# Chemistry (CH)

**CH 100 Chemistry and Society** (4 credit hours)
Awareness and understanding of chemistry in everyday life for the non-science student. Non-mathematical treatment of essential fundamental concepts. Emphasis on practical applications of chemistry to consumer affairs, energy, medicine, food, sports, and pollution. Laboratory activities are designed to provide a personal experience with the concepts discussed in the course. Credit is not allowed for CH 100 if student has prior credit for CH 101.

R: Credit is not allowed for CH 100 if student has prior credit for CH 101.
*GEP Natural Sciences*
*Typically offered in Fall and Spring*

**CH 101 Chemistry - A Molecular Science** (3 credit hours)
A fundamental study of molecular bonding, structure, and reactivity. Principles of atomic structure, ionic and covalent bonding, reaction energetics, intermolecular forces, precipitation reactions, acid/base reactions, oxidation/reduction processes, and introductions to organic and inorganic chemistry.

Prereq: One yr of high school chemistry and successful completion of the Chem Placement Exam or Chem Modules Exam, or completion of CH 111 w/ a grade of C- or better or a grade of S. Coreq: CH 102.
*GEP Natural Sciences*
*Typically offered in Fall, Spring, and Summer*

**CH 102 General Chemistry Laboratory** (1 credit hours)
Laboratory experience to accompany CH 101. Introduction to basic laboratory equipment and skills.

Corequisite: CH 101
*GEP Natural Sciences*
*Typically offered in Fall, Spring, and Summer*

**CH 103 General Chemistry I for Students in Chemical Sciences** (3 credit hours)
A study of the structure of atoms and the periodic trends of the elements, chemical bonding, the spatial and electronic structure of molecules, chemical reactions, quantification of materials and reactions, energy changes of reactions, and properties of gases. First half of a two semester sequence for students interested in a chemistry or closely related career. This course is open to 17CHEMBS, 17CHEMBA, 14EFY-14CHEI, 11BIOCHBS, 11LSFY-11BCHI, and 17MARSCBS-17MARSCCHM majors and to students with departmental approval. Students cannot receive credit for both CH 101 and CH 103.

Prerequisites: (Pass Chemistry Placement Exam, or Chemistry Placement Modules Exam, or CH 111 with a grade of C- or better) and eligibility for MA 107; Co-requisite: CH 104
*GEP Natural Sciences*
*Typically offered in Fall only*

**CH 104 General Chemistry Laboratory I for Students in Chemical Sciences** (1 credit hours)
Laboratory and computer-based experiments in chemical formulas, atomic structure, bonding, qualitative analysis, solutions, quantitative analysis of acids and bases, and calorimetry. First half of a two semester sequence for students interested in a chemistry or closely related career. This course is open to 17CHEMBS, 17CHEMBA, 14EFY-14CHEI, 11BIOCHBS, 11LSFY-11BCHI and 17MARSCBS-17MARSCCHM majors and to students with departmental approval. Students cannot receive credit for both CH 102 and CH 104.

Co-requisite: CH 103
*GEP Natural Sciences*
*Typically offered in Fall only*

**CH 111 Preparatory Chemistry** (3 credit hours)
Preparation for CH101. Review of main topics from high school emphasizing nomenclature, vocabulary, the periodic table and problem solving. Emphasis on mathematical skills, data handling, reaction types, stoichiometry and solutions. Credit for CH 111 is not allowed if a student has prior credit in CH 101. Credit for CH 111 does not count towards graduation for students in curricula that require CH 101.

*GEP Natural Sciences*
*Typically offered in Fall, Spring, and Summer*

**CH 201 Chemistry - A Quantitative Science** (3 credit hours)
Detailed quantitative aspects of solutions, solution stoichiometry, thermodynamics, chemical equilibrium, acid-base equilibria, solubility equilibria, electrochemistry, chemical kinetics, and nuclear chemistry.

Prerequisite: CH 101 with grade C- or better, CH 102, and eligibility for MA 121 or higher, Corequisite: CH 202
*GEP Natural Sciences*
*Typically offered in Fall, Spring, and Summer*

**CH 202 Quantitative Chemistry Laboratory** (1 credit hours)
Laboratory experience to complement CH 201. Experimental exploration of thermodynamic, kinetic, and electrochemical behavior.

