CHEM 821 Analytical Chemistry
Crosslisted with: CHEM 421
Prerequisites: CHEM 471/871 or 481/881; parallel CHEM 423/823
Description: Chemical and physical properties applied to quantitative chemical analysis. Solution equilibria, stoichiometry, and instrumental theory and techniques.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 823 Analytical Chemistry Laboratory
Crosslisted with: CHEM 423
Prerequisites: Same as for CHEM 421/821.
Description: Lab designed to accompany CHEM 421/821. Applications of analytical chemical principles to laboratory problems.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Format: LAB

CHEM 824 Applied Problems in Analytical Chemistry
Prerequisites: CHEM 821
Description: Selection and execution of analytical methods in the solution of typical academic and industrial chemical problems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 825A Ionic Equilibria
Prerequisites: or parallel: CHEM 821 or *824
Description: Survey of theory of ionic equilibrium systems of importance in chemical analysis.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LEC

CHEM 825B Electrochemical Methods
Prerequisites: CHEM 821 or *824
Description: Survey of principles and applications of electroanalytical chemistry.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Format: LEC

CHEM 825D Mass Spectrometry
Prerequisites: CHEM 821 or *824
Description: Survey of the fundamentals (1 cr) and applications (1 cr) of mass spectrometry.
Credit Hours: 1-2
Min credits per semester: 1
Max credits per semester: 2
Max credits per degree: 2
Format: LEC

CHEM 825E Data Handling
Prerequisites: or parallel: CHEM 821 or *824
Description: Application of statistical, graphical and numerical methods for the treatment of analytical chemical data.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LEC

CHEM 825G Chromatographic Separations
Prerequisites: CHEM 821 or *824
Description: Survey of principles and applications of modern chromatographic analysis.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Format: LEC

CHEM 825J Optical Methods of Analysis
Prerequisites: CHEM 821 or *824
Description: Survey of principles and analytical application of modern optical spectrometric methods.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Format: LEC

CHEM 831 Structure and Metabolism
Crosslisted with: BIOC 431, BIOC 831, BIOS 431, BIOS 831, CHEM 431
Prerequisites: CHEM 252 or CHEM 262 with a grade of C or better. LIFE 120 and BIOS 206 are recommended.
Notes: First course of a two-semester, comprehensive biochemistry course sequence.
Description: Structure and function of proteins, nucleic acids, carbohydrates and lipids; nature of enzymes; major metabolic pathways of catabolism; and biochemical energy production.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: VBMS 410

CHEM 832 Metabolism and Biological Information
Crosslisted with: BIOC 432, BIOC 832, BIOS 432, CHEM 432, BIOS 832
Prerequisites: BIOC 431/831 with a grade of C or better, BIOS 206 or AGRO 215.
Notes: Continuation of BIOC 431/831.
Description: Major metabolic pathways of anabolism, structural and biochemical aspects of biological information flow and use in biotechnology.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: BIOC 435; BIOC 934, BIOS 934, CHEM 934
CHEM 833 Biochemistry Laboratory
Crosslisted with: BIOC 433, BIOC 833, BIOS 833, BIOS 833, CHEM 433
Prerequisites: BIIR 431/831 (or concurrent enrollment) or CHEM 435/835.
Description: Introduction to techniques used in biochemical and biotechnology research, including measurement of pH, spectroscopy, analysis of enzymes, chromatography, fractionation of macromolecules, electrophoresis, and centrifugation.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Format: LEC

CHEM 834 Plant Biochemistry
Crosslisted with: AGRO 434, BIOC 434, BIOS 434, CHEM 434, AGRO 834, BIOC 834, BIOS 834
Prerequisites: BIOC/BIOS/CHM 431/831.
Description: Biochemical metabolism unique to plants. Relationships of topics previously acquired in general biochemistry to biochemical processes unique to plants. Biochemical mechanisms behind physiological processes discussed in plant or crop physiology.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 835 Chemical Biology
Prerequisites: CHEM 252 or 262, and 871 or 881
Description: Use of recent advances in genomics to organize the field of biochemistry as well as an understanding of how biologists, biochemists and chemists use this information to cure diseases. Credit toward the degree cannot be earned in both CHEM 835, and 831 and/or 832 or their equivalents.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: CHEM 936

