

CHEMISTRY (CHEM)

CHEM 101 – GENERAL CHEMISTRY I LABORATORY

1 credit.

Stoichiometry and the mole concept, chemical reactions, thermochemistry, electronic structure of atoms, periodic properties, chemical bonding, intermolecular forces, and the behavior of gases, liquids and solids. Equivalent to laboratory-only part of CHEM 103. Provides a mechanism for awarding credit for experiences with no lecture component. The combination of CHEM 101 and CHEM 105 is equivalent to CHEM 103.

Requisites: Consent of instructor

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Elementary

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 102 – GENERAL CHEMISTRY II LABORATORY

1 credit.

Principles and applications of chemical equilibrium, electrochemistry, thermodynamics, kinetics, organic chemistry and other topics that may include nuclear chemistry, biological chemistry and coordination chemistry. Equivalent to laboratory-only part of CHEM 104. Provides a mechanism for awarding credit for experiences with no lecture component. The combination of CHEM 102 and CHEM 106 is equivalent to CHEM 104.

Requisites: Consent of instructor

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Elementary

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 103 – GENERAL CHEMISTRY I

4 credits.

Stoichiometry and the mole concept, the behavior of gases, liquids and solids, thermochemistry, electronic structure of atoms and chemical bonding, descriptive chemistry of selected elements and compounds, intermolecular forces, and chemistry laboratory skills.

Requisites: MATH 112, 114, 171, 221, or placement into MATH 211 or 221. Not open to students with credit for CHEM 109 or 115

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Elementary

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 104 – GENERAL CHEMISTRY II

5 credits.

Principles and application of chemical equilibrium, coordination chemistry, oxidation-reduction and electrochemistry, kinetics, nuclear chemistry, introduction to organic chemistry, and chemistry laboratory skills.

Requisites: CHEM 103 and (MATH 112, 114, 171, or 221). Not open to students with credit for CHEM 109 or 115

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Elementary

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 105 – GENERAL CHEMISTRY I

3 credits.

Stoichiometry and the mole concept, chemical reactions, thermochemistry, electronic structure of atoms, periodic properties, chemical bonding, intermolecular forces, and the behavior of gases, liquids and solids. Equivalent to lecture-only part of CHEM 103. Provides a mechanism for awarding credit for experiences with no laboratory component. The combination of CHEM 101 and CHEM 105 is equivalent to CHEM 103.

Requisites: Consent of instructor

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Elementary

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 106 – GENERAL CHEMISTRY II

4 credits.

Principles and applications of chemical equilibrium, electrochemistry, thermodynamics, kinetics, organic chemistry and other topics that may include nuclear chemistry, biological chemistry and coordination chemistry. Equivalent to lecture-only part of CHEM 104. Provides a mechanism for awarding credit for experiences with no laboratory component. The combination of CHEM 102 and CHEM 106 is equivalent to CHEM 104.

Requisites: Consent of instructor

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Elementary

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 108 – CHEMISTRY IN OUR WORLD

5 credits.

Selected topics in inorganic and organic chemistry. Emphasis is on relevance to biological, environmental and social issues.

Requisites: Not open to students with credit for CHEM 104, 109, or 115

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Elementary

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 109 – ADVANCED GENERAL CHEMISTRY

5 credits.

Accelerated coverage of topics in general chemistry, including introduction to laboratory techniques. Topics include atomic and molecular structure, chemical equilibrium, acid-base chemistry, thermodynamics, kinetics, and electrochemistry.

Requisites: MATH 113, 114, 171, or placement into MATH 221. Not open to students with credit for CHEM 104 or 115

Course Designation: Gen Ed – Quantitative Reasoning Part B
Breadth – Physical Sci. Counts toward the Natural Sci req
Level – Elementary

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 115 – CHEMICAL PRINCIPLES I

5 credits.

Explores a detailed atomic and molecular view of matter and its interactions, with a specific focus on quantum theory, molecular structure, and chemical bonding. Application required for enrollment.

Requisites: Consent of instructor

Course Designation: Gen Ed – Quantitative Reasoning Part B
Breadth – Physical Sci. Counts toward the Natural Sci req
Level – Elementary

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 116 – CHEMICAL PRINCIPLES II

5 credits.

A quantitative treatment of macroscopic phenomena including thermodynamics, chemical equilibria, solution behavior, electrochemistry, and chemical kinetics.

Requisites: CHEM 115

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req
Level – Intermediate

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Honors – Accelerated Honors (!)

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 155 – STUDY ABROAD IN INTRODUCTORY CHEMISTRY

1-6 credits.

Study abroad equivalency for introductory chemistry. Enrollment in a UW-Madison resident study abroad program.

Requisites: None

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req
Level – Elementary

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

CHEM 175 – INTRODUCTORY TOPICS IN CHEMISTRY

1-3 credits.

Various topics in chemistry at the introductory level.

Requisites: None

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Elementary

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2023

Learning Outcomes: 1. Explore the relationships among chemical knowledge, the discipline and practice of chemistry, and related interdisciplinary areas of study. Audience: Undergraduate

2. Identify applications of chemistry to the world around us. Audience: Undergraduate

3. Synthesize scientific information and practice oral or written communications about scientific content. Audience: Undergraduate

CHEM 260 – ENTERING RESEARCH I

1 credit.

Introduction to skills that support conducting research in chemistry.

Requisites: CHEM 103, 109, or 115

Course Designation: Level – Intermediate

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 261 – ENTERING RESEARCH II

1 credit.

Advanced skills that support conducting research in chemistry.

Requisites: (CHEM 299, 681, 691, or 699, BIOCHEM 699, CBE 599) or concurrent enrollment

Course Designation: Level – Intermediate

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2016

CHEM 299 – DIRECTED STUDY

1-4 credits.

