CHEM 1103. University Chemistry I (ACTS Equivalency = CHEM 1414 Lecture). 3 Hours.

An introductory course for science, engineering or agriculture majors. Atomic structure, electron configurations and periodic properties, nomenclature and bonding in compounds, Lewis structure and resonance forms, molecular geometries and polarity, stoichiometry, solution chemistry and aqueous reactions, thermochemistry, gas laws and kinetic molecular theory. Corequisite: Drill component. Prerequisite: MATH 1203 or higher, or AP Calculus AB 3C or higher, or AP Calculus BC 4C or higher, or College Algebra CLEP 54 or higher. (Typically offered: Fall, Spring and Summer)

CHEM 1211L. University Chemistry II Laboratory (ACTS Equivalency = CHEM 1424 Lab). 1 Hour.

Qualitative and quantitative laboratory with data interpretation and exercises covering the topics of stoichiometry, thermodynamics, kinetics, chemical equilibrium, pH, and descriptive inorganic chemistry. Laboratory notebooks are required as part of every experiment. Designed for students in the honors programs. Laboratory 3 hours per week. Corequisite: CHEM 1123H and related course component drill for CHEM 1123H. (Typically offered: Fall and Spring)

This course is equivalent to CHEM 1121L.

CHEM 1212L. Chemistry for Majors II Laboratory. 1 Hour.

Qualitative and quantitative laboratory with data interpretation and exercises covering the topics of stoichiometry, thermodynamics, kinetics, chemical equilibrium, pH, and descriptive inorganic chemistry. Laboratory notebooks are required as part of every experiment. Laboratory 3 hours per week. Students may not receive credit for both CHEM 1211L and CHEM 1121L. Corequisite: CHEM 1203 and related course component drill for CHEM 1203. (Typically offered: Fall)