CHEM 836 Physical Basis of Macromolecular Function
Crosslisted with: BIOC 836
Description: Introduction to the theory and practice of biophysical characterization of macromolecules. The course will be based on primary research literature, although a supporting text will be used for in depth discussion of the methods.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 841 Inorganic Chemistry
Crosslisted with: CHEM 441
Prerequisites: CHEM 252 or 262, and 264; parallel: CHEM 441 and the accompanying lab course, CHEM 443/843, constitute a basic course in inorganic chemistry. Structure, bonding, properties, and reactions of inorganic compounds with emphasis on the relationships and trends that are embodied in the periodic table of the elements.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 843 Inorganic Chemistry Laboratory
Crosslisted with: CHEM 443
Prerequisites: CHEM 252 or 262, and 264; parallel: CHEM 841
Notes: Parallel: CHEM 441/841 or permission.
Description: Introduction to typical inorganic chemistry laboratory techniques through the preparation and characterization of inorganic compounds.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Format: LEC

CHEM 845 Modern Inorganic Chemistry
Prerequisites: CHEM 841, 843, and 882 or permission
Description: Topics in inorganic chemistry such as bioinorganics, catalysis, organometallic, materials and solid state chemistry. Theoretical principles and practical applications, and on correlating the physical and chemical properties of the chemical elements and inorganic chemical compounds.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 848 Redox Biochemistry
Crosslisted with: BIOC 848
Prerequisites: 3 hrs BIOC and 3 hrs inorganic chemistry
Description: Redox (oxidation and reduction)-based biochemical processes (energy generation, oxygen transfer, enzyme catalysis, signaling, gene regulation, and diseases). Recent progress in these areas. Roles of metals in biochemical reactions, metal homeostasis, and biosynthesis of metal cofactors and metal sites. Biochemistry and pathophysiology of redoxactive species and radicals. Antioxidant molecules and enzymes.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 855 Advanced Organic Chemistry
Prerequisites: CHEM 252 or 262 or equivalent
Description: Survey of modern concepts of structure/bonding, acidity/baseity, stereochemistry, and reaction mechanisms. Introduction to the fundamental tools used to investigate reaction mechanism (transition state theory, elementary Huckel theory, linear free energy relationships, rate laws and kinetic isotope effects). Mechanistic examples emphasize the major classes of organic reactions, particularly concerted, carbanionic and carbocationic. Development of reasoning skills.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: CHEM 865A; CHEM 865B; CHEM 865E
CHEM 863 Advanced Organic Preparations
Crosslisted with: CHEM 463
Prerequisites: CHEM 252 or 254.
Notes: For students who wish additional laboratory work in organic chemistry.
Credit Hours: 1-5
Min credits per semester: 1
Max credits per semester: 5
Max credits per degree: 5
Format: LAB

CHEM 865A Organic Reactions
Prerequisites: CHEM 855 and permission
Description: Modern reactions and methodology for organic synthesis. Examples of topics which may be covered include cycloadditions, rearrangements, and radical-based transformations.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Format: LEC

CHEM 856B Advanced Organic Reactions
Prerequisites: CHEM 855 and permission
Description: Additional reactions of importance for organic synthesis.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LEC

CHEM 865E Bioconjugate Reactions
Prerequisites: CHEM 855 and permission
Description: Organic reactions of particular relevance to interdisciplinary research in analytical/bioanalytical chemistry, biochemistry, and the life sciences. Formation of esters, thioesters, and amides; surface functionalization of inorganic or polymer supports; methods for cross-linking, conjugation, or immobilization of chemicals and biomolecules.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LEC

