

# Chemistry (CHM)

## Courses

### CHM 007 Preparation for General Chemistry 2 Credits

Intensive review of fundamental concepts in chemistry, including chemical equations, stoichiometry, dimensional analysis, and significant figures, with an emphasis on developing problem solving skills. This course is for students who need to take CHM 30 or 40, but who require additional preparation in chemistry.

### CHM 030 Introduction to Chemical Principles 0,4 Credits

An introduction to important topics in chemistry: atomic structure, properties of matter, chemical reactions, energy, structure and bonding in organic and inorganic compounds. The course features a lecture tightly linked to a three-hour studio experience that combines laboratory work and recitation.

**Attribute/Distribution:** LS, NS, NW, Q

### CHM 031 Chemical Equilibria in Aqueous Systems 0,4 Credits

An introduction to: intermolecular forces and their influence on physical properties and phase behavior; chemical kinetics; thermodynamics in chemical systems; and electrochemistry. The course includes a detailed treatment of equilibria in aqueous solutions, including acid-base, precipitation-solubility, metal-ligand, oxidation-reduction and distribution equilibria. The laboratory work emphasizes the qualitative and quantitative analysis of equilibria in aqueous media. Three lectures and one three-hour laboratory period.

**Prerequisites:** (CHM 030 or CHM 040) and (MATH 021 or MATH 031 or MATH 051 or MATH 075)

**Can be taken Concurrently:** MATH 021, MATH 031, MATH 051, MATH 075

**Attribute/Distribution:** NS, NW, Q

### CHM 040 Honors General Chemistry I 0,4 Credits

A first-semester course in chemistry for students planning to major in chemistry, biochemistry, chemical engineering, materials science, or other chemistry-related fields. Chemical and physical properties, structures, bonding concepts, and quantitative analysis. Laboratory includes synthesis, separation and analysis procedures; computer applications to chemistry. Three lectures and one three-hour laboratory period.

**Attribute/Distribution:** LS, NS, NW, Q

### CHM 041 Honors General Chemistry II 0,4 Credits

Continuation of Chemistry 40. Three lectures and one three-hour laboratory period.

**Prerequisites:** (CHM 040 or CHM 030) and (MATH 021 or MATH 031 or MATH 051 or MATH 075)

**Can be taken Concurrently:** MATH 021, MATH 031, MATH 051, MATH 075

**Attribute/Distribution:** NS, NW, Q

### CHM 091 Special Topics 1-4 Credits

Intensive study of a topic of special interest not covered in other courses.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS, NW

### CHM 110 Organic Chemistry I 0,3 Credits

Systematic survey of the typical compounds of carbon, their classification, and general relations; study of synthetic reactions.

**Prerequisites:** CHM 031 or CHM 041

**Attribute/Distribution:** NS

### CHM 111 Organic Chemistry Laboratory I 1 Credit

Preparation of pure organic compounds. Modern techniques of characterization.

**Prerequisites:** CHM 031 or CHM 041 or CHM 110

**Can be taken Concurrently:** CHM 110

**Attribute/Distribution:** NS, Q

### CHM 112 Organic Chemistry II 0,3 Credits

Continuation of CHM 110.

**Prerequisites:** (CHM 031 or CHM 041) and CHM 110

**Attribute/Distribution:** NS

### CHM 113 Organic Chemistry Laboratory II 1 Credit

Continuation of Organic Chemistry Laboratory I.

**Prerequisites:** (CHM 030 or CHM 040) and (CHM 031 or CHM 041) and CHM 110 and CHM 111 and CHM 112

**Can be taken Concurrently:** CHM 112

**Attribute/Distribution:** NS, Q

### CHM 177 Introduction to Research 1-2 Credits

For advanced freshmen and sophomore chemistry majors. Consent of department chair required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS, NW, Q

### CHM 191 Special Topics 1-4 Credits

Intensive study of a topic of special interest not covered in other courses.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS, NW

### CHM 194 Physical Chemistry for Biological Sciences 3 Credits

The principles and applications of physical chemical concepts to systems of biological interest, including the gas laws, thermodynamics of metabolic reactions, colligative properties, electrochemical equilibria, reaction kinetics and enzyme catalysis, and transport of macromolecules and viruses.

