Chemistry (CHEM)

CHEM 1001. FYE: Chemistry. 1 Hour.
Strongly recommended for entering freshmen and transfer students with 0-24 credits interested in the BS degree in chemistry. Designed to help students adapt to college life and become integrated into DSU. Students will refine academic skills, learn about college resources and procedures, and explore different fields of study, degree options, and career opportunities. Multiple listed with all other sections of FYE (all 1001 courses and ENGR 1000). Students may only take one FYE course for credit. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Know their way around Dixie State University. This includes knowing: where to find buildings and services that you may need on campus, what campus services are available to you, how to do things like add classes, drop classes, change your major, check your account balance, use your Dmail, and so on, how to get involved in college life, what your rights and responsibilities are as a student. 2. Know some strategies for dealing with the challenges of college life. This includes: managing your time, staying safe on campus, recognizing and dealing with stress, staying healthy, managing your money, networking with other students and professors, staying motivated when the going gets tough. 3. Know how to succeed academically. This includes knowing how to: use a course syllabus, read a college textbook, talk to your professors, take good notes, write good papers, study effectively, recognize and deal with test anxiety, take tests effectively, avoid academic dishonesty, take advantage of your learning style. 4. Understand your major or area of study. This includes knowing: what General Education is, and how to fulfill the GE requirements, how to chose a major that is right for you, what the course requirements are in your major, how to construct a graduation plan, what kinds of careers your major will prepare you for. FA.

CHEM 1010. Introduction to Chemistry (PS). 3 Hours.
Fulfills General Education Physical Science requirement for students majoring in Business, Communication, Fine Arts, Humanities, and other non-Science disciplines. Emphasizes basic chemical concepts within daily life. CHEM 1015 lab course recommended but not required. Inclusive Access Course Material fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Use the language of chemistry. 2. Use the Periodic Table of Elements to predict the behavior of atoms. 3. Apply chemical skills such as balancing an equation or drawing a Lewis dot structure for a covalent compound. 4. Explain how chemical concepts apply to the world around you and your everyday life. FA, SP, SU.

CHEM 1015. Introduction to Chemistry Lab (LAB). 1 Hour.
Lab portion of CHEM 1010. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Demonstrate correct laboratory techniques and the basis of the scientific method. 2. Collect and present data in a systematic manner. 3. Use common laboratory equipment for their designed purpose or technique. 4. Develop critical thinking skills in order to follow detailed laboratory procedures. 5. Apply general chemistry concepts to laboratory experiments. Course fee required. Corequisite: CHEM 1010. FA, SP.

CHEM 1020. Culinary Chemistry (PS). 3 Hours.
Fulfills General Education Physical Science requirement. Course content will demonstrate how basic scientific principles underlie everyday aspects of food and cooking; learning about fruits, grains, and meats to sauces and candies. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Know the fundamental principles of food preparation and meal management. 2. Be able to share recipes with class members by practicing at home, planning, and preparing food for the class. 3. Apply chemical principles to the understanding of the physical and natural world. 4. Distinguish between chemical and physical processes and properties of matter. 5. Understand how heat relates to chemical processes. 6. Describe the intermolecular forces which influence the properties of gases, liquids, and solids. FA.

CHEM 1110. Elementary General/Organic Chemistry (PS). 4 Hours.
Fulfills General Education Physical Science requirement for students majoring in Health Sciences, Family & Consumer Science, Natural Resources, or Agriculture. Not appropriate for students majoring in Life Sciences, Physical Sciences, pre-Medical, or other pre-professional programs. In this first semester of the 2-course sequence, topics will cover elementary chemistry, basic law, and reactions of inorganic chemistry. Successful completion satisfies prerequisite for CHEM 1120. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Explain and apply the major principles and vocabulary of general chemistry, including how we relate to chemicals on a daily basis. 2. Describe and use the periodic table to predict the behavior of elements, compounds, and atoms. 3. Apply basic skills such as balancing chemical equations, drawing Lewis dot structures, and predicting the results of radioactive decay. 4. Discuss basic chemical reactions and predicting products of basic chemical reactions. Prerequisites: MATH 1010 or higher (Grade C or higher) or equivalent placement score, taken within two years of enrollment in this course. Corequisites: CHEM 1115. FA.