CHEM 871 Physical Chemistry
Crosslisted with: CHEM 471
Prerequisites: CHEM 114 and 116, or 221, with a grade of 'C' or better; MATH 106 and 238, or 107; one year college physics.
Notes: Credit may not be earned in both CHEM 471/871 and CHEM 481/881.
Description: Conceptual and mathematical foundations of classical and statistical thermodynamics. Applications of thermodynamics to phase and chemical equilibria. Thermodynamics of solutions of small molecules and of polymers. Biological applications of thermodynamics. Introduction to chemical and biochemical spectroscopy.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC

CHEM 874 Topics in Chemical Pedagogy
Crosslisted with: TEAC 874
Description: Topical chemistry content for high school teachers organized according to the National Science Education Standards. A maximum combined total of 12 hours from TEAC *869 and/or *874 may be counted toward a masters degree. Credit in this course will not count towards a graduate degree in chemistry. Courses are Web-based.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 12
Format: LEC

CHEM 874A Topics in Chemical Pedagogy - Green Chemistry
Crosslisted with: TEAC 874A
Description: Topical chemistry content for high school teachers organized according to the National Science Education Standards. A maximum combined total of 12 hours from TEAC *869 and/or *874 may be counted toward a masters degree. Credit in this course will not count towards a graduate degree in chemistry. Courses are Web-based.
Credit Hours: 2-3
Min credits per semester: 2
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 874D Topics in Chemical Pedagogy - Demonstrations for High School Chemistry
Crosslisted with: TEAC 874D
Description: Topical chemistry content for high school teachers organized according to the National Science Education Standards. A maximum combined total of 12 hours from TEAC *869 and/or *874 may be counted toward a masters degree. Credit in this course will not count towards a graduate degree in chemistry. Courses are Web-based.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 874E Topics in Chemical Pedagogy - Experiments for High School Chemistry
Crosslisted with: TEAC 874E
Description: Topical chemistry content for high school teachers organized according to the National Science Education Standards. A maximum combined total of 12 hours from TEAC *869 and/or *874 may be counted toward a masters degree. Credit in this course will not count towards a graduate degree in chemistry. Courses are Web-based.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
CHEM 874J Topics in Chemical Pedagogy - Developing a Safety Culture
Crosslisted with: TEAC 874J
Description: Topical chemistry content for high school teachers organized according to the National Science Education Standards. A maximum combined total of 12 hours from TEAC *869 and/or *874 may be counted toward a masters degree. Credit in this course will not count towards a graduate degree in chemistry. Courses are Web-based.
Credit Hours: 1
Min credits per semester: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LEC

