FACULTY OF SCIENCE

CHEMISTRY

CHEM-0100 (3) Foundations of Chemistry

(3 hrs Lecture) The purpose of this course is to prepare students for CHEM-1111 Introduction to the Chemical Properties of Matter and CHEM-1112 Basic Principles of Chemical Reactivity. Topics include the characterization of chemical substances, chemical reactions, chemical quantities, and chemical systems. Notes: Standing in this course will satisfy the prerequisites for CHEM-1111 and CHEM-1112 (in place of Chemistry 40S, Pre-Calculus Mathematics 40S, and/or Applied Mathematics 40S). Non-science majors wishing to take a chemistry course for science credit should take CHEM-2801 Environmental Issues: A Chemistry Perspective. This course CANNOT be used as a credit towards the Chemistry or Biochemistry majors. Students with standing in CHEM-1111 or CHEM-1112 cannot register for this course.

CHEM-1111 (3) Introduction to Chemical Properties of Matter

(3 hrs Lecture | 3 hrs Lab) This course includes an introduction to atomic and molecular structure, chemical bonding, chemical reactivity, to the bulk properties of matter, and the descriptive chemistry of the elements. The laboratory component introduces students to basic chemistry laboratory practice and techniques. The fundamental concepts of chemical reactivity covered in this course and CHEM-1112 provide the essential foundation for students who wish to continue with Chemistry or Biochemistry as a major, and for students of Biology, Physics, Physical Geography, Environmental Studies, and Experimental Psychology.
Requisite Courses: Pre-Calculus Mathematics 40S or Applied Mathematics 40S, and Chemistry 40S; or CHEM-0100 [prerequisite(s)]; CHEM-1111L (lab) (must be taken concurrently).

CHEM-1112 (3) Basic Principles of Chemical Reactivity

(3 hrs Lecture | 3 hrs Lab) This course includes an introduction to chemical kinetics, chemical thermodynamics and equilibrium, and to acid/base and oxidation/reduction chemical reactions. The laboratory component introduces students to some of the basic techniques of practical chemistry. The fundamental concepts of chemical reactivity covered in this course and CHEM-1111 provide the essential foundation for students who wish to continue with Chemistry or Biochemistry as a major, and for students of Biology, Physics, Physical Geography, Environmental Studies, and Experimental Psychology.
Requisite Courses: Chemistry 40S and Pre-Calculus Math 40S or Applied Math 40S; or CHEM-0100 [prerequisite(s)]; CHEM-1112L (lab) (must be taken concurrently).

CHEM-2102 (3) Thermodynamics and Kinetics

(3 hrs Lecture | 3 hrs Lab) This course describes the principles and applications of thermodynamics, and the rates and mechanisms of chemical reactions. Laboratory work consists of experiments in the thermodynamics and kinetics of gases and solutions, and computer applications in data analysis and problem solving.
Restrictions: Students may not hold credit for this course and CHEM-2101.
Requisite Courses: CHEM-1111, CHEM-1112, and either MATH-1101, or MATH-1103 and MATH-1104 [prerequisite(s)]; CHEM-2102L (lab) (must be taken concurrently).

CHEM-2103 (3) Atoms, Molecules and Spectroscopy

(3 hrs Lecture | 3 hrs Lab) This course is an introduction to quantum chemistry, with applications in atomic and molecular structure and spectroscopy. Laboratory work consists of experiments in molecular spectroscopy and computational methods for determining molecular structures and properties.
Restrictions: Students may not hold credit for this course and CHEM-2101.
Requisite Courses: CHEM-1111, CHEM-1112, and either MATH-1101, or MATH-1103 and MATH-1104 [prerequisite(s)]; CHEM-2103L (lab) (must be taken concurrently).

CHEM-2202 (3) Organic Chemistry I

(3 hrs Lecture | 3 hrs Lab) This course is an introductory study of aliphatic carbon compounds. Topics to be covered include bonding; hybridization; resonance; acids and bases; the structure, nomenclature, synthesis and reactions of alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers and amines; the stereo chemistry of organic compounds; and nucleophilic substitution and elimination reactions and their use in organic synthesis. The laboratory includes an introduction to techniques commonly used in organic chemistry, through the preparation, purification and characterization of organic compounds.
Note: CHEM-1111 may be used as a co-requisite provided a minimum grade of 75 or equivalent was obtained in Chemistry 40S.
Restrictions: Students may not hold credit for this course and CHEM-2201.
Requisite Courses: CHEM-1111 and CHEM-1112 [prerequisite(s)]; CHEM-2202L (lab) (must be taken concurrently).