Prerequisite: CH 101, CH 102, Corequisite: CH 201
*GEP Natural Sciences*
*Typically offered in Fall, Spring, and Summer*

**CH 203 General Chemistry II for Students in Chemical Sciences** (3 credit hours)
A study of intermolecular forces between molecules, and their affect on the properties of solids, liquids and gases, and on phase changes. The interplay of energetics and chemical kinetics on equilibria, including gas phase, acid-base, redox, and solubility equilibria. Second half of a two semester sequence for students interested in a chemistry or closely related career. This course is open to 17CHEMBS, 17CHEMBA, 14EFY-14CHEI, 11BIOCHBS, 11LSFY-11BCHI, and 17MARSCBS-17MARSCCHM majors and to students with departmental approval. Students cannot receive credit for both CH 201 and CH 203.

Prerequisites: (CH 101 with a minimum of 3 grade points or CH 103), and (CH 102 or CH 104), and eligibility for MA 131 or higher; Co-requisite: CH 204
*GEP Natural Sciences*
*Typically offered in Spring only*

**CH 204 General Chemistry Laboratory II for Students in Chemical Sciences** (1 credit hours)
Laboratory experiments in solid state materials, preparation and analysis of an organic compound, separations, gases, solutions, equilibrium, acids and bases, and kinetics. Second half of a two semester sequence for students interested in a chemistry or closely related career. This course is open to 17CHEMBS, 17CHEMBA, 14EFY-14CHEI, 11BIOCHBS, 11LSFY-11BCHI, and 17MARSCBS-17MARSCCHM majors and to students with departmental approval. Students cannot receive credit for both CH 202 and CH 204.

Prerequisite: CH 104 with a minimum of C-. Co-requisite: CH 203
*GEP Natural Sciences*
*Typically offered in Spring only*

**CH 220 Introductory Organic Chemistry** (3 credit hours)
A one-semester course in the fundamental principles of organic chemistry. Preparation, reactions, and physical properties of alkanes, cycloalkanes, alcohols, alkyl halides, aromatic compounds, aldehydes, ketones, organic acids, acid derivatives, and amines. Credit is not allowed for both CH 220 and CH 221.

Prerequisite: CH 101. Corequisite: CH 222.
*Typically offered in Fall, Spring, and Summer*

**CH 221 Organic Chemistry I** (3 credit hours)
First half of two-semester sequence in the fundamentals of modern organic chemistry. Structure and bonding, stereochemistry, reactivity and synthesis of carbon compounds. Detailed coverage of aliphatic hydrocarbons, alcohols, ethers, and alkyl halides. Introduction to spectral techniques of IR, UV-vis, and NMR. Students cannot receive credit for both CH 221 and CH 225.

Prerequisite: CH 101 with a grade of C- or better and CH 102; Corequisite: CH 222
*Typically offered in Fall, Spring, and Summer*

**CH 222 Organic Chemistry I Lab** (1 credit hours)
Laboratory experience to accompany CH 220 or CH 221. Introduction to basic organic laboratory equipment and techniques. Students cannot receive credit for both CH 222 and CH 226.

Prerequisite: CH 101 and CH 102; Corequisite: CH 220 or CH 221
*Typically offered in Fall, Spring, and Summer*

**CH 223 Organic Chemistry II** (3 credit hours)
Second half of two-semester sequence in the fundamentals of modern organic chemistry. Structure and bonding, stereochemistry, reactivity and synthesis of carbon compounds. Detailed coverage of aromatic hydrocarbons, condensation reagents, and selected biological chemistry topics such as carbohydrates, lipids, and amino acids. Students cannot receive credit for both CH 223 and CH 227.

Prerequisite: CH 221 with a grade of C- or better and CH222; Corequisite: CH 224
*Typically offered in Fall, Spring, and Summer*

**CH 224 Organic Chemistry II Lab** (1 credit hours)
Laboratory experience to accompany CH 223. Introduction to basic organic laboratory equipment and techniques. Students cannot receive credit for both CH 224 and CH 228.