CHEM 874K Topics in Chemical Pedagogy - Chemistry of Life Processes: Biomolecules
Description: Topical chemistry content for high school teachers organized according to the National Science Education Standards. A maximum combined total of 12 hours from TEAC *869 and/or *874 may be counted toward a masters degree. Credit in this course will not count towards a graduate degree in chemistry. Courses are Web-based.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 874L Topics in Chemical Pedagogy - Addressing Misconceptions
Crosslisted with: TEAC 874L
Description: Topical chemistry content for high school teachers organized according to the National Science Education Standards. A maximum combined total of 12 hours from TEAC *869 and/or *874 may be counted toward a masters degree. Credit in this course will not count towards a graduate degree in chemistry. Courses are Web-based.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 874M Topics in Chemical Pedagogy - Mathematics Integration
Crosslisted with: MATH 874M, TEAC 874M
Description: Topical chemistry content for high school teachers organized according to the National Science Education Standards. A maximum combined total of 12 hours from TEAC *869 and/or *874 may be counted toward a masters degree. Credit in this course will not count towards a graduate degree in chemistry. May be counted towards the MAT and MSCT degrees in mathematics and statistics, not the MA, MS, or PhD. Courses are Web-based.
Credit Hours: 2-3
Min credits per semester: 2
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 874N Topics in Chemical Pedagogy - Inquiry Strategies
Crosslisted with: TEAC 874N
Description: Topical chemistry content for high school teachers organized according to the National Science Education Standards. A maximum combined total of 12 hours from TEAC *869 and/or *874 may be counted toward a masters degree. Credit in this course will not count towards a graduate degree in chemistry. Courses are Web-based.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 874Y Topics in Chemical Pedagogy - Graphing Calculator Activities
Crosslisted with: TEAC 874Y
Description: Topical chemistry content for high school teachers organized according to the National Science Education Standards. A maximum combined total of 12 hours from TEAC *869 and/or *874 may be counted toward a masters degree. Credit in this course will not count towards a graduate degree in chemistry. Courses are Web-based.
Credit Hours: 2-3
Min credits per semester: 2
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 875 Chemical Pedagogy in the High School Laboratory
Crosslisted with: TEAC 875
Description: Laboratory-based courses addressing specific issues connected with teaching laboratory work in high school chemistry programs. Credit in this course will not count towards a graduate degree in chemistry.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 875A Chemical Pedagogy in the High School Laboratory - Small-scale Experiments
Crosslisted with: TEAC 875A
Description: Laboratory-based courses addressing specific issues connected with teaching laboratory work in high school chemistry programs. Credit in this course will not count towards a graduate degree in chemistry.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
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<th>Credit Hours</th>
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<tr>
<td>CHEM 875B</td>
<td>Chemical Pedagogy in the High School Laboratory - Technology Integration</td>
<td>Laboratory-based courses addressing specific issues connected with teaching laboratory work in high school chemistry programs. Credit in this course will not count towards a graduate degree in chemistry.</td>
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<td>CHEM 875E</td>
<td>Chemical Pedagogy in the High School Laboratory - Inquiry Experiments</td>
<td>Laboratory-based courses addressing specific issues connected with teaching laboratory work in high school chemistry programs. Credit in this course will not count towards a graduate degree in chemistry.</td>
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<td>CHEM 875K</td>
<td>Chemical Pedagogy in the High School Laboratory - At-home Experiments</td>
<td>Laboratory-based courses addressing specific issues connected with teaching laboratory work in high school chemistry programs. Credit in this course will not count towards a graduate degree in chemistry.</td>
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<tr>
<td>CHEM 875P</td>
<td>Chemical Pedagogy in the High School Laboratory - Probe Experiments</td>
<td>Laboratory-based courses addressing specific issues connected with teaching laboratory work in high school chemistry programs. Credit in this course will not count towards a graduate degree in chemistry.</td>
<td>1-3</td>
<td>1</td>
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**CHEM 881 Physical Chemistry I**

- **Crosslisted with:** CHEM 481
- **Prerequisites:** CHEM 221 with grade of at least C; MATH 208; PHYS 212.
- **Notes:** Credit may not be earned in both CHEM 471/871 and 481/881.

**CHEM 882 Physical Chemistry II**

- **Crosslisted with:** CHEM 482
- **Prerequisites:** CHEM 481/881.
- **Notes:** This course should parallel CHEM 484/884. Continuation of CHEM 481/881.

<table>
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<tbody>
<tr>
<td>CHEM 883A</td>
<td>Physical Chemical Measurements</td>
<td>Applications of physical measurements and principles to study chemical systems and processes.</td>
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<tr>
<td>CHEM 884A</td>
<td>Physical Chemical Measurements</td>
<td>Applications of physical measurements and principles to study chemical systems and processes.</td>
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<tbody>
<tr>
<td>CHEM 885A</td>
<td>Survey of Modern Physical Chemistry</td>
<td>A one-semester survey course in modern physical chemistry, covering chemical thermodynamics, chemical kinetics, quantum chemistry, molecular structure and spectroscopy.</td>
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<tr>
<td>CHEM 875T</td>
<td>Chemical Pedagogy in the High School Laboratory - Traditional Experiments</td>
<td>Laboratory-based courses addressing specific issues connected with teaching laboratory work in high school chemistry programs. Credit in this course will not count towards a graduate degree in chemistry.</td>
<td>1-3</td>
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<td>CHEM 875T</td>
<td>Chemical Pedagogy in the High School Laboratory - Probe Experiments</td>
<td>Laboratory-based courses addressing specific issues connected with teaching laboratory work in high school chemistry programs. Credit in this course will not count towards a graduate degree in chemistry.</td>
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<td>CHEM 875T</td>
<td>Chemical Pedagogy in the High School Laboratory - Traditional Experiments</td>
<td>Laboratory-based courses addressing specific issues connected with teaching laboratory work in high school chemistry programs. Credit in this course will not count towards a graduate degree in chemistry.</td>
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<td>CHEM 875T</td>
<td>Chemical Pedagogy in the High School Laboratory - Probe Experiments</td>
<td>Laboratory-based courses addressing specific issues connected with teaching laboratory work in high school chemistry programs. Credit in this course will not count towards a graduate degree in chemistry.</td>
<td>1-3</td>
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</table>