**Prerequisites:** (CHM 030 or CHM 040) and (CHM 031 or CHM 041)

**Attribute/Distribution:** NS, Q

### CHM 291 Special Topics 1-4 Credits

Intensive study of a topic of special interest not covered in other courses.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS, NW

### CHM 300 Apprentice Teaching 1-4 Credits

Supervised participation in various aspects of the teaching of a course. Consent of instructor, department chairperson, and permission of the Dean required.

**Repeat Status:** Course may be repeated.

### CHM 305 Organometallic Chemistry 3 Credits

The chemistry of compounds containing bonds between carbon and the transition metals. Topics include the synthesis, characterization, and electronic structure of organometallic compounds, and mechanistic studies of their reactions. A description of common ligands and their bonding is covered, as well as applications of organometallic chemistry in organic synthesis and catalysis.

**Prerequisites:** CHM 112

**Attribute/Distribution:** NS

### CHM 307 Advanced Inorganic Chemistry 3 Credits

Introduction to transition metal complexes; theories of bonding; kinetics and mechanisms of transition metal complex reactions; and selected aspects of organometallic chemistry.

**Prerequisites:** CHM 031 or CHM 041

**Attribute/Distribution:** NS, NW, Q

### CHM 323 Chemical Biology 3 Credits

Chemical biology is a discipline at the interface of organic and biological chemistry. It entails the design, synthesis, and evaluation of probes, substrates, and materials for the study of biological systems using chemical principles. Chemical biology can also take inspiration from biological systems for the design and synthesis of novel molecules and materials for non-biological applications. The class is designed to be an introduction to chemical biology for upper-level undergraduates and graduate students.

**Prerequisites:** CHM 112 and (BIOS 371 or CHM 371)

### CHM 332 Analytical Chemistry 3 Credits

Theory and practice of chemical analysis. Principles of quantitative separations and determinations; theory and application of selected optical and electrical instruments in analytical chemistry; interpretation of numerical data, design of experiments, solute distribution in separation methods.

**Prerequisites:** (CHM 031 or CHM 041) and CHM 110

**Attribute/Distribution:** NS, Q

**CHM 334 Advanced Chemistry Laboratory I 0,3 Credits**

Exploration of synthetic methods and analysis techniques for inorganic and organic compounds. Determination of product structures and quantitative analysis using modern chemical analysis techniques, including NMR, GC-MS, GC, HPLC, FT-IR, and Electrochemistry.

**Prerequisites:** (CHM 110 and CHM 111 and CHM 112 and CHM 113 and CHM 332)

**Can be taken Concurrently:** CHM 332

**Attribute/Distribution:** Q, W

**CHM 335 Advanced Chemistry Laboratory II 0,3 Credits**

Continuation of CHM 334.

**Prerequisites:** (CHM 334)

**Attribute/Distribution:** Q, W

**CHM 336 Clinical Chemistry 3 Credits**

Applications of analytical chemistry to clinical problems. Discussion of methods in common use and the biochemical/medical significance of the results.

**Prerequisites:** CHM 031 or CHM 041 or CHM 332 or CHM 112

**Attribute/Distribution:** NS, Q

**CHM 337 Crystallography and Diffraction 3 Credits**

Introduction to crystal symmetry, point groups, and space groups. Emphasis on materials characterization by X-ray diffraction and electron diffraction. Specific topics include crystallographic notation, stereographic projections, orientation of single crystals, textures, phase identification, quantitative analysis, stress measurement, electron diffraction, ring and spot patterns, convergent beam electron diffraction (CBED), and space group determination. Applications in mineralogy, metallurgy, ceramics, microelectronics, polymers, and catalysts. Lectures and laboratory work. Prerequisites may be waived if student has senior standing in chemistry.

**Prerequisites:** CHM 031 or CHM 041 or MAT 203 or EES 131

**Attribute/Distribution:** NS

**CHM 340 Solid-State Chemistry 3 Credits**

This solid state chemistry course will introduce students into symmetry of extended solids, X-ray crystallography of solids, crystal structures, band theory, electronic and ionic conductivity in solids, defects in solids, silicate chemistry and nanoporous solids.