Mentored research project as arranged with a faculty or academic staff member.

Requisites: Consent of instructor

Course Designation: Level – Intermediate

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

CHEM 311 – CHEMISTRY ACROSS THE PERIODIC TABLE

4 credits.

Explores the properties, reactions and uses of elements and compounds, with emphasis on coordination chemistry of transition-metal ions, bioinorganic chemistry, solid-state structure and main-group elements. Introduces the synthesis and characterization of inorganic compounds.

Requisites: CHEM 104, 109, or 116**Course Designation:** Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Intermediate

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2024**CHEM 327 – FUNDAMENTALS OF ANALYTICAL SCIENCE**

4 credits.

Fundamentals of chemical measurement in chemistry, biology, engineering, geology, and the medical sciences. Topics include equilibria of complex systems, spectroscopy, electrochemistry, separations, and quantitative laboratory technique.

Requisites: CHEM 104 or 109. Not open to students with credit for CHEM 329.**Course Designation:** Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Intermediate

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2024**CHEM 329 – FUNDAMENTALS OF ANALYTICAL SCIENCE**

4 credits.

Fundamentals of chemical measurement in chemistry, biology, engineering, geology, and the medical sciences. Topics include equilibria of complex systems, spectroscopy, electrochemistry, separations, and quantitative laboratory technique. Covers chemical equilibria in greater depth and with greater mathematical rigor than CHEM 327.

Requisites: CHEM 104 or 109. Not open to students with credit for CHEM 327.**Course Designation:** Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Intermediate

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Honors – Accelerated Honors (!)

Repeatable for Credit: No**Last Taught:** Spring 2024**CHEM 341 – ELEMENTARY ORGANIC CHEMISTRY**

3 credits.

Core organic chemistry concepts of structure, reactivity, and synthesis with regards to the functional groups commonly found in commercial and biological substances. Covers a selection of topics from CHEM 343 and 345.

Requisites: CHEM 104, 109, or 116. Not open to students with credit for CHEM 343 or 345**Course Designation:** Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Intermediate

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Fall 2023**CHEM 342 – ELEMENTARY ORGANIC CHEMISTRY LABORATORY**

1 credit.

Introduces organic laboratory techniques in synthesis, purification and spectral interpretation.

Requisites: CHEM 341 or concurrent enrollment. Not open to students with credit for CHEM 344**Course Designation:** Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Intermediate

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Spring 2024

CHEM 343 – ORGANIC CHEMISTRY I

3 credits.

Principles of molecular structure and bonding applied to predict and explain the reactivity of alkanes, alkenes, alkynes, alkyl halides, alcohols, and thiols. Emphasis placed on rationalizing the stereochemical and regiochemical outcome of chemical processes.

Requisites: CHEM 104, 109, or 116

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Intermediate

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

Learning Outcomes: 1. Construct and use a transition state rendering to explain how donor-acceptor interactions result in the stereochemical or regiochemical outcome observed for a reaction Audience: Undergraduate

2. Construct and use an electron pushing mechanism or reaction energy profile to evaluate the validity of claims as to the outcome of a chemical process Audience: Undergraduate

3. Construct and use appropriate structural representations to explain observed differences in the physical and chemical properties of substances in terms of electrostatics, orbital overlap and energy Audience: Undergraduate

4. Construct and use a reaction energy profile to justify why a particular reaction system is likely to produce the product formed most quickly or which is most stable Audience: Undergraduate

5. Design and justify a multi-step synthetic route capable of feasibly generating a molecular target from specified starting materials Audience: Undergraduate

CHEM 344 – INTRODUCTORY ORGANIC CHEMISTRY LABORATORY

2 credits.

Introduces the basic synthesis, purification, and characterization techniques of organic chemistry, along with critical interpretation of experimental data.

Requisites: (CHEM 345 or concurrent enrollment) and (CHEM 102, 104, 109, or 116)

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Intermediate

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 345 – ORGANIC CHEMISTRY II

3 credits.

Principles of molecular structure and bonding applied to predict and explain the reactivity of aromatic systems, benzylic and allylic systems, aryl and vinyl halides, and carbonyl-containing compounds (e.g., ketones, carboxylic acids, esters, acid chlorides, amides). Emphasis placed on rationalizing the stereochemical and regiochemical outcome of chemical processes as well as arguing reaction outcomes from spectroscopic evidence.

Requisites: CHEM 343

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Intermediate

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

Learning Outcomes: 1. Construct and use a transition state rendering to explain how donor-acceptor interactions result in the stereochemical or regiochemical outcome observed for a reaction Audience: Undergraduate

2. Construct and use an electron pushing mechanism or reaction energy profile to evaluate the validity of claims as to the outcome of a chemical process Audience: Undergraduate

3. Construct and use appropriate structural representations to explain observed differences in the physical and chemical properties of substances in terms of electrostatics, orbital overlap and energy Audience: Undergraduate

4. Construct and use a reaction energy profile to justify why a particular reaction system is likely to produce the product formed most quickly or which is most stable Audience: Undergraduate

5. Construct or critique an argument, using spectroscopic evidence, as to the product(s) emergent from a particular reaction process. Audience: Undergraduate

6. Design and justify a multi-step synthetic route capable of feasibly generating a molecular target from specified starting materials Audience: Undergraduate

CHEM 346 – INTERMEDIATE ORGANIC CHEMISTRY LABORATORY

1-2 credits.

Multi-step synthetic processes. Advanced experimental techniques such as high-vacuum distillation. Independent research projects.

Requisites: CHEM 344 and 345

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 350 – COMMUNICATING CHEMISTRY TO THE PUBLIC VIA DEMONSTRATIONS

2 credits.