- **CHEM 881 Physical Chemistry I**
- **CHEM 882 Physical Chemistry II**
CHEM 886 Advanced Topics in Biophysical Chemistry
Crosslisted with: BIOC 486, BIOC 886, BIOS 486, BIOS 886, CHEM 486
Prerequisites: CHEM 471/871 or 481/881.
Description: Applications of thermodynamics to biochemical phenomena, optical properties of proteins and polynucleotides, and kinetics of rapid reactions.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 898 Special Problems
Prerequisites: Permission
Credit Hours: 1-24
Min credits per semester: 1
Max credits per semester: 24
Max credits per degree: 24
Format: LEC

CHEM 898A Introduction to Graduate Research
Prerequisites: Admission to chemistry graduate program.
Description: Series of lectures and activities designed to prepare for graduate research and graduate studies in chemistry.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 898B Research Update Interview
Description: Preparation for and presentation of the Research Update Interview. Open to graduate students in Chemistry in the third semester of their program, or with instructor permission.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: IND

CHEM 898E Original Proposal Oral
Description: Preparation for and presentation of an Original Research Proposal. Open to graduate students in Chemistry in the sixth semester of their program, or with instructor permission.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: IND

CHEM 899 Masters Thesis
Prerequisites: Admission to masters degree program and permission of major adviser
Credit Hours: 1-10
Min credits per semester: 1
Max credits per semester: 10
Max credits per degree: 99
Format: IND

CHEM 932 Proteins
Crosslisted with: BIOC 932, BIOS 932
Prerequisites: BIOC/BIOS/CHEM 832 or BIOC/BIOS/CHEM *839
Description: Protein structure and function.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Format: LEC

CHEM 933 Enzymes
Crosslisted with: BIOC 933, BIOS 933
Prerequisites: BIOC/BIOS/CHEM 432/832, or BIOC/BIOS/CHEM *839
Description: Kinetics regulation and reaction mechanisms of enzymes.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Format: LEC

CHEM 934 Genome Dynamics and Gene Expression
Crosslisted with: BIOC 934, BIOS 934
Prerequisites: BIOC/BIOS/CHEM 832 or permission
Description: Detailed examination of dynamic control mechanisms of genome maintenance and gene regulation. Mechanisms of transcription, translation, and replication based on analysis of current and seminal literature.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 935 Metabolic Function and Dysfunction
Crosslisted with: BIOC 935, BIOS 935
Prerequisites: BIOC/CHEM/BIOS 432/832 and permission
Description: Current metabolic research at the bioenergetic, metabolomic, and molecular level. The normal metabolic processes that go awry in cancer, obesity, and oxidative stress.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 936 Molecular Biology Methods
Prerequisites: CHEM 431/831, or CHEM 835, or with instructor permission
Description: The fundamentals of molecular biology and biotechnology and applications. The fundamentals include methods for DNA cloning, sequencing, annotation, recombination, mutagenesis, and expression. The applications include the production of molecular diagnostics and therapeutic agents etc. with a focus on the molecular biotechnology of microbial systems.
Credit Hours: 2-3
Min credits per semester: 2
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CHEM 943 Solid-State Chemistry
Prerequisites: CHEM *845 and *885
Description: Advanced course dealing with the structure, bonding, properties, and reactions of inorganic solid materials.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Format: LEC

