Chemistry

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Departmental Mission Statement: Modern chemistry is the study of matter and its transformations. Our department presents the theory, concepts, and laboratory experiences of chemistry in an intimate environment that allows for the personal professional development of students through both individual and team based approaches. The department's program is framed within the liberal arts model where we consider multiple perspectives to enhance our understanding of phenomena. Throughout the chemistry curriculum, students advance in their problem solving, critical thinking, laboratory safety, communication, and ethical skills and become prepared for careers as productive scientists and for lives as responsible citizens.

Communicating Plus - Chemistry: Students completing a major in chemistry develop skills in the four Communicating Plus areas — written communication, oral communication, critical thinking and problem solving — in required and elective course work in the discipline. Numerical, graphical, visual, oral, and written modes of communication are integral to chemistry courses and to the discipline. Laboratory reports in the 100 level courses are a combination of observations, calculations, and explanations. As data analysis and problem solving skills are developed in the 200 level courses, detailed documentation and oral and written reporting of laboratory work improve the student's scientific communication skills. In the 300 and 400 level and capstone courses, students are engaged in both individual and team oriented research projects and complete and report on a required senior research thesis. These culminating experiences allow students to further develop and demonstrate their mastery of disciplinary content and of the Communicating Plus skills.

Requirements for a major in chemistry: CHM 111, 112, 211, 214, 321, 333, 334, 342, three semesters of 501 and one semester of 502, two semesters of physics (151 and 152 or 171 and 172), plus two semesters of calculus (201 and 202) or a higher calculus course. CHM 111, 112, 211 and 214 constitute an introductory core and should be taken in sequence.

Majors must complete a research project which culminates in a substantial written thesis. Except in unusual circumstances, an experimental project is required. This thesis project can be initiated after the student's exposure to the introductory core, but must be essentially complete at the end of the fall semester of the senior year. A directed summer research project, either at Ripon, on another campus, or in an industrial laboratory, could also provide the basis for an acceptable thesis. It is expected that the project will be the equivalent of a minimum of four semester hours of credit.

The major described above, with the addition of CHM 422 and two of the following: 310, 413, 414, 415 or a 3-4 credit 500 level Departmental Studies course, satisfies the minimum standard for a professional degree in chemistry certified by the American Chemical Society. Students planning on obtaining an American Chemical Society degree need to register 400 laboratory hours in courses at the 200 level and higher. Thesis research can be included in this requirement. Students planning to pursue graduate work should select advanced courses and independent study based on their post-graduation interests and should also consider seriously the potential value of linear algebra, differential equations, and advanced calculus. Students should discuss the possibilities with members of the department before registration.

Laboratory periods for CHM 100 and 175 are two hours per week. All other laboratories are three to four hours, unless otherwise noted.

Requirements for a minor in chemistry: CHM 111, 112, 211, 214, and one course from CHM 321, 333, 334, 414, or 422.

Requirements for a teaching major in chemistry: CHM 111, 112, 211, 214, 321, 333, 334, 342, 401, 501 (two credits); PHY 151 and 152 or 171 and 172; MTH 201 and 202; and ENV 120.

Requirements for a teaching minor in chemistry: CHM 111, 112, 211, 214, and 401; either CHM 321, 333, or 334; and MTH 201 and 202.

100. Global Chemistry — Staff

Four credits.

Global societal issues such as air and water quality, climate change, use of fossil fuels, fracking, and pharmaceutical design are addressed through the understanding of basic chemistry intermixed with discussion of public policy. Weekly laboratory sessions stress how measurements, reactions, data collection, and observations inform environmental chemistry decision making and include chemical syntheses, exploring the effects of chemical pollutants, and the use of instrumentation to characterize chemicals found in the environment.

111. Organic Chemistry I — Willoughby

Five credits.