CHEM 1115. Elem General/Organic Chemistry Lab (LAB). 1 Hour.
Lab portion of CHEM 1110. Successful completion satisfies pre-requisite for CHEM 1125. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Demonstrate correct laboratory techniques and the basis of the scientific method. 2. Collect and present data in a systematic manner. 3. Use common laboratory equipment for their designed purpose or technique. 4. Develop critical thinking skills in order to follow detailed laboratory procedures. 5. Apply classroom knowledge in general and organic chemistry to laboratory methods and experiments. Course fee required. Corequisite: CHEM 1110. FA, SP, SU.

CHEM 1120. Elem Organic / Bio Chemistry. 4 Hours.
Continuation of the second semester in a 2-course sequence. Topics will cover organic and biochemistry in relation to chemistry of the body. Covers fundamental laws of carbohydrates, lipids, proteins, biochemical energy, enzymes, and molecular biology, as well as the organic functional groups related to these biochemicals. Successful completion prepares students for further study in Chemistry and Life Sciences. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Demonstrate knowledge of health science including general organic and biochemistry. 2. Apply knowledge of basic fundamental laws, concepts and theories in chemistry to biological diseases and everyday life. 3. Apply the process of science -- how scientific knowledge is generated and validated -- so that they can make independent, empirical inquiries about the natural world. 4. Utilize knowledge of the process of science by being able to interpret data in the form of tables, graphs and charge and then communicate those findings in oral or written form. Prerequisites: CHEM 1110 (grade C or higher). Corequisites: CHEM 1125. SP.

CHEM 1125. Elem Organic/Bio Chemistry Lab. 1 Hour.
Lab portion of CHEM 1120. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Demonstrate correct laboratory techniques and the basis of the scientific method. 2. Collect and present data in a systematic manner. 3. Use common laboratory equipment for their designed purpose or technique. 4. Develop critical thinking skills in order to follow detailed laboratory procedures. 5. Apply classroom knowledge in organic and biological chemistry to laboratory methods and experiments. Course fee required. Prerequisite: CHEM 1115 (Grade C or higher). Corequisite: CHEM 1120. SP.

CHEM 1150. Integrated Chemistry for Health Sciences (PS). 4 Hours.
Fulfills the General Education Physical Sciences Requirement and is a course designed to introduce relevant chemistry to students interested in the Health Professions. In particular this will meet the needs of pre-Nursing, Dental Hygiene, and other allied health students to become acquainted with key aspects of chemistry. Key aspects of General/Inorganic, Organic, and Biological Chemistry will be discussed. Four hours of lecture per week. Not appropriate for students majoring in Life Sciences, Physical Sciences, pre-Medical, or pre-Dental programs. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Explain and apply the major principles and vocabulary of general, organic, and biochemistry, including the relationships between chemicals and life. 2. Describe and use the periodic table to predict the behavior of elements, compounds, and atoms. 3. Apply basic skills such as balancing chemical equations, drawing Lewis dot structures, predicting the results of radioactive decay, and identifying organic functional groups. 4. Discuss the chemical processes involved in biological functions such as chemical buffers, protein formation, and carbohydrate metabolism. Prerequisites: MATH 1010 or higher (Grade C or higher) or equivalent placement score, taken within two years of enrollment in this course. Corequisites: CHEM 1155. FA, SP.

CHEM 1155. Integrated Chemistry for Health Sciences Laboratory (LAB). 1 Hour.
Fulfills General Education Lab requirements and is the Lab portion of CHEM 1150. Application of concept in general, organic, and biochemistry to laboratory techniques and experiments. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Apply correct laboratory techniques and the basis of the scientific method. 2. Collect and present data in a systematic manner. 3. Utilize common laboratory equipment and demonstrate knowledge of theory behind the equipment. 4. Develop critical thinking skills in order to follow detailed laboratory procedures. 5. Apply classroom knowledge in general, organic, and biochemistry to laboratory methods and experiments. Course fee required. Corequisite: CHEM 1150. FA, SP.