CHEM-2203 (3) Organic Chemistry II

(3 hrs Lecture | 3 hrs Lab) This course is an introductory study of the chemistry and structural identification of common aliphatic and aromatic organic compounds. Topics include the structure, nomenclature, synthesis and reactions of aromatic hydrocarbons, phenols, aldehydes, ketones, enolates, carboxylic acids, sulfur- and phosporus-containing compounds, and free-radicals. Spectroscopic instrumentation for structure determination is discussed, with an emphasis on infra-red (IR) and nuclear magnetic resonance (NMR) spectroscopy, and mass spectrometry (MS). The laboratory includes an introduction to techniques commonly used in organic chemistry, through the preparation, purification and characterization of compounds.

Note: CHEM-1112 may be used as a co-requisite provided a minimum grade of 75 or equivalent was obtained in Chemistry 40S.
Restrictions: Students may not hold credit for this course and CHEM-2201.
Requisite Courses: CHEM-2202 [prerequisite(s)]; CHEM-2203L (lab) (must be taken concurrently).

CHEM-2302 (3) Quantitative Chemical Analysis

(3 hrs Lecture | 3 hrs Lab) This is a first course in analytical chemistry which examines ionic equilibria in aqueous solutions and their use in chemical analysis. This course covers both volumetric and gravimetric analysis with a detailed examination of the pertinent equilibria involved in precipitation, acid-base, complexometric, and oxidation-reduction systems. The lab consists of a series of experiments designed to develop strong analytical techniques.
Requisite Courses: CHEM-1111 and CHEM-1112 [prerequisite(s)]; CHEM-2302L (lab) (must be taken concurrently).

CHEM-2401 (3) Inorganic Chemistry I

(3 hrs Lecture | 3 hrs Lab) This course provides an introduction to Inorganic Chemistry with a focus on fundamental concepts. The first part of the course deals with understanding and predicting molecular bonding and structure with examples taken mostly from the main group. The second part of the course deals with understanding and explaining the trends in chemical behaviour with emphasis being placed on the main group elements. Laboratory work demonstrates reactivity trends discussed in lecture and introduces the techniques associated with the synthesis and characterization of main group compounds.
Restrictions: Students may not hold credit for this course and CHEM-3402.
Requisite Courses: CHEM-1111 and CHEM-1112 [prerequisite(s)]; CHEM-2401L (lab) (must be taken concurrently).

CHEM-2502 (3) Introduction to Biochemistry

(3 hrs Lecture | 3 hrs Lab) This is an introductory course in biochemistry. Topics include: the structural characteristics and biological properties of biomolecules (carbohydrates, lipids, proteins, and nucleic acids); basic enzymology; and metabolism. Examples of the application of the principles of biochemistry to the study and treatment of human diseases are discussed.
Note: This course can be taken prior to or concurrently with CHEM 3502 or CHEM 3503. Students who currently hold a B or higher in CHEM-3502 or CHEM-3503 may not receive credit for this course. Students may not hold credit for CHEM-2502 and CHEM-2503.
Requisite Courses: CHEM-1111 and CHEM-1112 [prerequisite(s)]; CHEM-2202 (must be taken previously or at the same time as this course); CHEM-2502L (lab) (must be taken concurrently).

CHEM-2701 (3) Computer Techniques and Applications for Chemistry

(3 hrs Lecture | 3 hrs Lab) This course introduces students to computer applications in the field of Chemistry. Topics include data handling; basic statistical analysis; graphing; drawing chemical structures,

equations, and diagrams; computations; molecular modelling and minimum energies; and the incorporation of diagrams, graphs, molecular structures, and equations directly into scientific documents.
Requisite Courses: CHEM-1111 and CHEM-1112 with a minimum grade of C [prerequisite(s)]; CHEM-2701L (lab) (must be taken concurrently).