Understanding the nature (i.e. physical properties) and tendencies (i.e. chemical properties) of carbon-based chemicals is crucial to the fields of medicine and materials science. The properties of the organic functional groups dictate how molecules such as pharmaceuticals, pheromones, metabolites, and fluorophores interact with humans, animals, and ecosystems as a whole. This course will first provide an introduction to the language of organic chemistry and how it applies to the aforementioned fields of study. After establishing a foundation in the language of the discipline, the fundamental chemical reactivity of several common organic functional groups will be discussed. The semester will culminate by discussing strategies for synthesizing complex organic molecules that may or may not have ever been discovered. The laboratory will focus on the preparation and purification of organic molecules. *Prerequisite: high school chemistry or consent of the instructors.*

112. Structure and Reactivity — Katahira

Five credits.

An introduction to the basic principles of chemistry. The structural relationship between the atom and the macroscopic properties of matter is studied through topics such as kinetic molecular theory, gases, quantum theory, molecular orbital theory, intermolecular forces, and the solid state. Chemical reactivity is introduced through the study of stoichiometry, kinetics, chemical equilibrium, thermodynamics, and electrochemistry. The laboratory includes studies in stoichiometry, qualitative analysis, gas laws, electrochemistry, acid-base equilibrium, kinetics, inorganic syntheses, and other topics. *Prerequisite: CHM 111 or high school chemistry and consent of the instructor.*

201. Departmental Seminar — Byron

One credit. Offered both semesters.

Selected topics presented by students, faculty, or visiting researchers and practicing professionals, followed by discussion. This course option is open to first- and second-year students. Grading is S-U.

211. Analytical Chemistry: Equilibrium and Quantitative Analysis — Byron

Five credits.

An introduction to analytical chemistry with special emphasis on equilibrium-based methods for quantitative determinations. Acid-base, complexation, precipitation, and oxidation-reduction equilibria are studied in the classroom and particular attention is paid to the roles of these reactions in biochemical systems. Spectroscopic and chromatographic methods of analysis are introduced in the laboratory. Other laboratory work stresses the development of quantitative techniques, laboratory notebook protocol, the statistical evaluation of data, and the carrying out of a group designed analytical research project. *Prerequisite: CHM 112.*

214. Organic Chemistry II — Willoughby

Five credits.

This course includes an advanced study of the properties of the fundamental functional groups discussed in Chemistry 111. Emphasis will be placed on important chemical reactions of these groups. Detailed mechanistic analysis will accompany the study of all new chemical reactions. Additionally, topics in modern spectroscopy (e.g., NMR, IR, UV-Vis) and mass spectrometry (e.g., via LC/MS, GC/MS, Hi-Res MS) will also be discussed, and these techniques will be frequently applied to organic structure elucidation. The laboratory will focus on microscale preparation, purification, and characterization of complex organic molecules. *Prerequisite: CHM 111 and 112 or consent of the instructor.*

300. Departmental Studies: Current Topics in Chemical Research — Staff

Variable credit.

Special subjects in Chemistry not covered by regular courses. This course may be repeated for credit when topics change. Please see the pertinent Schedule of Courses for the listing of topics courses and possible prerequisites. *Prerequisites: CHM 111 and consent of the instructor.*

310. Computational Chemistry — Scanlon

Variable credit course, 3-4 credits.

This course is designed as an introduction to the many applications of computational chemistry. The background theory of methods will be briefly discussed so that the proper method for each chemical topic can be chosen. The focus of the course will be to showcase how to use computational chemistry to solve chemical problems. To that end, several computational chemistry programs and graphical user interfaces will be utilized along with a basic introduction of UNIX. *Prerequisite: CHM 211 or 214 or 321.*

321. Descriptive Inorganic Chemistry — Katahira

Four credits.

The descriptive chemistry of the elements studied with respect to periodic trends. Atomic structure, ionic and covalent bonding, molecular structure, the solid state, solutions, coordination complexes, organometallic chemistry, experimental methods, conductivity, and superconductivity in inorganic solids are topics typically studied. In addition, the origin, discovery, isolation, and chemistry of selected elements are examined. No laboratory. *Prerequisite: CHM 214.*

332. Glassworking — Katahira

Variable credit course, 2-3 credits.

Instruction and practice in the elementary operations of glassblowing and their application to the construction of scientific apparatus and art objects. An introduction to glassworking in art and science is included. Studio emphasis may be either in scientific apparatus or art or a combination. Lectures, demonstrations, field trips, and studio. See ART 132. *Does not fulfill the First Year Explorations Requirement in the Natural Sciences. Prerequisite: consent of the instructor.*

333. Physical Chemistry: Quantum Mechanics, Spectroscopy, and Statistical Thermodynamics — Scanlon

Five credits.