**Prerequisites:** CHM 031 or CHM 041

**Attribute/Distribution:** NS, NW, Q

**CHM 341 Molecular Structure, Bonding and Dynamics 3 Credits**

Nature of chemical bonding as related to structure and properties of molecules and extended systems. Quantum chemistry of atoms and molecules applied to chemical transformations and spectroscopic transitions. Symmetry analysis and selection rules. Interpretation of electronic, vibrational and rotational spectra.

**Prerequisites:** (MATH 023 or MATH 033) and (PHY 021 or PHY 013) and (CHM 031 or CHM 041)

**Attribute/Distribution:** NS, Q

**CHM 342 Thermodynamics & Kinetics 3 Credits**

Development of the principles of classical and statistical thermodynamics and their application to chemical systems. In classical thermodynamics emphasis will be on systems in which composition is of major concern: solutions, chemical and phase equilibria. Kinetic theory of gases; chemical reaction kinetics; chemical reaction dynamics.

**Prerequisites:** (CHM 031 or CHM 041) and (PHY 013 or PHY 021) and (MATH 022 or MATH 032 or MATH 052)

**Attribute/Distribution:** Q

**CHM 343 Physical Chemistry Laboratory 2 Credits**

Laboratory studies that illustrate and extend the various fields of study in experimental physical chemistry as discussed in CHM 341 and CHM 342.

**Prerequisites:** CHM 031 or CHM 041 or CHM 194 or CHE 210 or CHM 342

**Attribute/Distribution:** NS, W, WRIT

**CHM 346 Photochemistry of Consequence 3 Credits**

Photochemistry involves using photons (light from the sun) to drive critical chemical reactions and is attractive because of its application to solar energy. Fundamental processes in photochemistry will be covered. Topics will include: energy transfer, electron transfer, proton-coupled electron transfer processes and their applications to biological systems.

**Prerequisites:** CHM 031 or CHM 041

**Attribute/Distribution:** NS

**CHM 350 Special Topics 1-3 Credits**

Selected advanced topics in chemistry.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS

**CHM 351 Professional Development Seminar 2 Credits**

Topics for the developing professional chemist include lab safety, using a laboratory notebook, searching the scientific literature, reading and writing scientific papers, ethics, and developing both a poster and an oral presentation. Students will present their own poster and a short talk on the same subject. Each student will write his/her own resume and participate in a mock interview session.

**Attribute/Distribution:** NS

**CHM 356 Spectral Analysis 3 Credits**

Use of data from nuclear magnetic resonance, infrared, ultraviolet, and mass spectrometric techniques for the determination of structure of organic compounds. Emphasis on information from one- and two-dimensional proton and carbon NMR, and a mechanistic interpretation of data from mass spectrometry.

**Prerequisites:** CHM 112

**CHM 357 Organic Reaction Mechanisms 3 Credits**

Intensive in class problem solving that involves the formulation of reasonable reaction mechanisms for complex multistep pathways, i.e. organic transformations that proceed via highly energetic intermediates such as carbocations, carbanions, free radicals, carbenes, and nitrenes.

**Prerequisites:** CHM 112

**CHM 358 Advanced Organic Chemistry 3 Credits**

Reaction mechanism types and supporting physical-chemical data. Classes of mechanisms include elimination, substitution, rearrangement, oxidation-reduction, enolate alkylations, and others. Must have completed one year of organic chemistry.

**Prerequisites:** CHM 112

**Attribute/Distribution:** NS

**CHM 362 Molecular Biophysics 3 Credits**

This course focuses on the physical tools that exist to obtain information about biological macromolecules, with an emphasis on spectroscopic and imaging techniques (e.g., circular dichroism, fluorescence spectroscopy, FRET, BRET, calorimetry, analytical ultracentrifugation, X-ray crystallography, electron microscopy, dynamic light scattering, surface plasmon resonance). Lectures and discussion of research articles are used to illustrate the use of the different tools and methods.

**Prerequisites:** BIOS 371 or CHM 371

**Attribute/Distribution:** NS

**CHM 364 Bioinorganic Chemistry 3 Credits**

This course will cover inorganic chemistry as it relates to biology, with emphasis on how metal ions and cofactors are employed by biological systems. Topics will include metalloproteins, metal cofactors, and metals in medicine. Experimental methods used to study bioinorganic chemistry will also be discussed.

