162 Chemistry Laboratory II
Fall, Spring. (1-0-3) RB: (CEM 161 or LB 171L or CEM 185H) and ((CEM 142 or concurrently) and (CEM 152 or concurrently)) Not open to students with credit in CEM 186H or LB 172L. Analytical and inorganic chemistry; redox and acid base titrations; spectrophotometric and gravimetric analysis; preparation and analysis of coordination complexes of nickel, iron, and cobalt.

181H Honors Chemistry I
Fall. 4(4-0) P: (MTH 124 or concurrently) or (MTH 152H or concurrently) or (LB 118 or concurrently) or (LB 118 or concurrently) R: Approval of department. Elements and compounds; stoichiometry; reactions; atomic structure and quantum mechanics; chemical bonding and molecular structure; spectroscopy; coordination chemistry and theories of bonding; structure of biochemical molecules.

182H Honors Chemistry II
Spring. 4(4-0) P: (CEM 151 or CEM 181H or LB 171) and (MTH 126 or concurrently) or (MTH 153H or concurrently) R: Approval of department. Thermodynamics and chemical equilibria; acids and bases; redox chemistry; main group elements; solid state; group theory and symmetry; molecular orbital theory; transition metal chemistry and spectroscopy.

185H Honors Chemistry Laboratory I
Fall. 2(0-6) P: CEM 181H or concurrently R: Approval of department. Spectroscopy and diffraction methods for the study of electronic structure and molecular geometry; synthesis and separation methods for the preparation and characterization of molecules; application to inorganic, organic, and biochemical molecules and materials.

186H Honors Chemistry Laboratory II
Spring. 2(0-6) P: CEM 182H or concurrently R: Approval of department. Laboratory research.

151 General and Descriptive Chemistry
Fall, Spring. 3(4-0) P: CEM 141 or CEM 151 or CEM 181H or LB 171 Not open to students with credit in CEM 351. Chemistry of carbon compounds. Chemistry of the main organic functional groups with applications to everyday life, industry, and biology.

152 Principles of Chemistry
Spring. 3(4-0) P: CEM 151 or CEM 181H or LB 171 Not open to students with credit in CEM 142 or CEM 182H or LB 172. The mole concept and stoichiometry; solution stoichiometry; thermochemistry; gases, liquids, and solids; kinetics; chemical equilibria; acid-based equilibria; aqueous equilibria; thermodynamics; redox and electrochemistry.

161 Chemistry Laboratory I
Fall, Spring. 1(0-3) P: (CEM 141 or concurrently) or (CEM 151 or concurrently) Not open to students with credit in CEM 185H or LB 171L. Experiments in general chemistry; stoichiometry, calormetry, electrochemistry, molecular geometry, gas laws, kinetics, acids and bases, and inorganic chemistry.

352 Organic Chemistry II
Spring. 3(4-0) P: (CEM 351 or concurrently) and (CEM 262 or CEM 186H) Not open to students with credit in CEM 252. Carboxylate derivatives. Conjugation. Aromaticity. Amino acids. Proteins. Carbohydrates. Nucleic acids.

355 Organic Laboratory I
Spring. 2(0-5) P: (CEM 162 or CEM 186H or LB 172L) and (CEM 352 or concurrently) and completion of Tier I writing requirement Not open to students with credit in CEM 255. Organic laboratory techniques. Distillation. Spectroscopy. Melting points. Recrystallization. Chromatography. Measuring physical properties.

356 Organic Laboratory II
Fall. 2(0-6) P: CEM 355 Multi-step organic synthesis. Qualitative organic analysis. Separation, identification, and characteriza-

383 Introductory Physical Chemistry I
Fall. 3(4-0) P: (CEM 142 or CEM 152 or CEM 182H or LB 172L) and (CEM 133 or MTH 153H or MTH 126 or LB 119) SA: CEM 391 Physical chemistry of macroscopic systems: thermodynamics, kinetics, electrochemistry.

384 Introductory Physical Chemistry II
Spring. 3(4-0) P: CEM 383 Not open to students with credit in CEM 461. Physical chemistry of microscopic systems: quantum mechanics, spectroscopy.

395 Analytical/Physical Laboratory
Spring. 2(1-4) P: (CEM 483 and completion of Tier I writing requirement) and (CEM 262 or CEM 186H) RB: One year of general chemistry, calculus, and general physics. SA: CEM 372, CEM 472 C: CEM 484 concurrently. Chemical kinetics, thermodynamics, and computer-based data analysis methods.

400H Honors Work
Fall, Spring. Summer. 1 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. P: Completion of Tier I writing requirement. R: Approval of department. Readings and investigations in chemistry.
Written and oral reports on selected journal articles.

Advanced Synthesis Laboratory
Fall. 3(0-0) P: (CEM 411) and completion of Tier I writing requirement. R: Open only to juniors or seniors in the Bachelor of Science degree program in Chemistry. Methods of synthesizing inorganic and organometallic compounds.

Independent Study
Fall, Spring, Summer. 1 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Approval of department.
Faculty supervised readings in chemistry.