This course is equivalent to CHEM 1121L.
CHEM 1223. Chemistry for Majors II. 3 Hours.
The second half of a two-semester course designed specifically for students planning to major in chemistry or biochemistry. Students may not receive credit for both CHEM 1223 and CHEM 1123. Pre- or Corequisite: MATH 1284C or higher. Corequisite: CHEM 1221L and related course component drill section for CHEM 1223. Prerequisite: CHEM 1203 and CHEM 1201L (or CHEM 1103 and CHEM 1101L). (Typically offered: Spring)
This course is equivalent to CHEM 1123.
CHEM 2261L. Analytical Chemistry Laboratory. 1 Hour.
Covers techniques of classical and instrumental methods of chemical separation and analysis. Laboratory 4 hours per week. Chemistry Majors/Minors must take analytical lecture and lab prior to any physical chemistry course. Chemistry Majors/Minors should take analytical lecture and lab together. Pre- or Corequisite: CHEM 2263. Prerequisite: (CHEM 1123 and CHEM 1121L) or (CHEM 1123H and CHEM 1121M) or (CHEM 1223 and CHEM 1221L) or (CHEM 1073 and CHEM 1071L) and MATH 1203 or higher, or AP Calculus AB 3C or higher, or AP Calculus BC 4C or higher, or CLEP College Algebra 54 or higher. (Typically offered: Fall and Spring)
CHEM 2263. Analytical Chemistry Lecture. 3 Hours.
Principles of chemical separations, analysis by classical and instrumental methods, and chemical equilibrium in physical and biological systems. Lecture 3 hours per week. Chemistry Majors/Minors must take analytical lecture and lab prior to any physical chemistry course. Chemistry Majors/Minors should take analytical lecture and lab together. Prerequisite: (CHEM 1123 and CHEM 1121L) or (CHEM 1123H and CHEM 1121M) or (CHEM 1223 and CHEM 1221L) or (CHEM 1073 and CHEM 1071L) and MATH 1203 or higher, or AP Calculus AB 3C or higher, or AP Calculus BC 4C or higher, or CLEP College Algebra 54 or higher. (Typically offered: Fall and Spring)
CHEM 2611L. Organic Physiological Chemistry Laboratory (ACTS Equivalency = CHEM 1224 Lab). 1 Hour.
A focus on properties of organic compounds as well as reactions of organic compounds with an emphasis on functional groups along with some classifications of certain types of compounds. Laboratory 3 hours per week. Corequisite: CHEM 2613 and related course component drill for CHEM 2613. (Typically offered: Fall, Spring and Summer)
CHEM 2613. Organic Physiological Chemistry (ACTS Equivalency = CHEM 1224 Lecture). 3 Hours.
One semester survey of organic chemistry necessary for understanding of biological systems, with some related physiological chemistry. Lecture 3 hours per week. Corequisite: CHEM 2611L and related course component drill section for CHEM 2613. Prerequisite: (CHEM 1073 and CHEM 1071L) or (CHEM 1123 and CHEM 1121L) or (CHEM 1123H and CHEM 1121M) or (CHEM 1223 and CHEM 1221L). (Typically offered: Fall, Spring and Summer)
CHEM 3203. Forensic Chemistry. 3 Hours.
Survey of chemistry used in criminal investigations. Topics may include detection and identification of drugs, alcohol, toxins, explosives and gun powder residue. Chemical analysis of paint, ink, paper, soil, glass and fibers. Chemical detection of blood and fingerprints. Extraction of DNA from evidence, DNA fingerprinting. Prerequisite: CHEM 2613, or CHEM 3613 (recommended), or CHEM 3613H, or CHEM 3713. (Typically offered: Irregular)
CHEM 3203H. Honors Forensic Chemistry. 3 Hours.
Survey of chemistry used in criminal investigations. Topics may include detection and identification of drugs, alcohol, toxins, explosives and gun powder residue. Chemical analysis of paint, ink, paper, soil, glass and fibers. Chemical detection of blood and fingerprints. Extraction of DNA from evidence, DNA fingerprinting. As a requirement of honors designation additional honors-level work is required of students enrolled in this section. Prerequisite: CHEM 2613, or CHEM 3613 (recommended), or CHEM 3613H, or CHEM 3713. (Typically offered: Irregular)
This course is equivalent to CHEM 3203.
CHEM 3273. UTeach Research Methods. 3 Hours.
A project-based course for prospective science and mathematics teachers utilizing scientific research methods and inquiry to solve research problems. Corequisite: Drill component. Prerequisite: ARSC 1201 and ARSC 1221. (Typically offered: Spring)