Prerequisite: CH 221 and CH 222; Corequisite: CH 223
*Typically offered in Fall, Spring, and Summer*

**CH 225 Organic Chemistry I for Students in Chemical Sciences** (3 credit hours)
First half of a two semester sequence in organic chemistry for students interested in a chemistry or closely related career. Structure and bonding, stereochemistry, reactivity and synthesis of aliphatic hydrocarbons, alcohols, ethers and alkyl halides. Introduction to IR, NMR, and mass spectral techniques. This course is open to 17CHEMBS, 17CHEMBA, 14EFY-14CHEI, 14CHEBS, 11BIOCHBS, 11LSFY-11BCHI, and 17MARSCBS-17MARSCHM majors and to students with departmental approval. Students cannot receive credit for both CH 221 and CH 225.

Prerequisites: (CH 201 or CH 203) and (CH 202 or CH 204); Co-requisite: CH 226
*Typically offered in Fall only*

**CH 226 Organic Chemistry Laboratory I for Students in Chemical Sciences** (1 credit hours)
First half of a two semester laboratory sequence in organic chemistry for students interested in a chemistry or closely related career. Laboratory experiments in the determination of physical properties of organic compounds, separation of mixtures and purification of compounds, synthesis and spectroscopic characterization of organic compounds, and the execution of a multi-step synthesis. This course is open to 17CHEMBS, 17CHEMBA, 14EFY-14CHEI, 14CHEBS, 11BIOCHBS, 11LSFY-11BCHI and 17MARSCBS-17MARSCHM majors and to students with departmental approval. Students cannot receive credit for both CH 222 and CH 226.

Co-requisite: CH 225
*Typically offered in Fall only*

**CH 227 Organic Chemistry II for Students in Chemical Sciences** (3 credit hours)
Second half of a two semester sequence in organic chemistry for students interested in a chemistry or other closely related career. Structure and bonding, stereochemistry, reactivity and synthesis of aromatic compounds. Condensation reactions and organic compounds of biological interest. This course is open to 17CHEMBS, 17CHEMBA, 14EFY-14CHEI, 14CHEBS, 11BIOCHBS, 11LSFY-11BCHI and 17MARSCBS-17MARSCHM majors and to students with departmental approval. Students cannot receive credit for both CH 223 and CH 227.

Prerequisites: (CH 221 B or better or CH 225) & (CH 222 or CH 226); Corequisite: CH 228; Restricted to:17CHEMBS, 17CHEMBA, 14CHEI, 14CHEBS, 11BIOCHBS, or 17MARSCHM majors or dept approval. Students cannot receive credit for both CH 223 and CH 227.
*Typically offered in Spring only*

**CH 228 Organic Chemistry Laboratory II for Students in Chemical Sciences** (1 credit hours)
Second half of a two semester laboratory sequence in organic chemistry for students interested in a chemistry or closely related career. Laboratory experiments in multi-step organic synthesis, identification and characterization of compounds by spectroscopic methods. Searching the chemical literature. This course is open to 17CHEMBS, 17CHEMBA, 14EFY-14CHEI, 14CHEBS, 11BIOCHBS, 11LSFY-11BCHI and 17MARSCBS-17MARSCHM majors and to students with departmental approval. Students cannot receive credit for both CH 224 and CH 228.

Co-requisite: CH 227
*Typically offered in Spring only*

**CH 230 Computational Chemistry Lab I** (1 credit hours)
An introduction to computational methods in the chemical sciences. A quantitative introduction to inter- and intramolecular forces in gas and condensed phases. Potential energy surfaces of molecules and chemical reactions. First of a two-semester sequence.

Prerequisite: CH 221 or CH 225: Co-requisite: MA 241
*Typically offered in Fall only*

**CH 232 Computational Chemistry Lab II** (1 credit hours)
An introduction to computational methods in the chemical sciences. A computer-based introduction to quantum mechanics, including atomic and molecular orbitals and molecular orbital theory with applications to inorganic chemistry.