Independent Research
Fall, Spring, Summer. 1 to 12 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Approval of department.
Faculty supervised independent investigations in chemistry.

Advanced Analytical Chemistry
Fall, 3(3-0) P: CEM 395 and CEM 352 and CEM 483 SA: CEM 361, CEM 362
Instrumental methods of analysis, including spectroscopy, chromatography, and electrochemistry.

Analytical Chemistry Laboratory
Spring, 2(1-3) P: (CEM 434 or concurrently) and completion of Tier I writing requirement.
SA: CEM 372, CEM 472
Electronic and optical components of chemical instrumentation. Spectroscopic and chromatographic methods.

Chemical Safety
Fall, 1(1-0) P: CEM 142 and CEM 252
Prudent laboratory practices. Regulatory agencies' expectations of chemical industries and academia.

Seminar in Computational Chemistry
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 6 credits in all enrollments for this course. P: (MTH 133 and CSE 231) and ((CEM 152 or concurrently) or (CEM 182H or concurrently)) RB: CPS 260 and CEM 351
Written and oral reports on selected journal articles in computational chemistry.

Quantum Chemistry
Fall, 3(4-0) P: (MTH 235 or MTH 255H) and (PHY 184 or PHY 294H or LB 274) and (CEM 142 or CEM 152 or CEM 182H or LB 172) RB: CEM 348 or CEM 392 SA: CEM 361, CEM 391
Postulates of quantum mechanics and the application to model systems, atoms and molecules. Introduction to molecular spectroscopy.

Molecular Thermodynamics
Spring, 3(4-0) P: (MTH 235 or MTH 255H) and (PHY 184 or PHY 294H or LB 274) and (CEM 142 or CEM 152 or CEM 182H or LB 172) RB: CEM 483 or CEM 392 SA: CEM 361, CEM 391
Statistical mechanics and its use in classical chemical thermodynamics. Applications of thermodynamics to chemical systems at equilibrium.

Modern Nuclear Chemistry
Spring of even years. 3(3-0) P: (CEM 141 or CEM 152 or CEM 182H) and (PHY 232 or PHY 184) RB: CEM 392 or CEM 384 or PHY 471 SA: CEM 430
Elementary nuclear processes and properties; radioactivity, its measurement and its interaction with matter.

Molecular Spectroscopy
Fall, 2(1-4) P: CEM 483 and CEM 395 RB: One year of physical chemistry. SA: CEM 172
Experiments in magnetic resonance, optical, and vibrational spectroscopies.

Chemical Physics Seminar
Fall, Spring, Summer. 1(1-0) A student may earn a maximum of 2 credits in all enrollments for this course. P: ((PHY 321) and completion of Tier I writing requirement) or (MTH 235 or LB 220 or MTH 255H)
Written and oral reports on selected journal articles in chemical physics.

Advanced Inorganic Chemistry I
Fall, 3(3-0) R: Open only to graduate students in College of Natural Science or College of Engineering.
Principles of chemical bonding, electronic structure, and reaction mechanisms of main group and transition metal compounds. Concepts of group theory.

Advanced Inorganic Chemistry II
Spring, 3(3-0) RB: CEM 811 R: Open only to graduate students in College of Natural Science or College of Engineering.
Descriptive chemistry of inorganic compounds. Emphasis on synthesis, structure, and reaction patterns of coordination, organometallic, and solid state compounds of transition metals and main group elements.

Organometallic Chemistry
Fall, 3(3-0)
Organometallic functional groups. Principles of electronic structure, and bonding in organometallic species will be related to reactivity patterns in common systems. Preparation of complexes with applications to catalytic and stoichiometric organic synthesis.

Mass Spectrometry
Fall, Spring, 3(3-0) R: Open only to graduate students in the College of Natural Science or College of Engineering.
Instrumentation of mass spectrometry. Interpreting mass spectra of organic and inorganic molecules. Applications to analysis of large molecules and chromatography.

Advanced Analytical Chemistry I
Fall, 3(3-0) R: Open to graduate students in the College of Engineering or in the College of Natural Science or in the School of Criminal Justice.
Separations, molecular spectroscopy and mass spectrometry.
881 Atomic and Molecular Structure
Fall: 3(3-0) R: Open only to graduate students in College of Natural Science or College of Engineering.
Postulates of quantum mechanics, analytical solutions of the Schroedinger equation, theoretical descriptions of chemical bonding, spectroscopy, statistical mechanics, and statistical thermodynamics.

882 Kinetics and Spectroscopic Methods
Spring: 3(3-0) R: Open only to graduate students in College of Natural Science or College of Engineering.
Rate equations and mechanisms of chemical reactions: reaction rate theory, kinetic theory of gases, photochemistry. Spectroscopic methods, and applications of spectroscopy in reaction kinetics.

883 Computational Quantum Chemistry
Fall: 3(2-3) RB: CEM 461 or CEM 881 Computational methods in determining electronic energy levels, equilibrium nuclear configurations, and other molecular properties.