Gain experience in the safe and proper presentation of chemical demonstrations. Join experienced staff who enjoy doing demonstrations and who continue to develop the art of presenting them; learn from students, staff, and faculty from science departments, music, theater and other performing artists who combine their art with scientific experiments to share the joy and excitement of both artistic and scientific creativity. Public presentations will be offered both on and off campus to a wide variety of audiences (students, teachers, parents and the community at large) in a variety of settings (school settings and public venues).

Requisites: CHEM 103, 108 or 109**Course Designation:** Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Fall 2017**CHEM 355 – STUDY ABROAD IN INTERMEDIATE CHEMISTRY**

1-6 credits.

Study abroad equivalency for intermediate chemistry. Enrollment in a UW-Madison resident study abroad program.

Requisites: None**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**CHEM 361 – MACHINE LEARNING IN CHEMISTRY**

3 credits.

An in-depth introduction to the use of machine learning techniques in Chemistry. Topics will include basics of probability theory and statistics, basics of function fitting and parameter inference, basics of optimization, and machine learning techniques. Discuss a selection of Chemistry topics that are particularly amenable to analysis using machine learning. These might include generative models for organic synthesis, force-fields, application to phase transitions, structure and dynamics of molecular systems, and AI-driven drug discovery.

Requisites: (CHEM 103, 109, or 115) and (MATH 234, 320, 331, 340, or 375)**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Learning Outcomes:** 1. Employ statistical and machine learning models to analyze chemical datasets. Audience: Undergraduate

2. Represent chemical compounds using molecular descriptors. Audience: Undergraduate

3. Model and predict properties and activities of chemical compounds. Audience: Undergraduate

4. Apply appropriate machine learning approaches to analyze time-series data for molecular systems. Audience: Undergraduate

5. Apply machine-learning-based potential functions to describe chemical and biological molecules. Audience: Undergraduate

6. Be familiar with programming techniques and common tools in machine learning when applied to molecular systems. Audience: Undergraduate

7. Assess the quality of machine learning approaches in the chemistry literature. Audience: Undergraduate

CHEM 375 – INTERMEDIATE TOPICS IN CHEMISTRY

1-4 credits.

Various topics in chemistry at the intermediate level.

Requisites: CHEM 104, 109, or 116**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions**Last Taught:** Fall 2022

CHEM/M S & E 421 – POLYMERIC MATERIALS

3 credits.

Polymer chemistry and physics terminologies, structure-property relationship, polymer characterization, polymer synthesis, material requirements for optoelectronics including conjugated polymers, thin film transistors, light emitting diodes, non-linear optical materials, holographic data storage and liquid crystal polymers.

Requisites: CHEM 341, 343, or member of Engineering Guest Students

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Intermediate

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM/CBE 505 – ASPECTS OF INDUSTRIAL CHEMISTRY AND BUSINESS FUNDAMENTALS

3 credits.

Learn the chemistry and chemical engineering that defines societies' standard of living. Commercial chemical processes will be reviewed. Practical realities of how a discovery moves from research to commercial product will be taught through examples and case studies. Financial concepts that guide investment will be reviewed.

Requisites: Junior standing and CHEM 345, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 509 – SENIOR SEMINAR

2 credits.

Synthesize and integrate advanced chemistry knowledge and skills. Through a series of seminars, specific research problems will be identified. Work in groups utilizing the chemical literature to identify routes to the solutions of these problems.

Requisites: (CHEM 561 or 565) and CHEM 563 or concurrent enrollment in CHEM 563

Course Designation: Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2019

CHEM 511 – ADVANCED INORGANIC CHEMISTRY

3 credits.

Emphasizes the symmetry, structure and bonding of inorganic compounds. Selected topics may include applications in transition metal chemistry, organometallic chemistry, industrial catalysis, advanced bioinorganic chemistry, solid-state chemistry or main group chemistry.

Requisites: (CHEM 345 or concurrent enrollment and junior standing) or graduate/professional standing

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Honors – Accelerated Honors (!)

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 512 – ADVANCED SYNTHESIS AND LABORATORY TECHNIQUES

1-2 credits.

Synthesis, purification, and characterization of compounds spanning the sub-disciplines of inorganic chemistry, including main-group, transition metal, bioinorganic, organometallic, and solid-state compounds. Laboratory skills developed include Schlenck techniques, glovebox methods, and high-temperature methods, all with an emphasis on chemical safety. Characterization methods may include UV-visible and IR spectroscopy, multi-nuclear NMR spectroscopy, magnetic susceptibility, cyclic voltammetry, mass spectrometry, X-ray diffraction, and chromatographic methods.

Requisites: CHEM 311

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

Learning Outcomes: 1. Use the chemical literature to identify methods of synthesis for specific compounds Audience: Undergraduate

10. Troubleshoot experiments that do not yield anticipated results Audience: Undergraduate

2. Interpret published synthetic procedures to come up with a plan to reproduce the synthesis of the desired compounds Audience: Undergraduate

3. Apply the theoretical synthetic principles, including and understanding of how and why reactions work, by performing laboratory experiments Audience: Undergraduate

4. Apply synthetic techniques/skills, and demonstrate scientific/information literacy, critical and creative thinking, quantitative reasoning, and communication Audience: Undergraduate

5. Apply the fundamentals of synthetic inorganic chemistry, including laboratory safety, handling of air-sensitive and water-sensitive reagents and products, and commonly used characterization techniques Audience: Undergraduate

6. Use Schlenck techniques and glovebox methods to synthesize and manipulate air-sensitive compounds Audience: Undergraduate

7. Use hydrothermal and tube-furnace methods to synthesize materials Audience: Undergraduate

8. Assess compound purity using reported and measured magnetic moments of compounds synthesized in the laboratory Audience: Undergraduate

9. Assess compound purity using the spectroscopic techniques of nuclear magnetic resonance, infrared and UV/Visible spectroscopy Audience: Undergraduate

CHEM 524 – CHEMICAL INSTRUMENTATION

3 credits.