This course is cross-listed with PHYS 3273, BIOL 3273.
CHEM 3451L. Elements of Physical Chemistry Laboratory. 1 Hour.
Experimental measurements of the physical properties, chemical systems, error analysis and report writing. Experiments cover topics in thermochemistry, heat capacity, chemical kinetics, spectroscopy, and phase/chemical equilibrium using a variety of physical chemistry techniques. Laboratory 4 hours per week. Corequisite: Chemistry majors and chemistry minors must enroll in CHEM 3453 concurrently. Prerequisite: CHEM 2261L and PHYS 2031L (or PHYS 2074). (Typically offered: Fall)
CHEM 3453. Elements of Physical Chemistry. 3 Hours.
One semester accelerated course in physical chemistry primarily for students majoring/minoring in chemistry with biochemistry option, or pre-professional and agriculture students. Topics include thermodynamics, phase & chemical equilibrium, chemical kinetics, quantum chemistry and spectroscopy. Presented at the same level as the 2-semester course with some recourse to calculus, although covering fewer topics in quantum chemistry. Lecture 3 hours per week. Students cannot earn credit for both CHEM 3453 and CHEM 3514. Corequisite: Chemistry majors and chemistry minors must enroll in CHEM 3451L concurrently. Prerequisite: CHEM 2263 and PHYS 2033 (or PHYS 2074), and MATH 2554 (or MATH 2043). (Typically offered: Fall)
CHEM 3504. Physical Chemistry I. 4 Hours.
First semester of a 2-semester course in physical chemistry designed for chemistry majors and chemistry minors with topics covering wave-particle duality, quantum chemistry, atomic and molecular structure, bonding, spectroscopy and elementary statistical mechanics. Lecture and recitation 4 hours per week. Pre- or Corequisite: MATH 2564. Prerequisite: CHEM 2263 and PHYS 2074. (Typically offered: Fall)
CHEM 3512L. Physical Chemistry Laboratory. 2 Hours.
Experimental studies of molecular structure, thermochemistry, and chemical kinetics, and the determination of other physicochemical properties of matter. Laboratory 8 hours per week. Students cannot earn credit for both CHEM 3451L and CHEM 3512L. Corequisite: Chemistry majors and chemistry minors must take CHEM 3514 concurrently. Prerequisite: CHEM 2261L and PHYS 2031L (or PHYS 2074). (Typically offered: Spring)
CHEM 3514. Physical Chemistry II. 4 Hours.
Second semester of a 2-semester course in physical chemistry aimed for B.S. chemistry majors/minors with topics covering the laws of thermodynamics, phase & chemical equilibria; structure and properties of solutions, chemical potential, and chemical kinetics. Lecture and recitation 4 hours per week. Students cannot earn credit for both CHEM 3453 and CHEM 3514. Corequisite: Chemistry majors and chemistry minors must enroll in CHEM 3512L concurrently. Prerequisite: CHEM 3504. (Typically offered: Spring)
CHEM 3601L. Organic Chemistry I Laboratory. 1 Hour.
Introduction to basic techniques for separation, purification, and identification of organic compounds. Laboratory exercises in organic chemistry. Meets 3 hours per week. Pre- or Corequisite: CHEM 3603 and related course component drill for CHEM 3603. (Typically offered: Fall and Summer)
CHEM 3602M. Honors Organic Chemistry I Laboratory. 2 Hours.
Introduction to basic techniques for separation, purification, and identification of organic compounds. Drill lecture-discussion (1hr/wk) and laboratory (4hr/wk). Writing component. Required drill. Corequisite: CHEM 3603H and related course component drill sections for CHEM 3603H and CHEM 3602M. Prerequisite: Honors candidacy. (Typically offered: Fall and Summer)
This course is equivalent to CHEM 3601L.
CHEM 3603. Organic Chemistry I. 3 Hours.
Introduction to organic compounds including alkanes, haloalkanes, alkenes, and alkynes; properties including basic stereochemistry and reactions including nucleophilic substitution, elimination, and electrophilic addition reactions. Lecture 3 hours per week. Corequisite: CHEM 3601L and related course component drill section for CHEM 3603. Prerequisite: (CHEM 1123 and CHEM 1121L) or (CHEM 1123H and CHEM 1121H) or (CHEM 1223 and CHEM 1221L). (Typically offered: Fall and Summer)