**Prerequisites:** CHM 371 or BIOS 371

**Attribute/Distribution:** NS

**CHM 365 Protein Separation & Biophysical Analysis 3 Credits**

Laboratory studies of techniques and principles used for the isolation, characterization, and biophysical analysis of proteins.

**Prerequisites:** BIOS 371 or CHM 371

**Attribute/Distribution:** NS

**CHM 371 (BIOS 371) Elements of Biochemistry I 0,3 Credits**

A general study of carbohydrates, proteins, lipids, nucleic acids and other biological substances and their importance in life processes. Protein and enzyme chemistry are emphasized. Must have completed one year of organic chemistry.

**Prerequisites:** CHM 112

**Attribute/Distribution:** NS

**CHM 372 (BIOS 372) Elements of Biochemistry II 3 Credits**

Dynamic aspects of biochemistry: enzyme reactions including energetics, kinetics and mechanisms, metabolism of carbohydrates, lipids, proteins and nucleic acids, photosynthesis, electron transport mechanisms, coupled reactions, phosphorylations, and the synthesis of biological macromolecules.

**Prerequisites:** BIOS 473 or ((BIOS 371 or CHM 371) and BIOS 041)

**Attribute/Distribution:** NS

**CHM 373 Lipids and Membranes 3 Credits**

The study of lipids and lipid membranes similar to those found in mammalian cells including methods of synthesis, surface activity, bilayer and micellar structures, lipid mixing, fluidity, permeability and membrane stability. Special emphasis will be given to the current evidence for and against the lipid raft hypothesis.

**Prerequisites:** BIOS 372 or CHM 372

**Attribute/Distribution:** NS

**CHM 375 Research Chemistry Laboratory 1-3 Credits**

An introduction to independent study or laboratory investigation under faculty guidance. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS, Q

**CHM 376 Advanced Research Chemistry Laboratory 1-6 Credits**

Advanced independent study or laboratory investigation under faculty guidance. Consent of faculty research supervisor.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** NS, Q

**CHM 377 (BIOS 377) Biochemistry Laboratory 0,3 Credits**

Laboratory studies of the properties of chemicals of biological origin and the influence of chemical and physical factors on these properties. Laboratory techniques used for the isolation and identification of biochemicals.

**Prerequisites:** (BIOS 371 or CHM 371) and (BIOS 031 or BIOS 041)

**Can be taken Concurrently:** BIOS 371, CHM 371

**Attribute/Distribution:** NS

**CHM 388 (CHE 388, MAT 388) Polymer Characterization 3 Credits**

Description of molecular weight measurements using dilute solutions (solution viscosity, size exclusion chromatography, osmotic pressure, and light scattering). Introduction to polymer thermal analysis techniques such as differential scanning calorimetry (DSC), dynamic mechanical analysis (DMA), and thermomechanical analyzer (TMA). Discussion of structure and morphology of polymers and polymer blends using nuclear magnetic resonance (NMR), infrared spectroscopy (IR), Raman spectroscopy, UV analysis, transmission electron microscopy (TEM), scanning electron microscopy (SEM), atomic force microscopy (AFM). Crystallinity measurements using SANS, SAXS, and WAXS.

**Prerequisites:** MAT 033 or MAT 204 or MAT 392 or MAT 393

**CHM 389 Honors Project 1-6 Credits**

Opportunity for Chemistry majors to pursue an Honors Project. Consent of instructor required.

**Repeat Status:** Course may be repeated.

**Attribute/Distribution:** Q, W

**CHM 391 (CHE 391) Colloid and Surface Chemistry 3 Credits**

Physical chemistry of everyday phenomena. Intermolecular forces and electrostatic phenomena at interfaces, boundary tensions and films at interfaces, mass and charge transport in colloidal suspensions, electrostatic and London forces in disperse systems, gas adsorption and heterogeneous catalysis.