Basic principles for designing, developing, and using chemical instrumentation and applying these principles in the laboratory. Spectroscopy, separations, and mass spectrometry instruments are emphasized.

Requisites: (CHEM 116, 327, or 329), CHEM 343, MATH 222, and (PHYSICS 202, 208, or 248)

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Honors – Accelerated Honors (!)

Repeatable for Credit: No

Last Taught: Spring 2024

Learning Outcomes: 1. Demonstrate knowledge of the fundamental principles for the design of chemical instrumentation. Audience: Undergraduate

2. Apply knowledge of chemical instrumentation to make effective chemical measurements. Audience: Undergraduate

3. Critically analyze and evaluate results of measurements made with chemical instrumentation Audience: Undergraduate

CHEM 547 – ADVANCED ORGANIC CHEMISTRY

3 credits.

Modern principles of synthetic and mechanistic organic chemistry.

Requisites: CHEM 345

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Honors – Accelerated Honors (!)

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 555 – STUDY ABROAD IN ADVANCED CHEMISTRY

1-6 credits.

Study abroad equivalency for advanced chemistry. Enrollment in a UW-Madison resident study abroad program.

Requisites: None

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

CHEM 561 – PHYSICAL CHEMISTRY

3 credits.

Macroscopic theory: equilibrium thermodynamics, chemical kinetics and transport properties.

Requisites: (CHEM 116, 327, or 329), MATH 222, and (PHYSICS 201, 207, or 247). Not open to students with credit for CHEM 565

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Honors – Accelerated Honors (!)

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 562 – PHYSICAL CHEMISTRY

3 credits.

Molecular theory: quantum chemistry, molecular structure and spectra, statistical mechanics, selected topics in the molecular theory of matter in bulk.

Requisites: MATH 222, (PHYSICS 202, 208, or 248), and (CHEM 561, 565, CBE 310, or M S & E 330)

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Honors – Accelerated Honors (!)

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 563 – PHYSICAL CHEMISTRY LABORATORY I

1 credit.

Principles of experimental physical chemistry applied to the acquisition of thermodynamic and kinetic data; use of basic physical laboratory equipment; related computations, analysis of errors, interpretation of results.

Requisites: (CHEM 116, 327 or 329) and (CHEM 561 or concurrent enrollment, CHEM 565 or concurrent enrollment, CBE 310, or M S & E 330)

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

Learning Outcomes: 1. Understand the quality and information content of experimental measurements. Audience: Undergraduate

2. Emulate the process by which new knowledge is generated. Audience: Undergraduate

3. Communicate scientific content in oral conversation. Audience: Undergraduate

4. Make connections between the physical chemistry laboratory experience and other courses. Audience: Undergraduate

CHEM 564 – PHYSICAL CHEMISTRY LABORATORY II

1 credit.

Principles of experimental physical chemistry applied to the acquisition and interpretation of basic data on molecular structure and dynamics, and properties of macromolecules; principles and use of spectroscopic and other electronic instrumentation.

Requisites: (CHEM 562 or concurrent enrollment) and CHEM 563

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

Learning Outcomes: 1. Understand the fundamentals of spectroscopic techniques. Audience: Undergraduate

2. Understand the basics of instrumentation in relation to making an experimental measurement. Audience: Undergraduate

3. Communicate scientific content in oral conversation. Audience: Undergraduate

4. Make connections between quantum mechanics and qualitative physical descriptions. Audience: Undergraduate

CHEM 565 – BIOPHYSICAL CHEMISTRY

4 credits.

Equilibrium thermodynamics, chemical kinetics, and transport properties, with emphasis on solution behavior and applications to biological macromolecules in solution. Focus on biological applications of physical chemistry.

Requisites: (CHEM 116, 327, or 329), MATH 222, (PHYSICS 201, 207, or 247), and (BIOCORE 383 or concurrent enrollment, BIOCHEM 501 or concurrent enrollment, or BIOCHEM 507 or concurrent enrollment). Not open to students with credit for CHEM 561

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 575 – ADVANCED TOPICS IN CHEMISTRY

1-4 credits.

Various topics in chemistry at the advanced level.

Requisites: CHEM 311, 327, 329, or 343

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

CHEM 605 – SPECTROCHEMICAL MEASUREMENTS

3 credits.

Determination of organic structures and reaction mechanisms using mass spectrometry and nuclear magnetic resonance techniques.

Requisites: CHEM 344 and 345, or graduate/professional standing

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Grad 50% – Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 606 – PHYSICAL METHODS FOR STRUCTURE DETERMINATION

1-3 credits.

A survey of spectroscopic methods for inorganic structure determination. Introduces major non-crystallographic techniques with an emphasis on the application to structural analysis. The basic theory and methodology of each form of spectroscopy will be presented. Topics covered include: ligand field theory, electronic absorption, Raman, Mossbauer and EPR spectroscopies, and magnetic susceptibility.

Requisites: Graduate/professional standing

Course Designation: Grad 50% – Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 607 – LABORATORY SAFETY

1 credit.

Aspects of laboratory safety relating to chemical, electrical, optical, mechanical, cryogenic and radiological hazards will be discussed. Safety equipment, techniques (including first aid), and facilities will be introduced.

Requisites: Graduate/professional standing

Course Designation: Grad 50% – Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 608 – SYMMETRY, BONDING, AND MOLECULAR SHAPES

1-3 credits.

Elementary bonding theory and its application to understanding molecular geometry and reactivity. Emphasizes qualitative methods applied to the bonding of elements from throughout the periodic table.