CHEM 3603H. Honors Organic Chemistry I. 3 Hours.
In-depth introduction to organic compounds; properties and reactions. Including alkanes, haloalkanes, alkenes and alkynes; nucleophilic substitution, elimination, and electrophilic addition reactions. Lecture 3 hours per week. Corequisite: CHEM 3602M and related course component drill sections for CHEM 3603H and CHEM 3602M. Prerequisite: Honors candidacy and ((CHEM 1123 and CHEM 1121L) or (CHEM 1123H and CHEM 1121H) or (CHEM 1223 and CHEM 1221L)). (Typically offered: Fall and Summer)

This course is equivalent to CHEM 3603.

CHEM 3611L. Organic Chemistry II Laboratory. 1 Hour.
Continuation of CHEM 3601L and introduction to basic techniques of synthesis, isolation, and determination of structure and reactivity of organic compounds. Laboratory exercises in organic chemistry. Meets 3 hours per week. Corequisite: CHEM 3613 and related course component drill for CHEM 3613. Prerequisite: CHEM 3601L. (Typically offered: Spring and Summer)

CHEM 3612M. Honors Organic Chemistry II Laboratory. 2 Hours.
Continuation of CHEM 3602M and introduction to basic techniques of synthesis, isolation, and determination of structure and reactivity of organic compounds. Drill lecture-discussion (1 hour/wk) and laboratory (4 hours/wk). Writing component. Drill required. Corequisite: CHEM 3613H and related course component drill sections for CHEM 3612M and CHEM 3613H. Prerequisite: Honors candidacy and CHEM 3602M. (Typically offered: Spring and Summer)

This course is equivalent to CHEM 3611L.

CHEM 3613. Organic Chemistry II. 3 Hours.
Basic chemistry of aromatic and carbonyl compounds: properties and reactions. Lecture 3 hours per week. Corequisite: CHEM 3611L and related course component drill section for CHEM 3613. Prerequisite: (CHEM 3603 and CHEM 3601L) or (CHEM 3603H and CHEM 3602M) or (CHEM 3703 and CHEM 3702L). (Typically offered: Spring and Summer)

CHEM 3613H. Honors Organic Chemistry II. 3 Hours.
In-depth coverage of the basic chemistry of aromatic and carbonyl compounds; properties and reactions. Lecture 3 hours per week. Corequisite: CHEM 3612M and related course component drill sections for CHEM 3613H and CHEM 3612M. Prerequisite: Honors candidacy and CHEM 3603H and CHEM 3602M. (Typically offered: Spring and Summer)

This course is equivalent to CHEM 3613.