Prerequisite: CH 221 or CH 225, Corequisite: MA 241
*Typically offered in Spring only*

**CH 295 Special Topics in Chemistry** (1-3 credit hours)
Special topics in chemistry at the early undergraduate level. Trial offerings of new or experimental courses in chemistry. Enrollment requires permission of the department.

*Typically offered in Fall, Spring, and Summer*

**CH 315 Quantitative Analysis** (3 credit hours)
Introduce the fundamental principles and modern techniques of chemical analyses. This includes examination of electrolytic solutions, including acid-base, oxidation-reduction, and solubility equilibria, and introduction to spectrochemical, electrochemical, volumetric and chromatographic methods of analysis, modern chemical instrumentation, and interpretation of data.

Prerequisite: (CH 201 or CH 203) with a grade of C- or better, Co-requisite: CH 316
*Typically offered in Fall, Spring, and Summer*

**CH 316 Quantitative Analysis Laboratory** (1 credit hours)
Application of spectrochemical, electrochemical, volumetric, and chromatographic methods of analysis for the identification and quantification of components in a mixture.

Prerequisite: (CH 201 or CH 203) and (CH 202 or CH 204); Corequisite: CH 315
*Typically offered in Fall, Spring, and Summer*

**CH 331 Introductory Physical Chemistry** (4 credit hours)
Fundamental physiochemical principles including chemical thermodynamics, physical and chemical equilibrium, electrochemistry and reaction kinetics. For students requiring only a single semester of physical chemistry.

Prerequisite: (CH 201 or CH 203) and (CH 202 and 204) and (MA 231 or 241) and (PY 205 or PY 211)
*Typically offered in Fall, Spring, and Summer*

**CH 335/PSE 335 Principles of Green Chemistry** (4 credit hours)
Introduction to the topic of green chemistry as an emerging field; Identification of hazards and classes; overview of sources; alternative solvents and reagents; sustainability of chemical reactions; alternative chemical reactions and pathways; alternative feedstocks; enzymatic catalysis; ionic liquids; re-engineering of chemical processes; chemical synthesis.

Prerequisite: Grade of C or better in CH 101/102, CH 201/202 (or equivalent general chemistry series), and CH 221/22 (or equivalent)
*Typically offered in Fall only*

**CH 345 Chemistry and War** (3 credit hours)
This course will cover the influence of chemical discoveries on major military conflicts, from World War I to the present, as well as the effect that military conflicts during this time had on chemical discoveries. Topics will include but are not limited to: explosives, chemical weapons, nuclear weapons, military medicine, and chemical/biological weapons detection.

Prerequisites: CH 223 or CH 227
*GEP Interdisciplinary Perspectives*
*Typically offered in Spring only*

**CH 401 Systematic Inorganic Chemistry I** (3 credit hours)
Descriptive chemistry of the elements with particular attention to their reactions in aqueous solution. Emphasis on the chemistry of the main group elements and the periodicity of their chemical properties. Introduction to transition element and coordination chemistry. Major paper required.

Prerequisite: (CH 201 or CH 203) with grade of C- or better.
*Typically offered in Fall and Spring*

**CH 403 Systematic Inorganic Chemistry II** (3 credit hours)
Development and application of theoretical principles to the structure and energies of inorganic substances. Particular attention to the chemistry of coordination compounds of the transition elements. Special applications to bioinorganic chemistry,organometallic chemistry, and inorganic solid state chemistry.

Prerequisite: CH 401, CH 431
*Typically offered in Fall and Spring*

**CH 415 Analytical Chemistry II** (3 credit hours)
Methods of quantitative analysis based on electronic instrumentation. Signal processing and electronics, spectroscopy (atomic, x-ray fluorescence, infrared/Raman, surface), voltammetry, chromatography (gas, liquid), mass spectrometry as well as chemical transducers and statistical methods of data handling.

Prerequisite: CH 315 or PCC 412
*Typically offered in Fall only*

**CH 431 Physical Chemistry I** (3 credit hours)
Development of the basic concepts of quantum mechanics and wavefunctions as applied to atomic structure, to the translational, rotational and vibrational motion in molecules, and to molecular spectroscopy. Development of partition functions as applied to thermodynamic properties of materials. Cannot get credit for both CH 431 and CH 437.