Requisites: Graduate/professional standing

Course Designation: Grad 50% – Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 613 – CHEMICAL CRYSTALLOGRAPHY

3 credits.

Theory of structural chemistry, experimental methods involved, applications to problems of chemical interest; use of diffractometric equipment and computer data analysis for an actual structure determination.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2023

CHEM 622 – ORGANIC ANALYSIS

2 credits.

Biological Mass Spectrometry: Fundamentals and Applications.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 623 – EXPERIMENTAL SPECTROSCOPY

2-3 credits.

Current spectroscopic methods employed in chemical analysis with applications in atomic and molecular absorption spectroscopy, infrared and Raman vibrational spectroscopy, fluorescence and light scattering; lecture and laboratory projects.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 624 – ELECTROCHEMISTRY

2-3 credits.

Interfacial electron transfer and mass transport processes in electrochemistry, with applications to electroanalysis, electrodeposition and electrochemical separations.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM/GENETICS 626 – GENOMIC SCIENCE

2 credits.

Brings cutting-edge topics in the genomic sciences into the reach of those in chemistry, biology, engineering, computer science statistics fields. Enables biologically-oriented students to deal with advances in analytical science so that they may incorporate new genomic science concepts into their own scientific repertoires.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

CHEM 629 – ATMOSPHERIC CHEMICAL MECHANISMS

3 credits.

Focuses on the chemical mechanisms and kinetics of reactive gases and aerosol in Earth's atmosphere. Fundamental concepts from analytical, physical, and organic chemistry will be used as tools to describe atmospheric processes occurring in both the troposphere and the stratosphere. Specific topics include: Evolution and chemical composition of Earth's atmosphere; applications of the steady-state approximation; residence and renewal time; sources, transformation, transport and deposition of trace gases in the troposphere; air pollution control strategies; stratospheric chemistry.

Requisites: CBE 310 or concurrent enrollment in CHEM 561 or 565; or graduate/professional standing

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2023

Learning Outcomes: 1. Develop a deep chemical intuition for atmospheric chemical mechanisms and processes operating over wide ranges of time and length scales. Audience: Both Grad Undergrad

2. Construct photochemical box models of atmospheric processes (e.g., smog formation) to determine the response of criteria air pollutants to changes in atmospheric emissions. Audience: Both Grad Undergrad

3. Articulate and synthesize complex chemical knowledge and understanding in both written and oral formats. Audience: Graduate

CHEM 630 – SELECTED TOPICS IN ANALYTICAL CHEMISTRY

1-3 credits.

Lectures of a specialized nature in advanced analytical chemistry.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2023

CHEM 635 – TOPICS IN COMPUTATIONAL CHEMISTRY

1 credit.

An introduction to computational chemistry. Covers new techniques and developments in the literature, and specific types of calculations that are relevant to current research and needs.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

**CHEM 636 – TOPICS IN CHEMICAL INSTRUMENTATION:
INTRODUCTION TO NMR**

2 credits.

Theory and practice of nuclear magnetic resonance (NMR) spectroscopy.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2024**CHEM 637 – TOPICS IN CHEMICAL INSTRUMENTATION:
ADVANCED METHODS IN NMR**

1-2 credits.

Advanced methods of nuclear magnetic resonance (NMR) spectroscopy.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Summer 2017**CHEM 641 – ADVANCED ORGANIC CHEMISTRY**

3 credits.

Topics in physical organic chemistry.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2023**CHEM 652 – CHEMISTRY OF INORGANIC MATERIALS**

3 credits.

Materials chemistry of inorganic solids. Focuses on the application of chemical concepts to an understanding of properties of solids and how these properties are manifested in practical applications.

Requisites: Graduate/professional standing**Repeatable for Credit:** No**Last Taught:** Fall 2023**CHEM 653 – CHEMISTRY OF NANOSCALE MATERIALS**

3 credits.

Introduction to solid state materials chemistry, with an emphasis on contemporary topics in the chemistry of nanomaterials. Incorporates fundamental knowledge of solid-state chemistry and traditional materials chemistry with current nanoscale and nanostructural materials research.

Requisites: (CHEM 311 and 561) or graduate/professional standing**Course Designation:** Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No**Last Taught:** Fall 2022**CHEM 654 – MATERIALS CHEMISTRY OF POLYMERS**

2-3 credits.

Polymer classification, synthesis, and molecular architecture; solid state structure and characterization; glassy state and glass transition; polymer rheology in solids and gels; transport, dielectric and optical properties.

Requisites: CHEM 345 and (CHEM 561, 565 or CBE 310), or graduate/professional standing**Course Designation:** Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No**Last Taught:** Spring 2024**CHEM 661 – CHEMICAL AND STATISTICAL THERMODYNAMICS**

3 credits.

Basic chemical thermodynamics with applications to chemical and phase equilibria and the study of solutions; introduction to statistical mechanics and calculation of thermodynamic quantities from molecular models; stability and fluctuations.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2023**CHEM 664 – PHYSICAL CHEMISTRY OF MACROMOLECULES**

2-3 credits.

Structure, thermodynamics, and dynamics of polymers in solution and in the bulk; theoretical models and experimental methods; polymer characterization.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2023

CHEM 665 – BIOPHYSICAL CHEMISTRY

3 credits.

Equilibrium thermodynamics and chemical kinetics with emphasis on solution behavior and applications to biological macromolecules in solution. Focus on biological applications of physical chemistry.

Requisites: (CHEM 116, 327, or 329), MATH 222, (PHYSICS 201, 207, or 247), and (BIOCHEM 501, 507, BIOCORE 383, or concurrent enrollment), or graduate/professional standing. Not open to students with credit for CHEM 561.

Course Designation: Breadth – Physical Sci. Counts toward the Natural Sci req

Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Grad 50% – Counts toward 50% graduate coursework requirement

Honors – Accelerated Honors (!)