CHEM 1200. Preparation for Gen Chemistry (PS). 3 Hours.
For students with little or no background in Chemistry and is designed to prepare students for General Chemistry. Covers basic topics through lecture and online problems. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Apply chemical principles to the understanding of the physical and natural world. 2. Apply mathematical skills and the mole concept to solve chemical problems, balancing equations and stoichiometry. 3. Apply skills and knowledge required to be successful in university courses in science. Prerequisite: MATH 1010 or higher (Grade C or higher or can be concurrently enrolled).

CHEM 1210. Principles of Chemistry I (PS). 4 Hours.
Fulfills General Education Physical Science requirement for students majoring in Life or Physical Sciences, Engineering, and pre-professional programs (pre-medical, pre-dental, etc.). Provides theoretical and practical framework for further study in the sciences; emphasizes measurement, stoichiometry, the nature of the atom, chemical periodicity, the states of matter, thermodynamics and bonding. Successful completion satisfies pre-requisite for CHEM 1220. Completion of a prior Chemistry course is strongly recommended before enrolling in this course. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Apply chemical principles to the understanding of the physical and natural world. 2. Utilize mathematical skills and the mole concept to solve chemical problems in balancing reaction equations, mass relationships, stoichiometry and their application to titrations. 3. Predict atomic structure, chemical bonding or molecular geometry based on theoretical models and results of empirical studies including periodic trends. 4. Describe the intermolecular forces which influence the properties of gases, liquids, and solids, and quantitatively determine the physical state of materials. 5. Determine the solubility, concentrations, and ionic properties of compounds dissolved in aqueous solution. Prerequisites: MATH 1050 or higher (Grade C or higher) or equivalent placement score, taken within two years of enrollment in this course. Corequisites: CHEM 1215. FA, SP.

CHEM 1215. Principles of Chemistry I Lab (LAB). 1 Hour.
Lab portion of CHEM 1210. Successful completion satisfies pre-requisite for CHEM 1225. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Apply chemical principles covered in CHEM 1210 lecture to the understanding of the physical and natural world. 2. Use basic laboratory equipment and techniques of laboratory measurement and procedure. 3. Apply mathematical models to the analysis of laboratory data. 4. Record scientific data (including uncertainty) and complete a laboratory report. 5. Distinguish between precision and accuracy. Course fee required. Corequisite: CHEM 1210. FA, SP.

CHEM 1220. Principles of Chemistry II. 4 Hours.
Continuation of CHEM 1210. Emphasizes kinetics, equilibrium, descriptive chemistry, nuclear chemistry, and special topics. Successful completion prepares students for and satisfies prerequisite for CHEM 2310 and further study in life and physical sciences. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Describe the nature of molecular interactions by using kinetic data. 2. Apply chemical principles to the understanding of the physical and natural world. 3. Explain chemical processes and discuss their impact on the technological and environmental concerns of our modern industrialized society. 4. Describe the relationship between electrical and chemical energy. 5. Analyze equilibria in aqueous solutions and calculate the concentration of reactants and products at equilibrium. Prerequisites: CHEM 1210 (Grade C or higher). Corequisites: CHEM 1225. FA, SP.

CHEM 1225. Principles of Chemistry II Lab. 1 Hour.
Lab portion of CHEM 1220. Successful completion satisfies prerequisite for CHEM 2315. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Describe the influence of chemical change in the context of environmental situations and technological applications. 2. Explain the use of basic laboratory equipment and techniques of laboratory measurement and procedure. 3. Apply mathematical models to the analysis of laboratory data. 4. Discuss experimental observations in the laboratory setting and creating scientific reports to communicate the information gained. Course fee required. Prerequisites: CHEM 1215 (Grade C or higher). Corequisites: CHEM 1220. FA, SP.