Prerequisite: (CH 201 or CH 203) and MA 242 and (PY 203 or 208); Corequisite: MA 341
*Typically offered in Fall and Spring*

**CH 433 Physical Chemistry II** (3 credit hours)
A classical thermodynamic treatment of states of matter, activities and chemical potentials, energy changes, equilibria, and electrochemical processes. The kinetics of multi-step, catalytic and enzyme reactions.

Prerequisite: MA 341
*Typically offered in Fall and Spring*

**CH 435 Introduction to Quantum Chemistry** (3 credit hours)
An introduction to the basic principles of quantum theory and its application to atomic and molecular structure and spectroscopy.

Prerequisite: CH 431
*Typically offered in Spring only*

**CH 437 Physical Chemistry for Engineers** (4 credit hours)
Selected physiochemical principles including quantum theory, spectroscopy, statistical thermodynamics, and rates of chemical reactions. Credit may not be claimed for both CH 431 and CH 437.

Prerequisite: PY 208 and CHE 315 and MA 341
*Typically offered in Spring only*

**CH 441 Forensic Chemistry** (3 credit hours)
Chemical identification (recognition), and chemical separation techniques (identification) used to demarcate class and individual characteristics relevant in legal claims.

Prerequisite: (CH 201 or CH 203) and (CH 223 or CH 227)
*Typically offered in Spring only*

**CH 442 Advanced Synthetic Techniques** (4 credit hours)
An advanced laboratory class in the synthesis, separation and characterization of organic, inorganic, and polymeric materials. Techniques include reactions under inert atmosphere, column chromatography, fractional distillations, NMR spectroscopy, and other advanced procedures. Scientific writing is emphasized.

Prerequisite: CH 223 or CH 227, Corequisite: CH 401
*Typically offered in Fall and Spring*

**CH 444 Advanced Synthetic Techniques II** (4 credit hours)
An advanced laboratory class in the synthesis, separation and characterization of organic, inorganic, polymer and materials compounds. Techniques include literature searches, reactions, under inert atmosphere, column chromatography, fractional distillations, NMR spectroscopy, and other advanced procedures. This course builds upon the skills acquired in CH 442 and has significant independent work.

Prerequisite: CH 442
*Typically offered in Spring only*

**CH 452 Advanced Measurement Techniques I** (4 credit hours)
Modern analytical and physical chemistry laboratory techniques. Emphasis on statistical methods, chemical thermodynamics, chromatography, atomic and molecular spectroscopy, report writing, scientific methodology, and laboratory safety.

Prerequisites: CH 315 and CH 316 and 431, all with grade of C- or better.
Corequisites: CH 415 and CH 433
*Typically offered in Fall and Spring*

**CH 454 Advanced Measurement Techniques II** (4 credit hours)
Advanced analytical techniques including Liquid Chromatography (HPLC), Gas Chromatography (GC), Atomic Absorption Spectroscopy (AAS), Spectrophotometry, Molecular Fluorescence, and Mass Spectrometry (MS). Physical aspects including time resolved spectrophotometric measurement of kinetics, dynamic fluorescence quenching and resonance Raman spectroscopy. Students will also participate in carrying out a project through consultation with the instructor and search of the literature.

Prerequisite: CH 452 with a grade of C- or better
*Typically offered in Fall only*

**CH 463/CH 563 Molecular Origins of Life** (3 credit hours)
Survey of the present state of understanding of the molecular mechanisms leading to the emergence of sustainable self-replicating systems in the prebiotic era on the early Earth, including historical context, experimental studies, and theoretical foundation. The course will include a focus on the fundamental chemistry of and mechanisms for the plausible prebiotic formation of diverse biomolecules (including amino acids, sugars, nucleotides, lipids, tetrapyrroles) and self-organizing chemistry leading to protocells, the proposed early progenitors of living cells. Credit will not be given for both CH 463 and CH 563.

Prerequisite: BCH 351 or BCH 451 or Permission of Instructor
*Typically offered in Spring only*

**CH 495 Special Topics in Chemistry** (1-4 credit hours)
Special topics in chemistry at the advanced undergraduate level. Trial offerings of new or experimental courses in chemistry. Enrollment requires permission of the department.