CHEM-2801 (3) Environmental Issues: A Chemistry Perspective

(3 hrs Lecture) This course examines a number of environmental and societal issues, such as global warming and acid rain. Basic chemical and physical concepts are introduced as required to supplement the discussion. Topics include the past, present and future use of energy in society; plastics; nutrition; and green/sustainable chemistry. Online discussion groups and assignments are used to facilitate debate and conceptual understanding. This course prepares students for introductory chemistry and environmental sciences courses. The course may also serve as a topical survey for senior science students.
Note: CHEM-2801 may be used to fulfil the Science requirement for the BA degree. It can also be used for credit towards the Chemistry major in the 5-Year BEd/BSc degree. CHEM-2801 cannot be used as major credit for the Chemistry or Biochemistry degrees.

CHEM-3101 (3) Physical Chemistry of Condensed Phases

(3 hrs Lecture) This course examines the thermodynamics, structures, and physical properties of liquids, solids and surfaces. Topics include phase transitions, chemical reactions, ionic solutions, and transport properties (conductivity, diffusion, viscous flow, surface tension, and capillarity).
Requisite Courses: CHEM-2102 or permission of instructor [prerequisite(s)].

CHEM-3102 (3) Quantum Chemistry and Spectroscopy

(3 hrs Lecture | 3 hrs Lab) This course examines the quantum theory of chemical bonding, molecular properties, and spectroscopy.
Requisite Courses: CHEM-2103 [prerequisite(s)].

CHEM-3202 (3) Reaction Mechanisms in Organic Chemistry

(3 hrs Lecture) This course deals with the application of physical chemical principles to organic compounds and their reactions. It includes topics such as the effects of structure on reactivity, heterolytic reaction mechanisms, acidity functions, catalysis, solvent effects, and isotope effects.
Restrictions: Students may not hold credit for this course and CHEM-3201.
Requisite Courses: CHEM-2202 and CHEM-2203 [prerequisite(s)].

CHEM-3204 (3) Organic Structure Determination

(3 hrs Lecture) This course teaches the application of spectroscopic techniques (1D and 2D multinuclear NMR, IR, MS, UV) to organic structure determination. Classical methods still in common use are briefly covered.
Restrictions: Students may not hold credit for this course and CHEM-3201.
Requisite Courses: CHEM-2202 and CHEM-2203 [prerequisite(s)].

CHEM-3205 (3) Organic Synthesis

(3 hrs Lecture) This course deals with the synthesis of organic compounds. Topics include synthetic strategies, conformational analysis, use of protecting groups, and chiral induction. Molecular orbital theory will be introduced and applied to the study of pericyclic reactions.
Restrictions: Students may not hold credit for this course and CHEM-4202.
Requisite Courses: CHEM-2202 and CHEM-2203 [prerequisite(s)].

CHEM-3206 (3) Advanced Organic Chemistry Laboratory

(3 hrs Lecture) This course provides students with advanced laboratory experience in Organic Chemistry. Students are exposed to the theory and application of methods for experimental design; purification of reagents; working with air/moisture sensitive reagents; and the isolation, purification and identification of natural products. Students set up and conduct several experiments and formulate reports on their work.
Requisite Courses: CHEM-2203 with a minimum grade of C [prerequisite(s)].

CHEM-3302 (3) Methods of Chemical Analysis

(3 hrs Lecture | 3 hrs Lab) This course introduces students to the procedures of analytical chemistry including sampling, preparation of the sample for analysis, instrument calibration, and statistical treatment of data. Specific analytical methods discussed include potentiometry and atomic and molecular spectroscopy. This involves a series of analyses using instrumental techniques.
Restrictions: Students may not hold credit for this course and CHEM-2301.
Requisite Courses: CHEM-2302 [prerequisite(s)]; CHEM-3302L (lab) (must be taken concurrently).

CHEM-3401 (3) Inorganic Chemistry II: Coordination Chemistry

(3 hrs Lecture | 3 hrs Lab) This course examines the bonding, structure, and reactivity of coordination compounds of the transition metals. Building on the fundamentals covered in CHEM-2401(3), we discuss the nature of the metal-ligand bond, including its effect on physical and chemical properties of metal complexes. General trends in transition metal coordination chemistry are examined with an emphasis on understanding and predicting the reactivity and structures of coordination compounds. Laboratory work involves synthesis and characterization of transition metal coordination compounds.
Restrictions: Students may not hold credit for this course and CHEM-3402 | CHEM-3404.

Requisite Courses: CHEM-2202 and CHEM-2401 [prerequisite(s)]; CHEM-2203 (must be taken previously or at the same time as this course); CHEM-3401L (lab) (must be taken concurrently).