CHEM 3702L. Organic Chemistry I Lab for Chemistry Majors. 2 Hours.
Introduction to basic techniques for separation, purification, and identification of organic compounds. Drill lecture-discussion (1 hr/wk) and laboratory (4 hr/wk). Writing component. Required drill. Corequisite: CHEM 3703 and related course component drill sections for CHEM 3703 and CHEM 3702L. Prerequisite: Chemistry major or minor. (Typically offered: Fall)

CHEM 3703. Organic Chemistry I Lecture for Chemistry Majors. 3 Hours.
In-depth introduction to organic compounds including alkanes, haloalkanes, alkenes and alkynes; properties including basic stereochemistry and reactions including nucleophilic substitution, elimination, and electrophilic addition. Lecture 3 hours per week. Corequisite: CHEM 3702L and related course component drill sections for CHEM 3703 and CHEM 3702L. Prerequisite: Chemistry major or minor and (CHEM 1123 and CHEM 1121L) or (CHEM 1123H and CHEM 1121M) or (CHEM 1223 and CHEM 1221L). (Typically offered: Fall)

This course is equivalent to CHEM 3603.

CHEM 3712L. Organic Chemistry II Lab for Chemistry Majors. 2 Hours.
Continuation of CHEM 3702L and introduction to basic techniques of synthesis, isolation, and determination of structure and reactivity of organic compounds. Drill lecture-discussion (1 hour/wk) and laboratory (4 hours/wk). Writing component. Drill required. Corequisite: CHEM 3713 and related course component drill sections for CHEM 3713 and CHEM 3712L. Prerequisite: Chemistry major or minor and CHEM 3702L. (Typically offered: Spring)

CHEM 3713. Organic Chemistry II Lecture for Chemistry Majors. 3 Hours.
Continuation of in-depth coverage of the basic chemistry of the compounds of carbon. Properties and reactions of aromatic and carbonyl functional groups. Lecture 3 hours per week. Corequisite: CHEM 3712L and related course component drill sections for CHEM 3713 and CHEM 3712L. Prerequisite: Chemistry major or minor and CHEM 3703 and CHEM 3702L. (Typically offered: Spring)

This course is equivalent to CHEM 3613.

CHEM 3813. Elements of Biochemistry. 3 Hours.
One semester survey course of the fundamentals of biochemistry. Structures, properties, and reactions of major classes of biomolecules. Basics of enzyme catalysis. Overview of metabolism. Credit for both CHEM 3813 and CHEM 4813H may not be counted toward a chemistry degree. Lecture 3 hours per week. Prerequisite: (CHEM 3613 and CHEM 3611L) or (CHEM 3613H and CHEM 3612M) or (CHEM 3713 and CHEM 3712L) or (CHEM 2613 and CHEM 2611L). (Typically offered: Fall, Spring and Summer)

CHEM 3923H. Honors Colloquium. 3 Hours.
Covers a special topic or issue. Offered as a part of the honors program. Prerequisite: Honors candidacy. (Typically offered: Fall, Spring and Summer)

CHEM 400V. Chemistry Research. 1-4 Hour.
Research problems. Students need to enroll in their supervising faculty mentor's section. CHBC students conducting research under a faculty mentor outside of CHBC must enroll in the CHBC chair's section. Additionally, honors students need the approval of the CHBC department honors advisor. Honors students must complete thesis in senior year. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.

CHEM 400VH. Honors Chemistry Research. 1-4 Hour.
Research problems. Students need to enroll in their supervising faculty mentor's section. CHBC students conducting research under a faculty mentor outside of CHBC must enroll in the CHBC chair's section. Additionally, honors students need the approval of the CHBC department honors advisor. Honors students must complete thesis in senior year. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.

This course is equivalent to CHEM 400V.