CHEM 2310. Organic Chemistry I. 4 Hours.
For Chemistry, Biology, pre-Medical, pre-Dental, pre-Optometry, pre-Pharmacy majors, pre-Chiropractic, pre-Medical Technician, and pre-Veterinary majors. Introduction to functional groups and related reactions, including an introduction to spectroscopy. Successful completion satisfies prerequisite for CHEM 2320. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Explain structures (hybridization, geometry, polarity) and compare physical properties (boiling point, melting point, solubility, conformation, stability) of organic compounds with various functional groups. 2. Name organic molecules using nomenclature, stereochemistry, and spectroscopy to give systematic names for compounds, draw correct structures, identify and label stereoisomers, recognize the possible stereochemical implications of a chemical reaction, and characterize and identify organic compounds. 3. Formulate, identifiy, and/or draw starting materials, reagents, and products for reactions of alkanes, alkenes, alkynes, and aromatics. 4. Apply mechanistic principles to recognize nucleophiles, electrophiles, acids, and bases, and correctly draw the mechanisms of selected reactions; use mechanisms to predict regio- and stereoselectivity of products. 5. Apply fundamental concepts to complex and advanced problems beyond the immediate context, including in making informed decisions in everyday life. Prerequisite: CHEM 1220 (Grade C or higher). Corequisite: CHEM 2315. FA, SP.

CHEM 2315. Organic Chemistry I Lab. 1 Hour.
Lab portion of CHEM 2310. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Demonstrate safe handling and appropriate disposal of laboratory chemicals. 2. Apply knowledge and principles from organic chemistry lecture to hands on laboratory experiences. 3. Perform appropriate calculations involving mass, moles, equivalents, volume, density, molecular weight, % composition, theoretical yield, % yield, and % recovery. 4. Demonstrate the ability to perform and the following organic laboratory techniques and explain the principles behind them: filtration, rotary evaporation, recrystallization, liquid/liquid extraction, TLC analysis, column chromatography, melting point, boiling point, distillation, and obtaining IR spectra. 5. Run an organic reaction, then isolate, purify, and characterize the products. 6. Write appropriate lab notebook entries which include an introduction, safety information, the reaction to be performed, a data table, a step by step procedure, and accurate and objective observations. 7. Write typewritten discussions which include a restatement of the purpose of the lab, a summary of the procedure used, a discussion of the observations and results obtained, and a conclusion based on this data. Course fee required. Prerequisite: CHEM 1225 (Grade C or higher). Corequisite: CHEM 2310. FA, SP.

CHEM 2320. Organic Chemistry II. 4 Hours.
A continuation of CHEM 2310. Further study of functional groups and related reactions, including organic reactions necessary for synthesis of larger molecules. Successful completion prepares students for further study in biochemistry and physical chemistry. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Utilize mechanistic principles to recognize nucleophiles and electrophiles, acids and bases, and correctly draw the mechanisms of selected reactions; use mechanisms to predict the regio- and stereo-selectivity of product, and, in depth, the mechanism and kinetics of substitution and elimination reactions (SN1/SN2/E1/E2). 2. Identify, draw, and construct syntheses and reactions of numerous functional groups including: alkyl halides, alcohols, ethers, epoxides, carbonyl compounds, amines, and carbohydrates. 3. Design multi-step reaction sequences to synthesize increasingly complex organic molecules. 4. Pass a standardized Organic Chemistry exam covering the full year's course. 5. Apply fundamental concepts to complex and advanced problems beyond the immediate context, including in making informed decisions in everyday life. Prerequisites: CHEM 2310 (Grade C or higher). Corequisites: CHEM 2325. FA, SP.

CHEM 2325. Organic Chemistry II Lab. 1 Hour.
Lab portion of CHEM 2320. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Practice safe handling and appropriate disposal of laboratory chemicals. 2. Apply knowledge and principles from organic chemistry lecture to hands-on laboratory experiences. 3. Perform appropriate calculations involving mass, moles, equivalents, volume, density, molecular weight, % composition, theoretical yield, and % yield. 4. Demonstrate the ability to perform the following organic laboratory techniques and explain the principles behind them: filtration, rotary evaporation, recrystallization, liquid-liquid extraction, TLC analysis, column chromatography, melting point, boiling point, distillation, and obtaining IR spectra. 5. Run a variety of organic reactions, then isolate, purify, and characterize the products. 6. Use data from a mass spectrum, IR spectrum, 1H and 13C NMR spectra, chemical test results, and a boiling or melting point to determine the identity of an unknown organic compound. 7. Write an appropriate lab notebook entry including an introduction, important safety information, the reaction to be performed, a data table, a step-by-step procedure, and accurate and objective observations. 8. Write a typewritten discussion which includes a restatement of the purpose of the lab, a summary of the procedure used, a discussion of the observations and results obtained, and a conclusion based on this data. 9. Perform chemical demonstrations suitable for an audience of elementary school children. Course fee required. Prerequisite: CHEM 2315 (Grade C or higher). Corequisite: CHEM 2320. FA, SP.

