganic mechanisms. Experimental methods of establishing mechanisms of reaction.

**Credit Hours:** 3

### CHEM 8410: Chemistry of the Main Group Elements
Descriptive inorganic chemistry of the main group elements. Textbook material extensively supplemented with information from the current chemical literature.

**Credit Hours:** 3

### CHEM 8420: Supramolecular Chemistry
The basics of supramolecular chemistry will be covered, including host-guest complexes, reorganization, complementarily, thermodynamic interactions, self assembly and biochemical, molecular device and crystal engineering applications. Graded on A-F basis only.

**Credit Hours:** 3
Credit Hours: 3  
Prerequisites: BS in Chemistry, Biochemistry or Chemical Engineering

**CHEM 8430: Coordination Chemistry and Reactivity**  
The chemistry of the transition elements (d-block) and their reactivity will be discussed, including bonding, coordination numbers, oxidation states, and reactivity (kinetics). Graded on A-F basis only.

Credit Hours: 3  
Prerequisites: CHEM 4400 or equivalent; graduate standing in chemistry or instructor's consent

**CHEM 8440: Inorganic Structural Methods**  
Chemical bonding, application of group theory, spectroscopy; diffraction as applied to structure determination; structural implications of dipole moment and magnetic susceptibility measurements.

Credit Hours: 3

**CHEM 8450: Organometallics**  
Condensations effected by organometallics; dissolving metal reductions; sandwich compounds and related organotransition metal derivatives.

Credit Hours: 3

**CHEM 8460: Solid State Chemistry**  

Credit Hours: 3

**CHEM 8470: Actinide Chemistry**  
The course covers the inorganic and organometallic chemistry of the actinides. Graded on A-F basis only.

Credit Hours: 3

**CHEM 8480: Chemistry of Nanomaterials**  
This course will cover several aspects of nanomaterials including synthesis and processing of small particles, as well as their characterization by crystallography, scanning tunneling microscopy, magnetism, and other optical properties. Also studied will be the application of quantum confinement to the electronic and optical properties of nanomaterials and the development of photonic materials. The nanostructure of organic polymers, micelles, and the process of biomineralization to make organic-inorganic hybrid materials will also be discussed.

Credit Hours: 3

**CHEM 8600: Radiochemistry and Detection with Lab**  
An introductory course in the applications of radionuclides in chemistry. Topics include radioactive decay, interactions of radiation with matter, radioactive tracers, and nuclear methods of analysis. Directed towards entering graduate students.

Credit Hours: 3

**CHEM 8610: Advanced Radiochemistry**  
Reviews current advances in radiochemistry, hot atom chemistry, radiation chemistry, nuclear spectrometry.

Credit Hours: 3  
Prerequisites: CHEM 8600 or equivalent

**CHEM 8620: Nuclear Chemistry**  
Designed for graduate students in chemistry and related fields. Studies nuclear reaction and nuclear properties.

Credit Hours: 3  
Prerequisites: CHEM 3300, MATH 2300 or instructor's consent

**CHEM 8630: Radiopharmaceutical Chemistry**  
The radiotracer concept, history of nuclear medicine, radionuclide production, organic and inorganic chemistry of radiopharmaceutical chemistry, and applications will be discussed. Graded on A-F basis only.

Credit Hours: 3  
Prerequisites: undergraduate organic and inorganic chemistry; graduate standing in chemistry or instructor's consent

**CHEM 8640: Biological Radiochemistry**  
Covers the interaction of radiation on biological material. The effects of radiation overdose is discussed along with the use of radiation in therapy. Graded on A-F basis only.

Credit Hours: 3

**CHEM 9090: Post-candidacy Dissertation Research in Chemistry**  
Research leading to Ph.D. dissertation. Graded on a S/U basis only.

Credit Hour: 1-99