CHEM 945 Advanced Inorganic Chemistry
Prerequisites: CHEM *845
Description: Chemistry of the metallic compounds.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Format: LEC
CHEM 946 Organometallic Chemistry  
**Description:** The chemistry of compounds that occupy the boundary between inorganic and organic chemistry.  
**Credit Hours:** 1-6  
**Min credits per semester:** 1  
**Max credits per semester:** 6  
**Max credits per degree:** 6  
**Format:** LEC

CHEM 952 Stereochemistry of Organic Compounds  
**Prerequisites:** CHEM *855  
**Description:** Types of stereoisomerism in organic compounds. Steric strain and certain other steric effects in reactions of organic substances.  
**Credit Hours:** 2-4  
**Min credits per semester:** 2  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC

CHEM 953 Organic Reaction Mechanisms  
**Prerequisites:** CHEM *855  
**Description:** Classes of reaction mechanisms and the methods whereby mechanisms may be studied. Kinetic and equilibrium studies; isotopic labeling; activation parameters; linear free energy relationships; stereochemistry; NMR and other spectroscopic methods as applied to reaction mechanisms, including direct observation of reactive intermediates; interpreting the results of semi-empirical calculations of reaction pathways; and studies of acid- and base-catalysis mechanisms.  
**Credit Hours:** 2-4  
**Min credits per semester:** 2  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC

CHEM 954 Physical Organic Chemistry  
**Prerequisites:** CHEM *855  
**Description:** Elementary aspects of molecular orbital (MO) theory. Selected concepts in molecular symmetry and topology. Applications of MO calculations to reaction mechanisms and elucidation of electronic structure for organic molecules: calculations vs. experiment. Introduction to selected interdisciplinary topics.  
**Credit Hours:** 2-4  
**Min credits per semester:** 2  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC

CHEM 956 Advanced Synthetic Strategy  
**Prerequisites:** CHEM 865  
**Description:** Strategy and execution of organic synthesis. Retrosynthetic analysis; total synthesis of natural and unnatural products; methods for asymmetric synthesis; and applications of pericyclic reactions.  
**Credit Hours:** 2-4  
**Min credits per semester:** 2  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC

CHEM 964 Bioorganic Chemistry  
**Prerequisites:** CHEM *855  
**Description:** Organic chemistry of biological systems with particular emphasis on the molecular mechanisms of action of enzymes and their associated cofactors.  
**Credit Hours:** 2-4  
**Min credits per semester:** 2  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC

CHEM 965 Advanced Synthetic Strategy  
**Prerequisites:** CHEM 865  
**Description:** Strategy and execution of organic synthesis. Retrosynthetic analysis; total synthesis of natural and unnatural products; methods for asymmetric synthesis; and applications of pericyclic reactions.  
**Credit Hours:** 2-4  
**Min credits per semester:** 2  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC

CHEM 963 Metals in Organic Synthesis  
**Prerequisites:** CHEM 865  
**Description:** Use of organometallic reagents and catalysts in organic synthesis.  
**Credit Hours:** 2-4  
**Min credits per semester:** 2  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC

CHEM 962 Chemical Thermodynamics  
**Prerequisites:** CHEM *885  
**Description:** Principles of thermodynamics, with applications to chemical systems and processes, and illustrations from current literature.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC

CHEM 961 Chemical Kinetics  
**Prerequisites:** CHEM *885 or 982  
**Description:** Concepts and equations; successive, competing, and reversible reactions; equilibrium, collision, and activated-complex theories; reaction mechanism; heterogeneous reactions; current literature.  
**Credit Hours:** 2  
**Max credits per semester:** 2  
**Max credits per degree:** 2  
**Format:** LEC