CHEM 2700R. Methods in Chemistry Research. 1 Hour.
A preparatory course for undergraduate participation in field research projects in chemistry. Repeatable for a maximum of 3 credits. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Develop skills in collecting and organizing scientific data from field and laboratory investigations. 2. Extend knowledge of chemical concepts in a range of interdisciplinary contexts. 3. Devise the outline for a hypothesis-based research project in chemistry or biochemistry. Course fee required. Prerequisites: Instructor permission required.

CHEM 2990. Chemistry Seminar and Professional Development. 1 Hour.
Seminar course aimed to help students who have declared a chemistry major prepare for future careers in their field. Seminar and workshop activities will include potential career paths in chemistry and biochemistry, professional development and research experience opportunities, preparing cover letters and resumes/CVs, and the process of applying to graduate programs and jobs. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Identify potential opportunities as a chemistry degree graduate. 2. Prepare and evaluate professional materials that will be needed to apply for summer and post-graduate jobs and programs. 3. Interact and collaborate with faculty, peer students, and guest speakers in a professional setting. 4. Develop professional skills for interviews and collaborative settings. Prerequisite: Declared as Chemistry or Molecular Biology-Biochemistry major. FA.

CHEM 3000. Quantitative Chemical Analysis. 3 Hours.
This course is focusing on understanding the principles of analytical chemistry and the application of these principles in various scientific disciplines. This course is addressing aspects of modern chemical analysis with emphasis on chemical equilibrium. Volumetric, gravimetric, and instrumental methods are described. Course will cover basic statistics, chemical equilibrium, gravimetric analysis, volumetric analysis, acid-base chemistry, complexation, spectrophotometry, and separations. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Apply stoichiometry and chemical equilibrium for analysis. 2. Discuss and apply chemical measurement calibration. 3. Apply statistical methods for evaluating and interpreting data. Prerequisites: CHEM 1220 (Grade C or higher). Corequisites: CHEM 3005. FA.

CHEM 3005. Quantitative Chemical Analysis Laboratory. 1 Hour.
There is the required laboratory component to CHEM 3000. This course focuses on applying the principles of analytical chemistry and the application of these principles in various scientific disciplines. This course is addressing aspects of modern chemical analysis with emphasis on chemical equilibrium. Volumetric, gravimetric, and instrumental methods are utilized. Course will cover basic statistics, chemical equilibrium, gravimetric analysis, volumetric analysis, acid-base chemistry, complexation, spectrophotometry, and separations. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Apply stoichiometry and chemical equilibrium for analysis. 2. Apply statistical methods for evaluating and interpreting data. 3. Identify the proper analytical technique for sample analysis. Course fee required. Prerequisites: CHEM 1225 (Grade C or higher). Corequisites: CHEM 3000. FA.

CHEM 3060. Physical Chemistry 1. 4 Hours.
A problem-oriented course in atomic and molecular structure, states of matter, and chemical kinetics. Introduction to efficient retrieval of information from the physical chemical literature and thinking critically about the material. Students will understand the difference between classical and quantum mechanics, understanding the time, length, and energy scales on which chemical processes occur, and connect common approximation methods to standard chemical frameworks. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Understand the time, length, and energy scales on which chemical processes occur. 2. Understand the differences between classical and quantum mechanics. 3. Connect operators to observables. 4. Distinguish probabilities, amplitudes, averages, expectation values, and observables. 5. Understand the origin and implications of quantum coherence. 6. Interpret spectra. 7. Connect common approximation methods to standard chemical frameworks (Born-Oppenheimer, molecular orbitals). 8. Develop molecular-level critical thinking skills. Prerequisites: CHEM 1220 and PHYS 2210 (all Grade C or higher). FA (odd).