*Typically offered in Fall, Spring, and Summer*

**CH 499 Undergraduate Research in Chemistry** (1-3 credit hours)
Independent investigation of a research problem under the supervision of a chemistry faculty member. Individualized/Independent Study and Research courses require a Course Agreement for Students Enrolled in Non-Standard Courses be completed by the student and faculty member prior to registration by the department.

Prerequisite: Two years of chemistry
*Typically offered in Fall, Spring, and Summer*

**CH 563/CH 463 Molecular Origins of Life** (3 credit hours)
Survey of the present state of understanding of the molecular mechanisms leading to the emergence of sustainable self-replicating systems in the prebiotic era on the early Earth, including historical context, experimental studies, and theoretical foundation. The course will include a focus on the fundamental chemistry of and mechanisms for the plausible prebiotic formation of diverse biomolecules (including amino acids, sugars, nucleotides, lipids, tetrapyrroles) and self-organizing chemistry leading to protocells, the proposed early progenitors of living cells. Credit will not be given for both CH 463 and CH 563.

Prerequisite: BCH 351 or BCH 451 or Permission of Instructor
*Typically offered in Spring only*

**CH 572/BIT 572/BIO 572 Proteomics** (3 credit hours)
Introduction and history of the field of proteomics followed by the principles and applications of proteomics technology to understand protein expression and protein post-transitional modifications. Laboratory sessions include growing yeast with stable-isotope labeled amino acids, protein purification, Western blots, protein identification and quantification, and protein bioinformatic analysis. This is a half-semester course.

Prerequisite: BIT 410 or BIT 510 or BCH 454 (or approval from the instructor)
*Typically offered in Spring only*

**CH 601 Seminar** (1 credit hours)
Review and discussion of scientific articles, progress reports on research and special problems of interest to chemists.

Prerequisite: Graduate standing in CH
*Typically offered in Fall and Spring*

**CH 610 Special Topics In Chemistry** (1-6 credit hours)
Detailed study of a particular problem or technique pertaining to chemistry.

*Typically offered in Fall and Spring*

**CH 690 Master's Examination** (1-9 credit hours)
For students in non-thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

Prerequisite: Master's student
*Typically offered in Fall only*

**CH 693 Master's Supervised Research** (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Prerequisite: Master's student
*Typically offered in Summer only*

**CH 695 Master's Thesis Research** (1-9 credit hours)
Thesis research.

Prerequisite: Master's student
*Typically offered in Fall, Spring, and Summer*

**CH 696 Summer Thesis Research** (1 credit hours)
For graduate students whose programs of work specify no formal course work during a summer session and who will be devoting full time to thesis research.

Prerequisite: Master's student
*Typically offered in Summer only*

**CH 699 Master's Thesis Preparation** (1-9 credit hours)
For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

Prerequisite: Master's student
*Typically offered in Fall, Spring, and Summer*

**CH 701 Advanced Inorganic Chemistry I: Structure and Bonding** (3 credit hours)
Study of periodic table/trends, symmetry and molecular orbital theory of small molecules and extended structures, transition-metal coordination complexes, acid/base and redox reactivity of polyatomic ions, solid-state structures, and selected special topics.

*Typically offered in Fall only*

**CH 703 Advanced Inorganic Chemistry II: Applications of Group Theory to Bonding and Spectroscopy** (3 credit hours)
This course uses group theory as the basis for developing molecular orbital theory, vibrational spectroscopy, and electronic spectroscopy. Together, these methods are used to discuss topics of current research interest in inorganic chemistry.

Prerequisite: CH 701 or equivalent
*Typically offered in Spring only*

**CH 705 Organometallic and Inorganic Reaction Mechanism** (3 credit hours)
Coverage of concepts of bonding and structure of transition metal complexes with emphasis on the interaction of transition metal fragements with organic ligands; study of experimental methods of mechanistic study; treatment of inorganic and organometallic reactions including metal-mediated organic synthesis, metal-catalyzed polymer synthesis, and models of bioinorganic systems.