Repeatable for Credit: No

Last Taught: Spring 2024

Learning Outcomes: 1. Understand and apply fundamental principles of thermodynamics to biological systems. Audience: Both Grad Undergrad

2. Understand and apply fundamental principles of kinetics to biological systems. Audience: Both Grad Undergrad

3. Rationally interpret the results of experiments performed on biological systems in terms of energetics and outcome probabilities Audience: Both Grad Undergrad

4. Predict the outcome of biological processes, once experimentally or theoretically derived thermodynamic/kinetic parameters are known Audience: Both Grad Undergrad

5. Design new experiments on biological systems based on appropriate thermodynamic and kinetic criteria Audience: Both Grad Undergrad

6. Explain a selected topic related to the course material to other students Audience: Graduate

CHEM 668 – BIOPHYSICAL SPECTROSCOPY

2-3 credits.

Focuses on the underlying principles and applications of spectroscopic and microscopy methods employed to solve biological problems at the atomic and molecular level. Techniques covered include electronic absorption and fluorescence spectroscopy, circular dichroism, light scattering, fluorescence microscopy, multidimensional nuclear magnetic resonance and electron spin resonance.

Requisites: Graduate/professional standing

Course Designation: Grad 50% – Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 675 – INTRODUCTORY QUANTUM CHEMISTRY

3 credits.

Basic principles of quantum chemistry, exactly solvable problems, angular momentum, approximation methods, applications to electronic structure.

Requisites: Graduate/professional standing

Course Designation: Grad 50% – Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 681 – SENIOR HONORS THESIS

2-4 credits.

Mentored research for students completing a thesis in an Honors program.

Requisites: Consent of instructor

Course Designation: Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Honors – Honors Only Courses (H)

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2023

CHEM 682 – SENIOR HONORS THESIS

2-4 credits.

Mentored research for students completing a thesis in an Honors program.

Requisites: Consent of instructor

Course Designation: Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Honors – Honors Only Courses (H)

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

CHEM 691 – SENIOR THESIS

2-6 credits.

Mentored research for students completing a senior thesis.

Requisites: Consent of instructor

Course Designation: Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2023

CHEM 692 – SENIOR THESIS

2-6 credits.

Mentored research for students completing a senior thesis.

Requisites: Consent of instructor

Course Designation: Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

CHEM 699 – DIRECTED STUDY

1-6 credits.

Advanced mentored research project as arranged with a faculty or academic staff member.

Requisites: Consent of instructor

Course Designation: Level – Advanced

L&S Credit – Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

CHEM 701 – RESPONSIBLE CONDUCT OF RESEARCH IN THE CHEMICAL SCIENCES

1 credit.

Scientific integrity and professional behavior in the chemical sciences. Topics include conflict of interest, human and animal subjects in research, mentor and mentee responsibilities, collaborative research, peer review, data acquisition and management, research misconduct, responsible authorship and publication, and societal impacts.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, for 3 number of completions

Last Taught: Spring 2024

Learning Outcomes: 1. Articulate basic principles of moral/ethical reasoning Audience: Graduate

2. Articulate basic principles of universal design Audience: Graduate

3. Articulate how they contribute to diversity, equity and inclusion in their workplaces Audience: Graduate

4. Articulate their social responsibility in research, including societal and environmental impacts Audience: Graduate

5. Identify best practices in job searches and interviews, generating and managing data, writing and reviewing publications and grant applications Audience: Graduate

6. Identify best practices in networking, collaboration, giving and receiving feedback, setting expectations, effective communication with mentors and peers Audience: Graduate

7. Identify best practices in animal and human welfare in research Audience: Graduate

8. Recognize ethical breaches and articulate how to handle them, including conflicts of interest, research misconduct, inappropriate behavior Audience: Graduate

CHEM/BIOCHEM 704 – CHEMICAL BIOLOGY

3 credits.

Chemistry and biology of proteins, nucleic acids and carbohydrates; application of organic chemistry to problems in cell biology, biotechnology, and biomedicine.

Requisites: Declared in Biochemistry or Chemistry graduate program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 713 – INORGANIC AND ORGANOMETALLIC CHEMISTRY OF THE MAIN GROUP ELEMENTS

1-3 credits.

Descriptive inorganic chemistry, organometallic chemistry of main-group elements, and organosilicon chemistry.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 714 – ORGANOMETALLIC CHEMISTRY OF THE TRANSITION ELEMENTS

2-3 credits.

Fundamental and applied aspects of organotransition-metal chemistry, including structure and bonding, reactivity, and catalytic applications of organometallic complexes.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

CHEM 721 – INSTRUMENTAL ANALYSIS

3-4 credits.

Chemical instrumentation and instrumental methods of analysis.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2023

Learning Outcomes: 1. Demonstrate a deep knowledge of the fundamental principles for the design, development, and use of chemical instrumentation Audience: Graduate

2. Apply this knowledge to effectively use chemical instrumentation for your research. Audience: Graduate

3. Demonstrate skill in building and using chemical instrumentation (lab learning outcome.) Audience: Graduate

CHEM 725 – SEPARATIONS IN CHEMICAL ANALYSIS

2-3 credits.

Basic principles of chemical and biochemical separations by chromatography and electrophoresis.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2022

Learning Outcomes: 1. Lecture outcome – gain solid knowledge of the basic principles and terminology of chemical separations and demonstrate the ability to read and comprehend the scientific literature in the field.

Audience: Graduate

2. Laboratory outcome– acquire the hands-on experience necessary to apply the theory of separations to its practical implementation. Audience: Graduate

CHEM 728 – ELECTRONICS FOR CHEMICAL INSTRUMENTATION

3 credits.