CHEM 3065. Physical Chemistry I Lab. 1 Hour.
A problem-oriented course in atomic and molecular structure, states of matter, and chemical kinetics. Introduction to efficient retrieval of information from the physical chemical literature and thinking critically about the material. Students will understand the difference between classical and quantum mechanics, understanding the time, length, and energy scales on which chemical processes occur, and connect common approximation methods to standard chemical frameworks. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Understand the time, length, and energy scales on which chemical processes occur. 2. Understand the differences between classical and quantum mechanics. 3. Connect operators to observables. 4. Distinguish probabilities, amplitudes, averages, expectation values, and observables. 5. Understand the origin and implications of quantum coherence. 6. Interpret spectra. 7. Connect common approximation methods to standard chemical frameworks (Born-Oppenheimer, molecular orbitals). 8. Develop molecular-level critical thinking skills. Course fee required. Prerequisites: CHEM 1225 and PHYS 2215 (all Grade C or higher). Corequisite: CHEM 3060. FA (odd).

CHEM 3070. Physical Chemistry II. 4 Hours.
Introduction to microscopic and bulk thermodynamics, partition functions, theory of electrolytes and electrochemistry, and chemical kinetics. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Problem solve and critically think about thermodynamic and kinetic problems and extrapolate solutions based on learned theory. 2. Understand that thermodynamics gives relationship between macroscopic observables and that these can be evaluated using statistical mechanics. 3. Clearly define the conditions of the kinetic-molecular theory and be able to calculate the pressure of an ideal gas from its premises. 4. Take their learning of thermodynamics and kinetics and be able to communicate current knowledge in the field in written form. 5. Define the rate of a reaction. Understand the definition of a rate constant and rate coefficient. Integrate the rate equation for simpler systems. Prerequisites: CHEM 2320 and PHYS 2210 (all Grade C or higher). SP (even).

CHEM 3075. Physical Chemistry II Lab. 1 Hour.
A problem-oriented course in atomic and molecular structure, states of matter, and chemical kinetics. Introduction to efficient retrieval of information from the physical chemical literature and thinking critically about the material. Students will understand the kinetics and thermochemistry. The will gain understanding in statistical distributions, mechanistic pathways, and energy scales on which chemical processes occur, and connect common approximation methods to standard chemical frameworks. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Problem solve and critically think about thermodynamic and kinetic problems and extrapolate solutions based on learned theory. 2. Understand that thermodynamics gives relationship between macroscopic observables and that these can be evaluated using statistical mechanics. 3. Clearly define the conditions of the kinetic-molecular theory and be able to calculate the pressure of an ideal gas from its premises. 4. Take their learning of thermodynamics and kinetics and be able to communicate current knowledge in the field in written form. 5. Define the rate of a reaction. Understand the definition of a rate constant and rate coefficient. Integrate the rate equation for simpler systems. Course fee required. Prerequisites: CHEM 2325 and PHYS 2215 (all Grade C or higher). Corequisites: CHEM 3070. SP (even).

CHEM 3100. Inorganic Chemistry. 4 Hours.
Covers current theory and concepts in inorganic chemistry with an emphasis on general trends and periodic properties of the elements and their compounds. Topics include bonding and structure, acid-base theories, redox properties, molecular symmetry, coordination compounds, and crystal-field theory. Students will expand their knowledge of the role of metals in nature and use gained knowledge and critical thinking skills for problem solving. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Apply bonding theories to describe the structure and bonding of inorganic compounds. 2. Use symmetry and group theory to describe bonding and other chemical properties. 3. Predict periodic trends in main group and d-block elements. 4. Explain the mechanisms and predict the products of some common inorganic reactions. 5. Demonstrate the ability to solve basic problems in each of the major areas of inorganic chemistry. Prerequisites: CHEM 2320 (Grade C or higher). FA (even).

CHEM 3300. Instrumental Analysis. 4 Hours.
Focuses on understanding the theory and practice of modern analytical instrumentation. Course emphasis will be placed on chromatography, optical spectroscopy, mass spectrometry, microscopy as well as sample preparation techniques, statistical data treatment, and quality assurance of data. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Discuss the principles of the measurement by various instruments. 2. Generate data analysis, data manipulation and data interpretation. 3. Design analyses for specific problems with various analytes. 4. Produce scientific reports and presentations. Course fee required. Prerequisites: CHEM 3000 and CHEM 3005 (all Grade C or higher). SP.