CHEM-3502 (3) Intermediate Biochemistry I: Structure, Function, and Energetics of Biomolecules

(3 hrs Lecture | 3 hrs Lab) Topics to be examined in this course include the structure and function of biomolecules, including carbohydrates, lipids, nucleic acids, proteins, and "high energy" phosphate compounds (emphasizing the inter-relationship of structure and function); mechanisms and kinetics of enzyme-catalyzed reactions; membrane transport; and bioenergetics.
Note: CHEM-2202 may be used as a co-requisite provided that a minimum grade of B+ was obtained in CHEM-1111 and CHEM-1112.
Restrictions: Students may not hold credit for this course and CHEM-3501.
Requisite Courses: CHEM-1111 and CHEM-1112 and CHEM-2202 and BIOL-1115 [prerequisite(s)]; CHEM-3502L (lab) (must be taken concurrently).

CHEM-3503 (3) Intermediate Biochemistry II: Intermediary Metabolism

(3 hrs Lecture | 3 hrs Lab) This course examines major catabolic and anabolic pathways, and their regulation and integration.
Note: CHEM-2203 may be used as a co-requisite provided that a minimum grade of B+ was obtained in CHEM-1111 and CHEM-1112.
Restrictions: Students may not hold credit for this course and CHEM-3501.
Requisite Courses: CHEM-3502 [prerequisite(s)]; CHEM-3503L (lab) (must be taken concurrently).

CHEM-3504 (3) Plant Biochemistry – Experimental Course

(3 hrs Lecture) This course covers aspects of chemistry that are unique to plants. Topics include an introduction to basic biochemical concepts, photophosphorylation, photosynthesis, carbohydrate metabolism, nitrogen fixation, some aspects of secondary metabolism, and agricultural applications.

CHEM-3601 (3) Environmental Chemistry

(3 hrs Lecture) This course in environmental organic chemistry describes the properties, partitioning behaviour and reactivity of organic contaminants and their influence on the distribution, transport and fate of the chemical in the environment. Recent literature is used to discuss current issues in environmental chemistry, with an emphasis on long-range transport and global distribution of persistent, toxic and bioaccumulative contaminants.
Requisite Courses: CHEM-2202 and CHEM-2203 [prerequisite(s)].

CHEM-3611 (3) Environmental Toxicology

(3 hrs Lecture) This course provides an understanding of how and why chemicals may damage humans and other organisms. Basic principles of toxicology and environmental chemical exposure are covered, and detailed analysis is presented of the body's defences against toxicants and the physiological and/or biochemical mechanisms by which toxicants cause effects. Toxicological modeling and environmental risk assessment are introduced. Students apply these principles to explore emerging topics of interest in their own discipline.
Cross-listed: ENV-3611(3).
Restrictions: Students may not hold credit for this course and ENV-3611.
Requisite Courses: CHEM-2202 and CHEM-2203 [prerequisite(s)].

CHEM-3701 (3) Directed Studies in Chemistry

(3 hrs Lecture) This course is designed to allow students the opportunity to conduct individual research under the supervision of a faculty member. The study may take the form of a literature review, may be experimental in nature, or may involve the analysis of existing data.
Note: Permission to enroll is dependent on the availability of a suitable faculty member AND students must obtain written permission from the Chair of Chemistry in addition to the prerequisite. Note: This course may only be taken once for credit.
Requisite Courses: 12 credit hours of Chemistry courses and permission from the Chair of the Chemistry Department [prerequisite(s)].

CHEM-4101 (3) Quantum Chemistry

(3 hrs Lecture) This course covers the fundamentals of quantum chemistry, with an introduction to the electronic structure theory of molecules. The course also introduces computational chemistry techniques as valuable tools for research in all fields of chemistry.
Requisite Courses: CHEM-2103 [prerequisite(s)].

CHEM-4204 (3) Medicinal Chemistry

(3 hrs Lecture) This course deals with an introduction to pharmaceuticals from natural sources and their biosynthetic origin. This also includes various methods of synthesis, and studies on structure-activity relationships of anti-inflammatory, anti-cancer and anti-microbial chemotherapeutic agents.
Requisite Courses: CHEM-2202 and CHEM 2203 [prerequisite(s)].