Learn and apply the principles of analog and digital electronics and computer interfaces for controlling and monitoring components of importance to chemical instrumentation.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

Learning Outcomes: 1. Identify the working principles of the electronics behind modern chemical instrumentation Audience: Graduate

2. Interconnect and modify commercial instrumental modules for use in new applications Audience: Graduate

3. Build new instrumental modules based on operational amplifiers, microcontrollers, and other integrated circuits Audience: Graduate

CHEM 738 – INTRODUCTION TO MASS SPECTROMETRY

1 credit.

Introduction to the theory and practice of mass spectrometry. Topics include gas chromatography/mass spectrometry (GCMS), electrospray ionization (ESI), matrix assisted laser-desorption ionization (MALDI), liquid chromatography/mass spectrometry (LCMS), imaging mass spectrometry, and ion mobility mass spectrometry.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

Learning Outcomes: 1. Read and interpret mass spectra. Audience: Graduate

2. Match ionization methods to compound types. Audience: Graduate

3. Understand the coupling of separation techniques to mass spectrometers. Audience: Graduate

4. Recognize how mass spectrometry could be used in one's own research. Audience: Graduate

CHEM/B M E/MED PHYS 750 – BIOLOGICAL OPTICAL MICROSCOPY

3 credits.

Covers several aspects of state-of-the-art biological and biophysical imaging with an emphasis on instrumentation, beginning with an overview of geometrical optics and optical and fluorescence microscopy. The bulk of the course will focus on advanced imaging techniques including nonlinear optical processes (multi-photon excitation, second harmonic generation, and stimulated Raman processes) and emerging super-resolution methods. Special emphasis will be given to current imaging literature and experimental design. Knowledge of physics-based optics [such as PHYSICS 202] strongly recommended.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2021

CHEM 758 – CHEMISTRY EDUCATION RESEARCH

2 credits.

An introduction to chemistry education research and the theories that underpin it. Develop and refine models of learning on the basis of primary literature. Explore how theories of cognition could and should inform learning objectives and assessments in college chemistry learning environments. Substantial emphasis placed on critically reading and analyzing studies in the chemistry education research literature with an eye toward the implicit and explicit theories of cognition informing the work.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2022**Learning Outcomes:** 1. Develop and refine a model of learning based on discussion and analysis of the primary chemistry education and science education literature Audience: Graduate

2. Design assessable learning objectives describing what students should know and be able to do at the conclusion of a college chemistry course Audience: Graduate

3. Assess the validity of conclusions in the literature on the basis of theories of cognition underpinning assessments Audience: Graduate

4. Design assessments with the capacity to measure aspects of learning objectives using evidence-centered-design Audience: Graduate

CHEM 762 – MOLECULAR REACTION DYNAMICS

2-3 credits.

Microscopic approach to chemical dynamics.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2015**CHEM 763 – INTRODUCTION TO MOLECULAR SPECTROSCOPY**

2-3 credits.

Quantum mechanics of molecular rotation and vibration; principles of group theory; electronic, vibrational, and magnetic resonance spectroscopy in gas and condensed phases.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2023**CHEM/PHM SCI 766 – MOLECULAR RECOGNITION**

2-3 credits.

Origin, nature, classification, and description of intermolecular forces. The hydrophobic effect. Molecular complexes, binding constants, and their measurements. General principles of self-assembly, molecular recognition, complex formation, host design. Supramolecular systems and their dynamics. Micelles, bilayers, vesicles, biological membranes.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2022**CHEM 775 – ELECTRONIC STRUCTURE OF MOLECULES**

2-3 credits.

Applications of quantum mechanics to the electronic structure and properties of molecules.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2023**CHEM 777 – PHYSICAL CHEMISTRY OF SURFACES**

2-3 credits.

Structure, thermodynamics, kinetics, and reactivity of molecules at the interfaces between gases, liquids and solids, with applications to catalysis, atmospheric chemistry, monolayers, and thin films.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2024**CHEM 801 – SELECTED TOPICS IN INORGANIC CHEMISTRY**

1-3 credits.

Various selected topics in contemporary inorganic chemistry.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Fall 2023**CHEM 840 – ADVANCED TOPICS IN ORGANIC CHEMISTRY**

1-4 credits.

Various selected topics in contemporary organic chemistry.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2024**Learning Outcomes:** 1. Engage with, understand, and critique the primary research literature describing contemporary advances and historical topics in organic chemistry Audience: Graduate

2. Acquire a deep and sophisticated understanding of important topics and research areas associated with the practice of organic chemistry Audience: Graduate

CHEM 841 – ADVANCED ORGANIC CHEMISTRY

3 credits.

Synthesis of simple and complex organic compounds.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2024**CHEM 842 – ADVANCED ORGANIC CHEMISTRY**

1-3 credits.

Various selected topics in contemporary organic chemistry.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2016**CHEM 843 – ADVANCED ORGANIC CHEMISTRY**

1-3 credits.

Fundamental concepts in organic chemistry reactions and mechanisms.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2023**CHEM 845 – MACROMOLECULAR CHEMICAL BIOLOGY**

2 credits.

Critically read, analyze and discuss the primary literature in chemical biology by focusing on topics associated with macromolecules (largely proteins and nucleic acids).

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2023**Learning Outcomes:** 1. Critically read, analyze and discuss primary scientific literature in macromolecular chemical biology. Audience: Graduate

2. Evaluate the literature from the perspective of the scientific method. Audience: Graduate

3. Incorporate primary scientific literature into the student's research and scholarship. Audience: Graduate

4. Apply effective methods of scientific communication. Audience: Graduate

CHEM 858 – SPECIAL TOPICS IN CHEMISTRY EDUCATION

1-3 credits.