CHEM 4011H. Honors Seminar. 1 Hour.
Research seminar for chemistry majors enrolled in the honors program. Enrollment is required the spring semester of the junior and senior years for honors students. Senior honors students must make one research presentation to graduate with honors. Prerequisite: Honors candidacy, chemistry major and junior or senior standing. (Typically offered: Spring) May be repeated for up to 2 hours of degree credit.

CHEM 405V. Special Topics in Chemistry. 1-4 Hour.
Potential topics include: advanced spectroscopic methods, bioanalytical chemistry, bioorganic chemistry, biogeneric chemistry, biophysical chemistry, chemical sensors, drug discovery and design, nanomaterials, pharmaceutical chemistry, process analytical chemistry, and protein folding and design. (Typically offered: Irregular)

CHEM 4123. Advanced Inorganic Chemistry I. 3 Hours.
Reactions and properties of inorganic compounds from the standpoint of electronic structure and the periodic table. Emphasis on recent developments. Prerequisite: CHEM 3453 or CHEM 3514. (Typically offered: Fall)
CHEM 4153L. Nanotechnology Laboratory. 3 Hours.
Provides students with hands-on experience in various areas of nanotechnology, including nanoscale imaging, synthesis of nanomaterials, nanostructure assembly and manipulation, device and system integration, and performance evaluation. Students can earn credit for only one of the following courses: MEEG 4323L, BENG 4753L, BMEG 4103L, CHEM 4153L, PHYS 4793L. Corequisite: Drill component, junior standing and instructor consent. Prerequisite: MATH 2564, PHYS 2074, and CHEM 1123. (Typically offered: Fall) This course is cross-listed with MEEG 4323L, PHYS 4793L.
CHEM 4211L. Instrumental Analysis Laboratory. 1 Hour.
Provides laboratory experience in parallel with the lecture material in CHEM 4213. Laboratory 3 hours per week. Corequisite: CHEM 4213. (Typically offered: Spring)
CHEM 4213. Instrumental Analysis. 3 Hours.
Provides students, especially those in the agricultural, biological, and physical sciences, with an understanding of modern instrumental techniques of analysis. Lecture 3 hours per week. Corequisite: CHEM 4211L. Prerequisite: CHEM 2263 and CHEM 2261L and ((CHEM 3613 and CHEM 3611L) or (CHEM 3613H and CHEM 3612M) or (CHEM 3713 and CHEM 3712L)). (Typically offered: Spring)
CHEM 4283. Energy Conversion and Storage. 3 Hours.
Fundamental and applied concepts of energy storage and conversion, with sustainability implications. Chemical reactions (kinetics, thermodynamics, mass transfer), emphasizing oxidation-reduction, electrochemical, and interfacial processes, and impact on performance of fuel and biofuel cells, batteries, supercapacitors, and photochemical conversion. Prerequisite: CHEM 1123 and PHYS 2074. (Typically offered: Fall Even Years)
CHEM 4443. Physical Chemistry of Materials. 3 Hours.
Physical and chemical characteristics of materials and discussion of the science behind materials engineering and performance. Topics include theory, principles of characterization methods, modeling, and applications in the context of materials. Pre- or Corequisite: CHEM 3514. Prerequisite: CHEM 3453 or CHEG 3713 or MEEG 2403. (Typically offered: Spring Odd Years)
CHEM 4723. Experimental Methods in Organic Chemistry. 3 Hours.
Introduction to the application of synthetic and spectroscopic methods in organic chemistry, including mass spectrometry, infrared spectroscopy, and nuclear magnetic resonance spectrometry. Other laboratory techniques applicable to chemical research will be included. Lecture 3 hours and laboratory 3 hours per week. Lecture only meets the first half of the term. Laboratory meets the entire term. Corequisite: Lab component. Prerequisite: CHEM 3613 and CHEM 3611L, or CHEM 3613H or CHEM 3612M, or CHEM 3713 and CHEM 3712L. (Typically offered: Fall)
CHEM 4813H. Honors Biochemistry I. 3 Hours.
The first of a two-course series covering biochemistry for undergraduate students in biology, agriculture, and chemistry. Topics covered include protein structure and function, enzyme kinetics, enzyme mechanisms, and nucleic acid and carbohydrate structures. Credit cannot be earned in both CHEM 3813 and CHEM 4813H. Additional honors-level work required in this section. Prerequisite: Honors candidacy and CHEM 4813H. (Typically offered: Spring)
CHEM 4843H. Honors Biochemistry II. 3 Hours.
A continuation of CHEM 4813H covering topics including biological membranes and bioenergetics, photosynthesis, lipids and lipid metabolism, nucleic acid structure, structure and synthesis, and molecular biology. Credit cannot be earned in both CHEM 3813 and CHEM 4843H. Additional honors-level work required in this section. Prerequisite: Honors candidacy and CHEM 4813H. (Typically offered: Spring)
CHEM 4853. Biochemical Techniques. 3 Hours.
Techniques for handling, purifying and analyzing enzymes, structural proteins, and nucleic acids. Lecture 1 hour, laboratory 6 hours per week. Corequisite: Lab component. Pre or Corequisite: CHEM 3813 or CHEM 4843H. (Typically offered: Spring)
CHEM 505V. Special Topics in Chemistry. 1-4 Hour.
(Formerly CHEM 405V.) Potential topics include: advanced spectroscopic methods, bioanalytical chemistry, bioinorganic chemistry, bioorganic chemistry, biophysical chemistry, chemical sensors, drug discovery and design, nanomaterials, pharmaceutical chemistry, process analytical chemistry, and protein folding and design. Graduate degree credit will not be given for both CHEM 405V and CHEM 505V. Prerequisite: Instructor consent. (Typically offered: Irregular)
CHEM 5101. Introduction to Research. 1 Hour.
This eight week course introduces new graduate students to research opportunities and skills in chemistry and biochemistry. Meets 2 hours per week in the first half of the semester. Safety and ethics in research and scholarship are discussed. Students learn about research programs in the department to aid in choosing an advisor. (Typically offered: Fall)
CHEM 5123. Advanced Inorganic Chemistry. 3 Hours.
Reactions and properties of inorganic compounds from the standpoint of electronic structure and the periodic table. Emphasis on recent developments. Knowledge comparable to material in CHEM 3453 is recommended. (Typically offered: Fall)
CHEM 5143. Advanced Inorganic Chemistry II. 3 Hours.
Chemistry of metallic and non-metallic elements emphasizing molecular structure, bonding and the classification of reactions. Knowledge of inorganic chemistry comparable to material in CHEM 4123 and CHEM 5123 is recommended. (Typically offered: Irregular)
CHEM 5153. Structural Chemistry. 3 Hours.
Determination of molecular structure by diffraction, spectroscopic, and other techniques. Illustrative examples will be chosen from inorganic chemistry and biochemistry. (Typically offered: Irregular)
CHEM 5213. Instrumental Analysis. 3 Hours.
Provides students, especially those in the physical, agricultural, and biological sciences, with an understanding of the theory and practice of modern instrumental techniques of analysis. Lecture 3 hours per week. Knowledge comparable to material in CHEM 2263 and CHEM 3603 is recommended. (Typically offered: Spring)
CHEM 5233. Chemical Separations. 3 Hours.
Modern separation methods including liquid chromatography (adsorption, liquid-liquid partition, ion exchange, exclusion) and gas chromatography. Theory and instrumentation is discussed with emphasis on practical aspects of separation science. Prerequisite: CHEM 4213. (Typically offered: Fall Even Years)
CHEM 5243. Electrochemical Methods of Analysis. 3 Hours.
Topics will include diffusion, electron transfer kinetics, and reversible and irreversible electrode processes followed by a discussion of chronocoulometry, chronocoulometry, polarography, voltammetry, and chronopotentiometry. Knowledge of analytical chemistry comparable to material in CHEM 4213 is recommended. (Typically offered: Spring Even Years)
CHEM 5253. Spectrochemical Methods of Analysis. 3 Hours.
Principles and methods of modern spectroscopic analysis. Optics and instrumentation necessary for spectroscopy is also discussed. Topics include atomic and molecular absorption and emission techniques in the ultraviolet, visible, and infrared spectral regions. Knowledge of analytical chemistry comparable to material in CHEM 4213 is recommended. (Typically offered: Fall Odd Years)
CHEM 5283. Energy Conversion and Storage. 3 Hours.
Fundamental and applied concepts of energy storage and conversion with sustainability implications. Chemical reactions (kinetics, thermodynamics, mass transfer), emphasizing oxidation-reduction, electrochemical, and interfacial processes, and impact on performance of fuel and biofuel cells, batteries, supercapacitors, and photochemical conversion. (Typically offered: Fall Even Years)