Prerequisite: Graduate standing
*Typically offered in Spring only*

**CH 711 Advanced Analytical Chemistry I** (3 credit hours)
First semester of two-semester integrated sequence covering advanced methods for extraction and interpretation of chemical information from electronic/optical signals in chemical analysis. Digital and analog electronics, signal acquisition and processing, chemometrics, and instrumentation.

Prerequisite: CH 433; CH 415
*Typically offered in Fall only*

**CH 721 Advanced Organic Chemistry I** (3 credit hours)
Introduction to physical organic chemistry. Topics include: bonding/ introductory molecular orbital theory, reactive intermediates, aromaticity, pericyclic reactions, thermochemistry, linear free-energy relationships, kinetics, and transition-state theory. Topics and concepts are related to molecular reactivity and reaction mechanisms.

Prerequisite: CH 223 or CH 227 or CH 433 or CH 435
*Typically offered in Fall only*

**CH 723 Advanced Organic Chemistry II** (3 credit hours)
Introduction to acid-base theory and mechanistic organic chemistry as applied to synthetically useful organic reactions.

Prerequisite: CH 721
*Typically offered in Spring only*

**CH 725 Physical Methods in Organic Chemistry** (3 credit hours)
Application of physical methods to the solution of structural problems in organic chemistry. Methods discussed include electronic absorption spectroscopy, vibrational spectroscopy, nuclear magnetic resonance, and mass spectrometry.

Prerequisite: (CH 223 or CH 227) and CH 433 or CH 435
*Typically offered in Fall only*

**CH 727/BIO 727 Biological Mass Spectrometry** (3 credit hours)
Fundamentals of mass spectrometry including topics such as: mass, isotopic distributions, resolving power, mass accuracy. Ionization source topics: electron impact, chemical ionization, matrix-assisted laser desorption ionization, electrospray ionization and contemporary methods. Instrumentation and mass analyzers: quadrupole, time-of-flight, Fourier transform based mass analyzers; hybrid instruments such as a quadrupole orbitrap. Tandem mass spectrometry and dissociation. Applications: quantitation, small molecule analysis, and peptide sequencing.

Prerequisite: CH 223 or CH 227
*Typically offered in Fall only*

**CH 730 Advanced Physical Chemistry** (3 credit hours)
Survey of chemical thermodynamics and kinetics, with emphasis on reactions in liquid phase. Problem solving an important part of course. Designed for review and expansion on materials usually covered in a one-year undergraduate physical chemistry course.

Prerequisite: Graduate standing
*Typically offered in Fall only*

**CH 732 Advanced Physical Chemistry in Biological Applications** (3 credit hours)
Modern views on structure, function, and thermodynamic stability of biological macromolecules including proteins, nucleic acids, and biological membranes; theories and models of protein folding, high resolution experimental methods for structure determination of soluble and membrane proteins including solution and solid-state NMR spectroscopy.

Prerequisite: CH 431 or CH 433 or BCH 453 or equivalent

**CH 734 Spectroscopic Methods in Chemical Biology** (3 credit hours)
Physical principles underlying the experimental spectroscopic methods used to study structure and dynamics of biological macromolecules. Detailed discussion of experimental techniques include high-resolution solution Nuclear Magnetic Resonance, Electron Paramagnetic Resonance in combination with spin labeling and spin trapping methods, and fluorescence spectroscopy, including single molecule methods and fluorescence microscopy. This course is offered every third semester from Spring 2010.

Prerequisite: CH 331 or CH 431, CH 433 or equivalent

**CH 735 Magnetic Resonance in Chemistry** (3 credit hours)
This course is focused on physical and quantum mechanical principles that make magnetic resonance the most important spectroscopic technique in chemistry. Detailed discussion of description of magnetic resonance phenomena and NMR and EPR experimental techniques covers both classical and quantum mechanical treatments. Students of diverse backgrounds will gain in-depth knowledge of modern magnetic resonance as applied to problems in chemistry, materials, and nano-science, and biophysics.