**Prerequisites:** CHM 342

**Attribute/Distribution:** NS

**CHM 393 (CHE 393, MAT 393) Physical Polymer Science 3 Credits**

Structural and physical aspects of polymers (organic, inorganic, natural). Molecular and atomic basis for polymer properties and behavior. Characteristics of glassy, crystalline, and paracrystal-line states (including viscoelastic and relaxation behavior) for single- and multi-component systems. Thermodynamics and kinetics of transition phenomena. Structure, morphology, and behavior. Available to graduate and undergraduate students (with senior level standing) in CHE, CHEM or MAT.

**CHM 394 (CHE 394) Organic Polymer Science I 3 Credits**

Organic chemistry of synthetic high polymers. Polymer nomenclature, properties, and applications. Functionality and reactivity of monomers and polymers. Mechanism and kinetics of step-growth and chain-growth polymerization in homogenous and heterogenous media. Brief description of emulsion polymerization, ionic polymerization, and copolymerization. Must have completed one year of physical chemistry and one year of organic chemistry.

**Prerequisites:** CHM 031 or CHM 041 or CHM 110 or CHM 112 or CHM 342 or CHE 210

**Attribute/Distribution:** NS, Q

**CHM 400 First Year Graduate Student Seminar 0 Credits**

First year graduate student seminar course and introduction to research. Topics include: research opportunities in the department, introduction to instrumentation facilities, ethics in science, use of library facilities, effective teaching methods. Course may be repeated.

**Repeat Status:** Course may be repeated.

**CHM 405 Organometallic Chemistry 3 Credits**

The chemistry of compounds containing bonds between carbon and the transition metals. Topics include the synthesis, characterization, and electronic structure of organometallic compounds, and mechanistic studies of their reactions. A description of common ligands and their bonding is covered, as well as applications of organometallic chemistry in organic synthesis and catalysis.

**CHM 407 Advanced Inorganic Chemistry 3 Credits**

Introduction to transition metal complexes; theories of bonding; kinetics and mechanisms of transition metal complex reactions; and selected aspects of organometallic chemistry. Must have completed one semester of physical chemistry and have CAS graduate student status.

**CHM 421 Chemistry Research 1-6 Credits**

Research in one of the following fields of chemistry: analytical, inorganic, organic, physical, polymer, biochemistry. A maximum of 6 credits total may be earned. Consent of the instructor is required.

**Repeat Status:** Course may be repeated.

**CHM 423 Chemical Biology 3 Credits**

Chemical biology is a discipline at the interface of organic and biological chemistry. It entails the design, synthesis, and evaluation of probes, substrates, and materials for the study of biological systems using chemical principles. Chemical biology can also take inspiration from biological systems for the design and synthesis of novel molecules and materials for non-biological applications. The class is designed to be an introduction to chemical biology for upper-level undergraduates and graduate students.

**CHM 426 Statistical Thermodynamics 3 Credits**

Principles and applications of statistical mechanics to chemical problems. A study of the techniques for evaluating the properties of matter in bulk from the properties of molecules and their interactions.

**CHM 427 Thermodynamics & Kinetics 3 Credits**

Development of the principles of classical and statistical thermodynamics and their applications to chemical systems. In classical thermodynamics, emphasis will be on systems in which composition is of major concern: solutions, chemical and phase equilibria. Kinetic theory of gases; chemical reaction kinetics. Must have CAS graduate student status. This course cannot be taken by students who have already taken CHM 342.



**CHM 434 Advanced Topics in Spectroscopy 3 Credits**

Fundamentals of interactions of electromagnetic radiation with matter: electronic, vibrational, scattering based spectroscopies, instrumentation and signal processing. Advanced applications to the analysis of molecular structure and chemical processes including surface analysis, time-resolved spectroscopies, and ultrasensitive spectroscopic techniques.

**CHM 436 Special Topics in Analytical Chemistry 1-3 Credits**

Topics of contemporary interest in analytical chemistry.

**Repeat Status:** Course may be repeated.

**CHM 438 Analytical Chemistry 3 Credits**

Theory and practice of chemical analysis. Principles of quantitative separations and determinations; theory and application of selected optical and electrical instruments in analytical chemistry; interpretation of numerical data; design of experiments; solute distribution in separation methods. Must have CAS graduate student status.