CHEM 5383. Chemometrics. 3 Hours.
Chemometrics is the process of extracting relevant information from chemical data by mathematical and statistical tools. These tools allow for designing optimal experimental procedures, extracting important information from complex chemical systems, and better understanding of complex chemical systems. (Typically offered: Spring Even Years)

CHEM 5443. Physical Chemistry of Materials. 3 Hours.
Physical and chemical characteristics of materials and discussion of the science behind materials engineering and performance. Topics include theory, principles of characterization methods, modeling, and applications in the context of materials. Knowledge comparable to material in CHEM 3514 and CHEM 3504 or CHEM 3453 or CHEG 3713 or MEEG 2403 is recommended. (Typically offered: Irregular)

CHEM 5453. Quantum Chemistry I. 3 Hours.
Fundamental quantum theory: Hamiltonian formalism in classical mechanics, Schrödinger equation, operators, angular momentum, harmonic oscillator, barrier problems, rigid rotator, hydrogen atom, and interaction of matter with radiation. Knowledge of physical chemistry comparable to material in CHEM 3504 is recommended. (Typically offered: Spring Odd Years)

CHEM 5473. Chemical Kinetics. 3 Hours.
Theory and applications of the principles of kinetics to reactions between substances, both in the gaseous state and in solution. Knowledge of physical chemistry comparable to material in CHEM 3514 is recommended. (Typically offered: Spring)

CHEM 5573. Statistical Thermodynamics. 3 Hours.
Covers fundamentals in thermodynamics, molecular dynamics, Monte Carlo, phase transitions, behavior of gases and liquids and basic concepts in chemical kinetics and physical kinetics. Knowledge comparable to physical chemistry materials in CHEM 3514 is recommended. (Typically offered: Irregular)

CHEM 5603. Physical Organic Chemistry. 3 Hours.
Introduction to the theoretical interpretation of reactivity, reaction mechanisms, and molecular structure of organic compounds. Application of theories of electronic structure; emphasis on recent developments. Knowledge of material comparable to CHEM 3613, CHEM 3613H, CHEM 3713 and CHEM 3514 is recommended. (Typically offered: Fall)

CHEM 5633. Organic Reactions. 3 Hours.
The more important types of organic reactions and their applications to various classes of compounds. Knowledge of organic chemistry comparable to material in CHEM 3603 is recommended. (Typically offered: Irregular)

CHEM 5723. Experimental Methods in Organic Chemistry. 3 Hours.
Introduction to the application of synthetic and spectroscopic methods in organic chemistry, including mass spectrometry, infrared spectroscopy, and nuclear magnetic resonance spectrometry. Lecture 3 hours per week. Knowledge comparable to material in CHEM 3613 is recommended. (Typically offered: Fall)

CHEM 5753. Methods of Organic Analysis. 3 Hours.
Interpretation of physical measurements of organic compounds in terms of molecular structure. Emphasis on spectroscopic methods (infrared, ultraviolet, magnet resonance, and mass spectra). Knowledge of organic chemistry comparable to material in CHEM 3603 is recommended. (Typically offered: Fall)

CHEM 5813. Biochemistry I. 3 Hours.
The first of a two-course series covering biochemistry for graduate students in biology, agriculture, and chemistry. Topics covered include protein structure and function, enzyme kinetics, enzyme mechanisms, and nucleic acid and carbohydrate structures. Knowledge of organic chemistry comparable to material in CHEM 3613 is recommended. (Typically offered: Fall)

CHEM 5843. Biochemistry II. 3 Hours.
A continuation of CHEM 5813 covering topics including biological membranes and bioenergetics, photosynthesis, lipids and lipid metabolism, nucleic acid and amino acid metabolism, and molecular biology. Knowledge of organic chemistry comparable to material in CHEM 3613 is recommended. Prerequisite: CHEM 5813. (Typically offered: Spring)

CHEM 600V. Master's Thesis. 1-6 Hour.
Master's Thesis. Chemistry graduate students enroll in this course as needed until all CUMES are passed and the student is officially a doctoral candidate. Prerequisite: Chemistry graduate student. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.