An introduction to quantum mechanics with applications in spectroscopy. Bonding theory, atomic and molecular structure determinations, and quantum chemistry calculations are included. Laboratories are in the area of chemical quantum calculations, spectroscopy, and structure determination. *Prerequisites: MTH 201 and 202; and PHY 151 and 152 or 171 and 172 or consent of the instructor.*

334. Physical Chemistry: Chemical Thermodynamics and Kinetics — Scanlon

Five credits.

The study of chemical thermodynamics and its applications to chemistry and biochemistry. Kinetics of reactions, reaction mechanisms, and reaction rate theory are also covered. Laboratories illustrate and test established principles and provide basic experience with measurements yielding quantitative results. *Prerequisites: MTH 201 and 202 and PHY 151 and 152 or 171 and 172, or consent of the instructor.*

342. Advanced Laboratory — Katahira/Willoughby

Four credits.

A study of the preparation, isolation, and characterization of compounds. Where possible, the emphasis is on the techniques involved and the range of their applicability to either inorganic or organic systems. The quantitative aspects of separation and characterization will be emphasized. Includes discussions of the chemical literature and the effective written and oral communication of experimental results. Two laboratories and two discussions per week. *Prerequisite: CHM 214 or consent of the instructor.*

401. The Teaching of Chemistry — Staff

Two credits.

Methods of the teaching of chemistry in secondary schools. The development of the chemistry curriculum, lectures, problem assignments, evaluation instruments, demonstrations, laboratories, and laboratory safety will be covered. Required for teaching certification in chemistry. Does not count for the major.

413. Advanced Organic Chemistry — Willoughby

Three credits.

Advanced topics in organic chemistry with special emphasis on mechanism and theory, including polymers and other commercially important organic compounds. No laboratory. *Prerequisite: CHM 214 or consent of the instructor.*

414. Chemical Instrumentation — Byron

Four credits.

Designed to promote an understanding of instruments used for chemical and biochemical characterization. Atomic and molecular spectrophotometry, fluorometry, laser spectroscopy, mass spectrometry, nuclear magnetic resonance, electrochemistry and chromatography are studied in detail. Flexible laboratory exercises explore instrument optimization and chemical characteristics that influence instrumental design. *Prerequisite: CHM 211.*

415. Advanced Inorganic Chemistry — Katahira

Three credits.

Advanced topics in inorganic chemistry selected with reference to student backgrounds and interests. Topics include introduction to symmetry and group theory; the structure, stability, and electronic spectra of classical transition metal complexes; descriptive applications of molecular orbital theory; conductivity and superconductivity in solids; the metal-metal bond in transition metal clusters and multiple metal bonds; key reactions of organometallic compounds; experimental methods. No laboratory. *Prerequisite: CHM 321 or consent of the instructor.*

422. Biochemistry — Byron

Four credits.

An introduction to biochemistry with an emphasis on the structure and function of molecules, particularly proteins, found in living cells and on the energetics and dynamics of biochemical reactions. No laboratory. *Prerequisite: CHM 214 or consent of the instructor.*

501, 502. Departmental Seminar — Byron

One credit.

Selected topics presented by students, faculty, or visiting researchers and practicing professionals, followed by discussion. This course is required of junior and senior chemistry majors. Grading is S-U for Section 501. *Prerequisite: CHM 211 or 214 or 321.*

521, 522. Departmental Studies — Staff

Variable credit course, 1-5 credits.

Individual preparation in special phases of chemistry not covered in regular courses, with regular discussion periods. *Prerequisite: consent of the instructor.*

541, 542. Independent Study — Staff

Variable credit course, 1-5 credits each semester.

Supervised investigation of special problems in chemistry either as a laboratory or library research problem. A paper summarizing the semester's work is required. No more than twelve credit hours of independent study or internship may be taken, and no more than eight credit hours may be in one department. A registration form is required. *Prerequisites: junior or senior standing, consent of the department chair and a department project director, and 12 credits toward the major.*