**CHM 443 (MAT 443) Solid-State Chemistry 3 Credits**

This solid state chemistry course will introduce students into symmetry of extended solids, X-ray crystallography of solids, crystal structures, band theory, electronic and ionic conductivity in solids, defects in solids, silicate chemistry and nonporous solids.

**CHM 444 Molecular Structure, Bonding and Dynamics 0,3 Credits**

Nature of chemical bonding as related to structure and properties of molecules and extended systems. Quantum chemistry of atoms and molecules applied to chemical transformations and spectroscopic transitions. Symmetry analysis and selection rules. Interpretation of electronic, vibrational and rotational spectra. Must have CAS graduate student status.

**CHM 446 Photochemistry of Consequence 3 Credits**

Photochemistry involves using photons (light from the sun) to drive critical chemical reactions and is attractive because of its application to solar energy. Fundamental processes in photochemistry will be covered. Topics will include: energy transfer, electron transfer, proton-coupled electron transfer processes and their applications to biological systems.

**CHM 452 Advanced Organic Chemistry 3 Credits**

Reaction mechanism types and supporting physical chemical data. Classes of mechanisms include elimination, substitution, rearrangement, oxidation reduction, enolate alkylations, and others. Must have completed one year of organic chemistry and have CAS graduate student status.

**CHM 453 Heterocyclic Compounds 3 Credits**

An intensive study of the syntheses, reactions and properties of heteroaromatic compounds including derivatives of thiophene, pyrrole, furan, indole, pyridine, quinoline, the azoles and the diazines all considered from the viewpoint of modern theories of structure and reaction mechanisms.

**Prerequisites:** CHM 358 or CHM 452

**CHM 455 Organic Reactions 3 Credits**

Intensive survey of modern synthetic organic chemistry from a mechanistic standpoint. Classical Namereactions, olefin synthesis, organometallic reagents in synthesis, Woodward-Hoffmann rules, electrocyclic processes, enolate chemistry, and related reactions.

**Prerequisites:** or CHM 452, CHM 358 or CHM 452

**CHM 456 Spectral Analysis 3 Credits**

Use of data from nuclear magnetic resonance, infrared, ultraviolet, and mass spectrometric techniques for the determination of structure of organic compounds. Emphasis on information from one- and two-dimensional proton and carbon NMR, and a mechanistic interpretation of data from mass spectrometry.

**CHM 457 Organic Reaction Mechanisms 3 Credits**

Intensive in class problem solving that involves the formulation of reasonable reaction mechanisms for complex multistep pathways, i.e. organic transformations that proceed via highly energetic intermediates such as carbocations, carbanions, free radicals, carbenes, and nitrenes.

**CHM 458 Topics in Organic Chemistry 1-3 Credits**

An intensive study of limited areas in organic chemistry.

**Repeat Status:** Course may be repeated.

**CHM 462 3 Credits**

This course focuses on the physical tools that exist to obtain information about biological macromolecules, with an emphasis on spectroscopic and imaging techniques (e.g., circular dichroism, fluorescence spectroscopy, FRET, BRET, calorimetry, analytical ultracentrifugation, X-ray crystallography, electron microscopy, dynamic light scattering, surface plasmon resonance). Lectures and discussion of research articles are used to illustrate the use of the different tools and methods.

**CHM 464 Bioinorganic Chemistry 3 Credits**

This course will cover inorganic chemistry as it relates to biology, with emphasis on how metal ions and cofactors are employed by biological systems. Topics will include metalloproteins, metal cofactors, and metals in medicine. Experimental methods used to study bioinorganic chemistry will also be discussed.

**CHM 465 Protein Separation & Biophysical Analysis 3 Credits**

Laboratory studies of techniques and principles used for the isolation, characterization, and biophysical analysis of proteins.

**Attribute/Distribution:** NS

**CHM 472 (BIOS 472) Lipids and Membranes 3 Credits**

The study of lipids and lipid membranes similar to those found in mammalian cells including methods of synthesis, surface activity, bilayer and micellar structures, lipid mixing, fluidity, permeability and membrane stability. Special emphasis will be given to the current evidence for and against the lipid raft hypothesis.