Various selected topics in contemporary chemistry education.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2024**Learning Outcomes:** 1. Engage with, understand, and critique the primary research literature describing contemporary advances and historical topics in chemistry education Audience: Graduate

2. Acquire a deep and sophisticated understanding of important topics, research areas, and research methods associated with chemistry education. Audience: Graduate

CHEM 860 – SELECTED TOPICS IN PHYSICAL CHEMISTRY

1-3 credits.

Various selected topics in contemporary physical chemistry.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2024**CHEM 864 – STATISTICAL MECHANICS**

2-3 credits.

Fundamentals of statistical mechanics; applications to equilibrium and non-equilibrium properties of gases and condensed phases.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2024**CHEM/BIOCHEM 872 – SELECTED TOPICS IN MACROMOLECULAR AND BIOPHYSICAL CHEMISTRY**

1-3 credits.

Various selected topics in contemporary macromolecular or biophysical chemistry.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2024

CHEM 890 – HIGHLIGHTS AT THE CHEMISTRY-BIOLOGY INTERFACE

1 credit.

Oral presentations on thesis research at the chemistry-biology interface. Includes discussions of reproducibility, rigor, and the responsible conduct of research.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

Learning Outcomes: 1. Identify and clearly present key background concepts relating to their research Audience: Graduate

2. Explain experiments leading to research conclusions Audience: Graduate

3. Analyze the results of each experiment with the appropriate scientific rigor, and develop skills to justify their analytical choices Audience: Graduate

4. Identify short-term and long-term research steps and goals Audience: Graduate

5. Provide feedback to other trainees on presentation style and clarity, data analysis, and scientific rigor and responsible conduct of research Audience: Graduate

CHEM 900 – SEMINAR-INORGANIC CHEMISTRY

0 credits.

Presentations of recent research in inorganic chemistry and related areas by external and internal speakers.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

CHEM 901 – SEMINAR-TEACHING OF CHEMISTRY

0-1 credits.

The role of the teaching assistant in undergraduate chemistry instruction. Effective utilization of instructional aids. Innovations for better teaching.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2023

CHEM/BIOCHEM 918 – SINGLE MOLECULE APPROACHES TO BIOLOGY

1 credit.

A combination of recent literature and original research presentations relating to the use of single molecule techniques in biochemistry including fluorescence microscopy, tethered particle motion, patch-clamping, cryo-electron microscopy, optical trapping, magnetic tweezers, and super resolution microscopy.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2023

CHEM 920 – SEMINAR-ANALYTICAL CHEMISTRY

0 credits.

Presentations of recent research in analytical sciences and related areas by external and internal speakers.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

CHEM 923 – GENOMIC SCIENCES PROGRAM SEMINAR

1 credit.

Cross-disciplinary exposure to cutting edge research in genomic sciences. Seminars presented by trainees and other scientists who study genomics using approaches based in chemistry, computer science, biostatistics, engineering and biological and biomedical sciences. Research objectives, findings and future directions are discussed.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

Learning Outcomes: 1. Identify and summarize background information and key concepts important for the diverse audience to understand their research topic and aims. Audience: Graduate

2. Describe their experimental approach to answer the genomic questions poised in their research aims, paying attention to making their presentation accessible to the broad audience. Audience: Graduate

3. Analyze and provide critical guidance for interpreting the experimental results; describe issues of reproducibility and rigor. Audience: Graduate

4. Describe their new, proposed invention that pushes past the envelope of current investigations in genomic sciences Audience: Graduate

5. Apply knowledge of new concepts and systems in the genomic sciences by providing feedback and suggestions to help other trainees further their experimental aims. Audience: Graduate

CHEM 940 – SEMINAR-ORGANIC CHEMISTRY

0 credits.

Presentations of recent research in organic chemistry and related areas by external and internal speakers.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

CHEM 941 – SEMINAR-SYNTHETIC ORGANIC CHEMISTRY

0-1 credits.

Presentations of recent research in synthetic organic chemistry and related areas by external and internal speakers.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2016

CHEM 942 – SEMINAR-PHYSICAL ORGANIC CHEMISTRY

0-1 credits.

Presentations of recent research in physical organic chemistry and related areas by external and internal speakers.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2016

CHEM 943 – SEMINAR-BIO-ORGANIC CHEMISTRY

0-1 credits.

Presentations of recent research in bioorganic chemistry and related areas by external and internal speakers.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2016

CHEM/BIOCHEM 945 – SEMINAR-CHEMICAL BIOLOGY (ADVANCED)

1 credit.

Presentations and discussions of recently published research in chemical biology and related areas.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2023

CHEM 960 – SEMINAR-PHYSICAL CHEMISTRY

0-2 credits.

Presentations of recent research in physical chemistry and related areas by external and internal speakers.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

CHEM 980 – SEMINAR: REVIEW OF CURRENT RESEARCH

1 credit.

Research discussions facilitated by individual faculty members and occurring between all members of the research group.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

Learning Outcomes: 1. Develop new and novel directions in research. Audience: Graduate

2. Evaluate rigor and accuracy of current scientific literature. Audience: Graduate

3. Analyze and communicate key background concepts relating to current research succinctly and clearly. Audience: Graduate

4. Analyze and communicate experimental results with the appropriate scientific rigor. Audience: Graduate

5. Develop skills to justify experimental, theoretical, and analytical interpretations of data. Audience: Graduate

CHEM 990 – RESEARCH

1-15 credits.

Research supervised by individual faculty members.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

Learning Outcomes: 1. Exhibit a broad understanding of general chemical principles. Audience: Graduate

2. Conduct independent research using a variety of approaches.

Audience: Graduate

3. Think critically to address research challenges. Audience: Graduate

4. Exhibit and foster professional and ethical conduct in their research.

Audience: Graduate

5. Collaborate with other investigators within or outside the thesis lab.

Audience: Graduate