CHEM 3510. Biochemistry I. 3 Hours.
Covers cellular metabolism of biologically-important molecules (carbohydrate, lipids, proteins, and nucleic acids) as well as regulation of these metabolic processes. Principles will be taught using structure/function relationships. Inclusive Access Course Material (electronic book) fees may apply, see Fees tab under each course section for details. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Identify the properties of water and how the aqueous environment influences the behavior of biological macromolecules. 2. Duplicate the structures of amino acids, explain their chemical properties and their organization into polypeptides and proteins. 3. Describe key principles of protein function, structure and characterization. 4. Discuss enzymes and how they catalyze reactions, as well as enzyme kinetics. 5. Describe structure and basic function of carbohydrates and lipids, and describe their roles in biological systems, including through the use of of signal transduction pathways. Prerequisites: BIOL 1610 and CHEM 2320 (all Grade C or higher). Corequisites: CHEM 3515. FA.

CHEM 3515. Biochemistry I Lab. 1 Hour.
Introduction to current biochemical techniques including spectrophotometry, chromatography, and electrophoresis. Includes analysis and manipulation of nucleic acids. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Confirm proficiency in micropipetting and solution preparation. 2. Investigate protein expression and purification, SDS-PAGE electrophoresis, and Western blotting. 3. Predict enzymatic kinetics and formulate associated calculations. 4. Analyze and process data and draw appropriate conclusions. 5. Generate scientific ideas by writing them in clear, concise, logical, and an accurate manner. Course fee required. Prerequisites: BIOL 1615 and CHEM 2325 (all Grade C or higher). Corequisites: CHEM 3510. FA.

CHEM 3520. Biochemistry II. 3 Hours.
Continuation of Biochemistry I. Introduction into catabolic and anabolic processes of animal and plant metabolism. Includes protein and nucleic acid biosynthesis and signal transduction. Discussion of current biochemical methods. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Identify the molecules involved in the major biochemical metabolic pathways such as glycolysis, gluconeogenesis, citrate cycle, respiratory electron transport system, etc. 2. Explain the reactions and recognize rate-regulatory steps involved in the aforementioned pathways. 3. Discuss the origin of mitochondria and their essential role in oxidative phosphorylation. 4. Analyze the energy yield from the catabolism of any compound. 5. Explain how a membrane is synthesized by the incorporation of monoacyglycerols and their modifications and the synthesis and degradation of fatty acids mirror each other in their chemical reactions. Prerequisite: CHEM 3510 (Grade C or higher). Corequisite: CHEM 3525. SP.

CHEM 3525. Biochemistry II Lab. 1 Hour.
A laboratory course to be taken concurrently with CHEM 3520. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Compose a comprehensive laboratory report based on multiple experiments. 2. Examine and quantify multiple metabolites found in cells. 3. Produce a Western blot independently. 4. Generate primers to amplify a gene and characterize using agarose gels. Course fee required. Prerequisite: CHEM 3515 (Grade C or higher). Corequisite: CHEM 3520. SP.

CHEM 4100. Advanced Inorganic Chemistry. 3 Hours.
A continuation of CHEM 3100. Topics may include more in-depth emphasis on molecular symmetry, group theory, organometallic reactions, bonding and structure, acid-base theories, redox properties, coordination compounds, and crystal-field theory. Students will expand their knowledge of the role of metals in nature and use gained knowledge and critical thinking skills for problem solving. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Apply bonding theories to describe the structure and bonding of inorganic compounds. 2. Use symmetry and group theory to describe bonding and other chemical properties. 3. Understand and predict periodic trends in main group and d-block elements. 4. Explain the mechanisms and predict the products of some common inorganic reactions. 5. Demonstrate the ability to solve basic problems in each of the major areas of inorganic chemistry. Prerequisite: CHEM 3100 (Grade C or higher). SP (odd).