Prerequisite: CH 331 or CH 431, CH 433 or equivalent

**CH 736 Chemical Spectroscopy** (3 credit hours)
Introduction to rotational, vibrational and electronic molecular spectroscopy from a quantum mechanical viewpoint. Emphasis on the elucidation of structure, bonding and excited state properties of organic and inorganic molecules.

Prerequisite: CH 435
*Typically offered in Spring only*

**CH 737 Quantum Chemistry** (3 credit hours)
Elements of wave mechanics applied to stationary energy states and time-dependent phenomena. Applications of quantum theory to chemistry, particularly chemical bonds.

Prerequisite: MA 301, CH 435 or PY 407
*Typically offered in Fall only*

**CH 743 Electrochemistry** (3 credit hours)
Thermodynamics and kinetics of electrode reactions presented as well as experimental methods for studying them. Particular emphasis on measurement of standard potential and establishing number of electrons transferred. Applications of electrochemistry in production/storage of energy and in chemical analysis.

Prerequisite: CH 431 or CH 433
*Typically offered in Spring only*

**CH 745 Chemical Separation** (3 credit hours)
Basic principles of methods in chemical separation including gas chromatography, liquid chromatography, etc. Theory, instrumentation and applications of various chromatographic and electrophoretic techniques.

Prerequisite: CH 415, CH 416, Corequisite: CH 610 or 810
*Typically offered in Fall only*

**CH 755 Organic Reaction Mechanisms** (3 credit hours)
Effects of structure and substituents on direction and rates of organic reactions.

Prerequisite: CH 723, CH 433
*Typically offered in Fall only*

**CH 765 Chemistry of Materials** (3 credit hours)
Detailed examination of the relationship between chemical structure and physical properties of materials with potential use in applications. Different classes of molecules and materials requirements for several applications will be emphasized.

Prerequisite: CH 201 or equivalent
*Typically offered in Spring only*

**CH 770 Bioinorganic Chemistry** (3 credit hours)
The interface between inorganic and biological chemistry will be explored, focusing on the catalytic processes in metalloenzymes, and with an emphasis on the diverse roles of transition metals in biology. The physical methods required for the study of bioinorganic systems will be introduced, with application toward determining enzymatic mechanisms. Selected topics will include heme chemistry, nitrogen fixation, C-H bond activation, electron transfer, oxygen transport, metal ion uptake and toxicity, drug activation and/or metabolism by metalloenzymes, and metallodrugs.

Prerequisite: CH 401
*Typically offered in Spring only*

**CH 772 Solid State Chemistry** (3 credit hours)
Selected topics in solid-state chemistry including: extended symmetry, structure, bonding, characterizations, and special topics. Graduate standing in Chemistry required.

Prerequisite: CH 701 or equivalent
*Typically offered in Spring only*

**CH 795 Special Topics in Chemistry** (1-6 credit hours)
*Typically offered in Fall and Spring*

**CH 801 Seminar** (1 credit hours)
Review and discussion of scientific articles, progress reports on research and special problems of interest to chemists.

Prerequisite: Graduate standing in CH
*Typically offered in Fall and Spring*

**CH 810 Special Topics In Chemistry** (1-6 credit hours)
Detailed study of a particular problem or technique pertaining to chemistry.

*Typically offered in Fall only*

**CH 890 Doctoral Preliminary Examination** (1-9 credit hours)
For students who are preparing for and taking written and/or oral preliminary exams.

Prerequisite: Doctoral student
*Typically offered in Fall only*

**CH 893 Doctoral Supervised Research** (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Prerequisite: Doctoral student
*Typically offered in Fall only*

**CH 895 Doctoral Dissertation Research** (1-9 credit hours)
Dissertation research.

Prerequisite: Doctoral student
*Typically offered in Fall, Spring, and Summer*

**CH 896 Summer Dissertation Research** (1 credit hours)
For graduate students whose programs of work specify no formal course work during a summer session and who will be devoting full time to thesis research.

Prerequisite: Doctoral student
*Typically offered in Summer only*

**CH 899 Doctoral Dissertation Preparation** (1-9 credit hours)
For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

Prerequisite: Doctoral student
*Typically offered in Fall, Spring, and Summer*