CHEM-4302 (3) Instrumentation for Quantitative Analysis

(3 hrs Lecture) This course discusses the basic electronic principles and design of instrumentation for molecular and atomic spectroscopy as well as quantitative mass spectrometry. Students taking this course gain an appreciation of a variety of topics including basic electronics, signal acquisition, noise and signal enhancement. Apart from the classroom, students also participate in practical demonstrations in

the laboratory. Theory and applications for a variety of techniques available in this course include the following: atomic absorption and atomic emission spectroscopy, atomic mass spectrometry and x-ray fluorescence.
Requisite Courses: CHEM-2302 and CHEM-3302 [prerequisite(s)].

CHEM-4303 (3) Analytical Separations

(3 hrs Lecture | 3 hrs Lab) The crucial role of analytical separations in chemistry and biochemistry, both qualitative and quantitative, is discussed in detail. Theoretical background, principles of instrumentation, and applications are detailed for important chromatographic and mass spectrometric techniques for chemical isolation and identification. The laboratory exercises provide a unique opportunity to gain practical experience with modern techniques, including gas and liquid chromatography and mass spectrometry.
Requisite Courses: CHEM-2202 and CHEM-2203 (or the former CHEM-2201) and CHEM-3302 (or the former CHEM-2301) [prerequisite(s)]; CHEM-4303L (lab) (must be taken concurrently).

CHEM-4401 (3) Organometallic d-Block Chemistry

(3 hrs Lecture | 3 hrs Lab) This course focuses on compounds featuring transitions metal-carbon bonds. The course explores physical and bonding properties, characterization methods, and fundamental reaction mechanisms of organometallic compounds and applications of transition metal organometallics in homogenous catalysis (i.e., for organic synthesis and industrial chemical preparation).
Requisite Courses: CHEM-3401 [prerequisite(s)].

CHEM-4403 (3) Advanced Main Group Chemistry

(3 hrs Lecture) Aspects of main group chemistry are covered in this course, including electron-deficient compounds, main group organometallics, and ring systems and polymers. Focus is placed on bonding descriptions of main group compounds, as well as synthetic methods and characterization techniques (NMR, EPR, mass spectrometry, X-ray diffraction). The industrial applications of main group compounds are discussed.
Requisite Courses: CHEM-3401 [prerequisite(s)].

CHEM-4502 (3) Molecular Enzymology

(3 hrs Lecture) This course examines aspects of the structure, function, and regulation of enzymes. Topics include the inter-relationship of enzyme structure and function, current theories of the chemical basis of enzyme catalysis, enzyme kinetics, and the regulation of enzyme activity. Applications of our current understanding of enzyme biochemistry are discussed.
Requisite Courses: CHEM-3503 [prerequisite(s)].

CHEM-4506 (3) Methods in Biochemistry

(3 hrs Lecture | 3 hrs Lab) This course examines the application of physical methods to problems of biochemical interest. Topics to be covered include the isolation and stabilization of proteins; sub-cellular fractionation; methods for the assay of protein activity; the determination of enzyme kinetic parameters; purification and analysis of biomolecules (especially proteins) by selective precipitation (varying pH, salt concentration, and solvent), liquid chromatography (ion exchange, gel filtration, and affinity chromatography) and electrophoresis (slab gel and capillary); ultracentrifugation; and biochemical applications of the use of radioisotopes. Although emphasis is placed on the application of these techniques to proteins, application to other classes of biomolecules are examined as appropriate.
Requisite Courses: CHEM-3503 [prerequisite(s)]; CHEM-4506L (lab) (must be taken concurrently); CHEM-4502 (recommended prerequisite).

CHEM-4701 (6) Research Projects in Chemistry

(3 hrs Project / Thesis) This course is designed to allow students to investigate a specific research problem. Students work with a faculty member in a particular area of research while learning the techniques and methodology related to chemical research.
Note: Students are strongly urged to consult with the department at least two months in advance of any anticipated registration in this course, as approval for any planned project must be obtained from a specific faculty member as well as from the Department Chair.
Requisite Courses: 30 credit hours of coursework in Chemistry and permission from the Chair of Chemistry [prerequisite(s)].

CHEM-4703 (3) Topics in Chemistry

(3 hrs Lecture) Special topics in an area of analytical, environmental, inorganic, organic, physical, or biochemistry are addressed. Please consult the Chemistry Department for the current topic.
Note: Permission from the Chair of Chemistry is required.