CHEM 6011. Chemistry Seminar. 1 Hour.
Weekly discussion of current chemical research. Departmental and divisional seminars in analytical chemistry, biochemistry, inorganic, organic, and physical chemistry are held weekly. Seminar credit does not count toward the minimum hourly requirements for any chemistry graduate degree. (Typically offered: Fall and Spring) May be repeated for degree credit.

CHEM 619V. Special Topics in Inorganic Chemistry. 1-3 Hour.
Topics which have been covered in the past include: technique and theory of x-ray diffraction, electronic structure of transition metal complexes, inorganic reaction mechanisms, and physical methods in inorganic chemistry. (Typically offered: Irregular) May be repeated for degree credit.

CHEM 6283. Mass Spectrometry. 3 Hours.
This course is devoted to the fundamental principles and applications of analytical mass spectrometry. Interactions of ions with magnetic and electric fields and the implications with respect to mass spectrometer design are considered, as are the various types of mass spectrometer sources. Representative applications of mass spectrometry in chemical analysis are also discussed. Prerequisite: Graduate standing. (Typically offered: Spring Odd Years)

CHEM 629V. Special Topics in Analytical Chemistry. 1-3 Hour.
Topics that have been presented in the past include: electroanalytical techniques, kinetics of crystal growth, studies of electrode processes, lasers in chemical analysis, nucleosynthesis and isotopic properties of meteorites, thermonucleosynthesis of geological materials, early solar system chemistry and analytical cosmochemistry. (Typically offered: Irregular) May be repeated for degree credit.

CHEM 649V. Special Topics in Physical Chemistry. 1-3 Hour.
Topics which have been covered in the past include advanced kinetics, solution chemistry, molecular spectra, nuclear magnetic resonance spectroscopy, and methods of theoretical chemistry. (Typically offered: Irregular) May be repeated for degree credit.

CHEM 6633. Chemistry of Organic Natural Products. 3 Hours.
Selected topics concerned with structure elucidation and synthesis of such compounds as alkaloids, antibiotics, bacterial metabolites, plant pigments, steroids, terpenoids, etc. Prerequisite: CHEM 5603 and CHEM 5633. (Typically offered: Irregular)

CHEM 6643. Organometallic Chemistry. 3 Hours.
Theories and principles of organometallic chemistry. Concepts include bonding, stereochemistry, structure and reactivity, stereochemical principles, conformational, steric and stereoelectronic effects. Transition metal catalysis of organic reactions will also be described. Knowledge of material comparable to CHEM 3713 and CHEM 3514 is recommended. (Typically offered: Irregular)
CHEM 689V. Special Topics in Organic Chemistry. 1-3 Hour.
Topics which have been presented in the past include heterogeneous catalysis, isotope effect studies of organic reaction mechanisms, organometallic chemistry, stereochemistry, photochemistry, and carbanion chemistry. (Typically offered: Irregular) May be repeated for degree credit.

CHEM 6823. Physical Biochemistry. 3 Hours.
Physical chemistry of proteins, nucleic acids, and biological membranes. Ultracentrifugation, absorption and fluorescent spectrophotometry, nuclear magnetic resonance spectroscopy, x-ray diffraction, and other techniques. Prerequisite: CHEM 5813. (Typically offered: Fall Even Years)

CHEM 6863. Enzymes. 3 Hours.
Isolation, characterization, and general chemical and biochemical properties of enzymes. Kinetics, mechanisms, and control of enzyme reactions. Prerequisite: CHEM 5813 and CHEM 5843. (Typically offered: Fall Odd Years)

CHEM 6873. Molecular Biochemistry. 3 Hours.
Nucleic acid chemistry in vitro and in vivo, synthesis of DNA and RNA, genetic diseases, cancer biochemistry and genetic engineering. Prerequisite: CHEM 5813 and CHEM 5843. (Typically offered: Spring Odd Years)

CHEM 6883. Bioenergetics and Biomembranes. 3 Hours.
Cellular energy metabolism, photosynthesis, membrane transport, properties of membrane proteins, and the application of thermodynamics to biological systems. Prerequisite: CHEM 5813 and CHEM 5843. (Typically offered: Spring Even Years)

CHEM 700V. Doctoral Dissertation. 1-12 Hour.
Doctoral Dissertation. For chemistry graduate students who have passed all CUMES and have officially been admitted to doctoral candidacy. Prerequisite: Chemistry graduate student. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.