**Prerequisites:** BIOS 372 or CHM 372

**CHM 473 (BIOS 473) Principles of Biochemistry I 3 Credits**

Study of proteins, carbohydrates, lipids, nucleic acids and other biological substances. Protein and enzyme chemistry are emphasized. Must have completed one year each of general chemistry and organic chemistry.

**CHM 475 Advanced Topics in Chemistry 1 Credit**

Audiovisual courses in topics such as acid-base theory, NMR, chromatography, electroanalytical chemistry and mass-spectroscopy interpretation; course material obtained from the American Chemical Society.

**Repeat Status:** Course may be repeated.

**CHM 477 (BIOS 477) Topics In Biochemistry 1-3 Credits**

Selected areas of biochemistry, such as mechanisms of enzyme action, new developments in the chemistry of lipids, nucleic acids, carbohydrates and proteins. Must have completed one semester of biochemistry.

**Repeat Status:** Course may be repeated.

**CHM 481 Chemistry Seminar 1 Credit**

Student presentations on current research topics in the student's discipline but not on subjects close to the thesis. A one-hour presentation and attendance at other presentations are required for credit.

**Repeat Status:** Course may be repeated.

**CHM 482 (CHE 482, MAT 482) Mechanical Behaviors of Polymers 3 Credits**

Mechanical behavior of polymers. Characterization of experimentally observed viscoelastic response of polymeric solids with the aid of mechanical model analogs. Topics include time-temperature superposition, experimental characterization of large deformation and fracture processes, polymer adhesion, and the effects of fillers, plasticizer, moisture, and aging on mechanical behavior.

**CHM 483 (CHE 483, MAT 483, PSE 483) Emulsion Polymers 3 Credits**

Fundamental concepts important in manufacture, characterization, and application of polymer latexes. Topics include colloidal stability, polymerization mechanisms and kinetics, reactor design, characterization of particle surfaces, latex rheology, morphology considerations, polymerization with functional groups, film formation and various application problems.

**CHM 485 (CHE 485, MAT 485, PSE 485) Polymer Blends 3 Credits**

Synthesis, morphology, and mechanical behavior of polymer blends. Polymer/polymer miscibility and thermodynamics of mixing of polymer/solvent and polymer/polymer blends. Prediction of miscibility using various theoretical models and methods that can be used to help enhance miscibility (H bonding etc.). Methods to enhance the compatibility of polymer/polymer blends (e.g., block copolymers, ternary addition, IPNs), etc.). Types of polymer blends. Must have completed any introductory polymer course or equivalent.

**CHM 487 Topics in Colloid and Surface Chemistry 3 Credits**

Applications of colloid chemistry; special topics in surface chemistry. Lectures and seminar.

**Repeat Status:** Course may be repeated.

**CHM 488 Advanced Topics in Physical Chemistry 1-3 Credits**

Advanced topics in physical chemistry, such as photochemistry and molecular beam dynamics, Fourier transform spectroscopy, kinetics of rapid reactions, theory of magnetic resonance, liquids and solutions. Topic changes almost every time it is offered.

**Repeat Status:** Course may be repeated.

**CHM 489 Organic Polymer Science II 3 Credits**

Continuation of CHM 394. Theory and mechanism of ionic vinyladdition chaingrowth polymerization. Chain copolymerization by radical and ionic mechanism. Mechanism of ring-opening polymerization, stereochemistry of polymerization including ionic, coordination, and Ziegler-Natta mechanisms. Reactions of polymers, including crosslinking, reaction of functional groups, graft and block copolymers, and polymer carriers and supports.

**CHM 490 Thesis 1-6 Credits**

**Repeat Status:** Course may be repeated.

**CHM 492 (CHE 492, MAT 492) Topics in Polymer Science 3 Credits**

Intensive study of topics selected from areas of current research interest such as morphology and mechanical behavior, thermodynamics and kinetics of crystallization, new analytical techniques, molecular weight distribution, non-Newtonian flow behavior, second-order transition phenomena, novel polymer structures. Credit above three hours is granted only when different material is covered.

**CHM 494 Quantum Chemistry 3 Credits**

Principles and applications of quantum mechanics to chemical problems. Applications to chemical bonding, molecular structure, reactivity and spectroscopy.

**CHM 499 Dissertation 1-15 Credits**

**Repeat Status:** Course may be repeated.