888 Computational Chemistry
Spring: 3(2-3) Computational approaches to molecular problems. Use of ab initio and semi-empirical electronic structure, molecular mechanics and molecular dynamics software.

890 Chemical Problems and Reports
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 12 credits in all enrollments for this course.
Investigation and report of a nonthesis problem in chemistry.

899 Master's Thesis Research
Fall, Spring, Summer. 1 to 20 credits. A student may earn a maximum of 99 credits in all enrollments for this course. R: Open only to graduate students in the Department of Chemistry.
Master's thesis research.

913 Selected Topics in Inorganic Chemistry
Fall, Spring. 1 to 3 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open to graduate students in the Department of Chemistry or approval of department.
Current research topics in inorganic chemistry.

918 Inorganic Chemistry Seminar
Fall, Spring. 1(1-0) A student may earn a maximum of 3 credits in all enrollments for this course. R: Open to graduate students in the Department of Chemistry.
Advances in inorganic chemistry reported by graduate students.

924 Selected Topics in Analytical Chemistry
Fall, Spring. 2 to 3 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to graduate students in College of Natural Science or College of Engineering.
Advanced computer techniques, surface chemistry, analytical chemistry of polymers, or statistics for chemists.

938 Analytical Chemistry Seminar
Fall, Spring. 1(1-0) A student may earn a maximum of 3 credits in all enrollments for this course. R: Open to graduate students in the College of Engineering or in the College of Natural Science.
Advances in analytical chemistry reported by graduate students, faculty, and guest lecturers.

956 Selected Topics in Organic Chemistry
Fall, Spring. 1 to 3 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Open only to graduate students in College of Natural Science or College of Engineering.
Heterocyclic and organometallic chemistry, natural products, photochemistry, free radicals, or reaction mechanisms.

958 Organic Chemistry Seminar
Fall, Spring. 1(1-0) A student may earn a maximum of 2 credits in all enrollments for this course. R: Open to graduate students in the College of Engineering or in the College of Natural Science.
Advances in organic chemistry reported by graduate students.

971 Emerging Topics in Chemistry
Fall, Spring. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to doctoral students in the Chemistry or Chemical Physics major.
Discussion of a research topic of emerging interest in chemistry. Preparation of a proposal for funding of research.

985 Selected Topics in Nuclear Chemistry
Fall. 1 to 3 credits. A student may earn a maximum of 9 credits in all enrollments for this course. RB: Thermodynamics, Statistical Mechanics, Quantum Mechanics, Electricity and Magnetism, Differential and Integral Calculus, Differential Equations R: Open to doctoral students in the College of Engineering or in the College of Natural Science or in the Department of Chemistry.
Nuclear instruments, detectors and electronics, vacuum technology, electric and magnetic properties of nuclei, nuclear simulation tools, or nuclear spectroscopy and reactions.

987 Selected Topics in Physical Chemistry I
Fall. 1 to 3 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to doctoral students or approval of department.
Topics such as kinetics and photochemistry, macromolecular and surface chemistry, molecular spectroscopy, electric and magnetic properties of matter, or applications of statistical mechanics to chemical problems.

988 Selected Topics in Physical Chemistry II
Spring. 1 to 3 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to doctoral students or approval of department.
Topics such as analysis and interpretation of molecular spectra, advanced molecular structure theory, magnetic resonance, X-rays and crystal structure, scientific analysis of vacuum systems, or problems in statistical mechanics.

992 Quantum Chemistry and Statistical Thermodynamics II
Spring. 3(3-0) RB: CEM 991 Analytical and numerical methods for solving quantum chemical problems. Statistical mechanics of solids and liquids.

993 Advanced Topics in Quantum Chemistry
Spring of odd years. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to graduate students in the College of Natural Science or the College of Engineering.
Spectroscopic theory, properties of atoms and molecules in electric and magnetic fields, intermolecular forces. Many-body theory, molecular electronic structure, solid state chemistry, or molecular reaction dynamics.

994 Advanced Topics in Statistical Mechanics
Spring of even years. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to graduate students in the College of Natural Science or the College of Engineering.
Nonequilibrium statistical mechanics and thermodynamics. Correlation functions and spectroscopy, light scattering, magnetic relaxation, transport properties of fluids and gases, or statistical mechanics of chemical reactions.

995 Nuclear Chemistry Seminar
Fall, Spring. 1(1-0) A student may earn a maximum of 3 credits in all enrollments for this course. R: Open to graduate students in the Department of Chemistry or in the Department of Physics and Astronomy.
Advances in nuclear chemistry reported by graduate students, faculty, and guest lecturers.

998 Physical Chemistry Seminar
Fall, Spring. 1(1-0) A student may earn a maximum of 120 credits in all enrollments for this course. R: Open only to doctoral students in the Department of Chemistry.
Advances in physical chemistry reported by graduate students.

999 Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 120 credits in all enrollments for this course. R: Open only to doctoral students in the Department of Chemistry.
Doctoral dissertation research.