CHEM 984 Chemical Thermodynamics  
**Prerequisites:** CHEM *885 or 982  
**Description:** Application of equilibrium statistical mechanics to problems of chemical interest. Calculation of thermodynamic functions from molecular structure data. Molecular theories of gases, liquids, and solutions.  
**Credit Hours:** 2  
**Max credits per semester:** 2  
**Max credits per degree:** 2  
**Format:** LEC
CHEM 987A Molecular Spectroscopy  
**Prerequisites:** CHEM 482/882 or *885 or 972; and permission.  
**Description:** A quantitative treatment of the principal methods of electronic, optical, and magnetic resonance spectroscopy.  
**Credit Hours:** 2  
**Max credits per semester:** 2  
**Max credits per degree:** 2  
**Format:** LEC  

CHEM 987B Scattering  
**Prerequisites:** CHEM 482/882 or *885 or 972; and permission.  
**Description:** A quantitative treatment of the principal methods of light, electron and neutron scattering.  
**Credit Hours:** 2  
**Max credits per semester:** 2  
**Max credits per degree:** 2  
**Format:** LEC  

CHEM 990 Seminar in Chemistry  
**Description:** CHEM 990 consists of monthly lectures presented by guest speakers from other colleges and universities, the government, and industry. Registration in CHEM 990 is required of all full-time CHEM graduate students. Current topics of chemical interest.  
**Credit Hours:** 1-5  
**Min credits per semester:** 1  
**Max credits per semester:** 5  
**Max credits per degree:** 5  
**Format:** LEC  

CHEM 991A Selected Topics in Analytical Chemistry  
**Prerequisites:** CHEM 821 or *824, or parallel  
**Credit Hours:** 1-6  
**Min credits per semester:** 1  
**Max credits per semester:** 6  
**Max credits per degree:** 6  
**Format:** LEC  

CHEM 991B Special Topics in Inorganic Chemistry  
**Prerequisites:** CHEM *845 and permission  
**Credit Hours:** 1-6  
**Min credits per semester:** 1  
**Max credits per semester:** 6  
**Max credits per degree:** 6  
**Format:** LEC  

CHEM 991E Special Topics in Organic Chemistry  
**Prerequisites:** CHEM *855  
**Description:** Topics of special interest in modern organic chemistry.  
**Credit Hours:** 2-4  
**Min credits per semester:** 2  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC  

CHEM 991J Special Topics in Physical Chemistry  
**Prerequisites:** CHEM 881 and 882, or *885  
**Credit Hours:** 1-6  
**Min credits per semester:** 1  
**Max credits per semester:** 6  
**Max credits per degree:** 6  
**Format:** LEC  

CHEM 992A Graduate Seminar in Analytical/Bioanalytical Chemistry  
**Prerequisites:** Graduate student enrollment in Chemistry, or permission  
**Credit Hours:** 1-6  
**Min credits per semester:** 1  
**Max credits per semester:** 6  
**Max credits per degree:** 6  
**Format:** LEC  

CHEM 992E Graduate Seminar in Organic Chemistry/Chemical Biology  
**Prerequisites:** Graduate student enrollment in Chemistry, or permission  
**Credit Hours:** 1-6  
**Min credits per semester:** 1  
**Max credits per semester:** 6  
**Max credits per degree:** 6  
**Format:** LEC  

CHEM 992J Graduate Seminar in Physical/Inorganic/Materials Chemistry  
**Prerequisites:** Graduate student enrollment in Chemistry, or permission.  
**Credit Hours:** 1-6  
**Min credits per semester:** 1  
**Max credits per semester:** 6  
**Max credits per degree:** 6  
**Format:** LEC  

CHEM 992K Seminar in Biological Chemistry  
**Crosslisted with:** BIOC 992K  
**Prerequisites:** BIOC 832 or *839; and permission  
**Credit Hours:** 1-2  
**Min credits per semester:** 1  
**Max credits per semester:** 2  
**Max credits per degree:** 2  
**Format:** LEC  

CHEM 999 Doctoral Dissertation  
**Prerequisites:** Admission to doctoral degree program and permission of supervisory committee chair  
**Credit Hours:** 1-24  
**Min credits per semester:** 1  
**Max credits per semester:** 24  
**Max credits per degree:** 99  
**Format:** IND