CHEM 4200. Environmental Chemistry. 3 Hours.
This course will focus on the fundamental principles of chemistry necessary for understanding of the source, fate, and reactivity of compounds in natural and polluted environments. Emphasis will be placed on the environmental implications of energy utilization and on the chemistry of the atmosphere, hydrosphere, and lithosphere. Environmental issues that will be discussed include air pollution, stratospheric ozone depletion, pollution and treatment of water sources, and the utilization of insecticides and herbicides. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Describe the chemistry of the atmosphere and environmental and health consequences of indoor and outdoor pollution. 2. Describe the nature, reactivity, and environmental fates of toxic organic chemicals. 3. Discuss the chemistry of natural waters and their pollution and purification. 4. Evaluate environmental chemistry issues and generating a comprehensive scientific report. Prerequisite: CHEM 2320 (Grade C or higher). FA (odd).

CHEM 4310. Adv Organic Chemistry I. 3 Hours.
A problem-oriented course that explores organic structure, stereochemistry, and thermodynamics and kinetics in organic reaction mechanisms. Introduction to efficient retrieval of information from the organic chemical literature, and to thinking critically about the material. Introduction to molecular orbital theory and aromaticity and resulting spectroscopic properties. Offered based upon sufficient student need. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Predict the conformational preferences of common organic structures accounting for steric and electronic interactions. 2. Assign symmetry elements to molecules and determine symmetry point groups. 3. Describe stereochemical relationships and predict stereochemical outcomes for organic reactions. 4. Make logical predictions about the reactivity patterns to be expected from organic molecules. 5. Predict relative acidity of molecules. 6. Write kinetic rate laws for reactions and use these to evaluate proposed reaction mechanisms. 7. Draw molecular orbital diagrams for simple organic molecules. 8. Use Frontier Molecular Orbitals to understand and predict reactions. 9. Determine whether a pericyclic reaction is thermally or photochemically allowed using Molecular Orbital theory. 10. Learn to predict the products formed in various classes of pericyclic reactions. 11. Propose reasonable explanations for observed products. 12. Propose informative and incisive experimental tests to distinguish between mechanistic proposals. Prerequisites: CHEM 2320 and CHEM 2325 (all Grade C or higher). FA (even).

CHEM 4510. Chemistry of Materials. 3 Hours.
Provides the molecular understanding of materials structure and properties, including solid-state chemistry, chemical bonding in bulk materials, and properties of materials as function of local and extended structures. Topics include inorganic solids, organic and coordination polymers, organic conductors, hybrid materials, optical and magnetic materials, and biomaterials. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Distinguish inter- and intramolecular chemical bonding in bulk systems. 2. Predict local and extended network structures in solids, liquids, and glasses. 3. Use structural information to predict properties of bulk systems. 4. Correlate emerging properties from atomic to nano to bulk systems. 5. Predict and determine optical, electronic and magnetic properties of materials. 6. Apply techniques to determine structure and properties of materials. 7. Classify materials as being of natural, anthropogenic, or biological origin and application. Prerequisites: CHEM 2320 and CHEM 2325 and CHEM 3000 and CHEM 3005 (All grade C or higher). SP (odd).

CHEM 4610. Nutritional Biochemistry. 3 Hours.
A course in advanced biochemistry using nutrition as a model. The course will focus on human nutrition and metabolism. The functional and regulatory roles of macronutrients and micronutrients will be stressed. Additional components of the course will emphasize how nutrition science relates to nutrition information available to the lay public and drives nutrition policy. Students will be guided through an exploration of recent scientific literature in the areas of biochemistry and nutrition, and ways in which one informs the other. Current challenges in the field of nutrition will be related to the lecture material. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Understand the basic concepts of biochemistry-bonds between molecules, digestion and absorption, actions of enzymes, protein, carbohydrate, and fat metabolism, actions of hormones, and regulation of gene expression. 2. Understand and explain the digestion, absorption, and metabolism of the energy providing nutrients -- carbohydrate, lipid and protein. 3. Understand and explain the interrelationship of the energy providing nutrients (carbohydrate, lipids, and fat) in the various metabolic pathways and their roles in supporting disease prevention. 4. Understand and explain the role of micronutrients (vitamins and minerals) in disease prevention. Prerequisites: CHEM 3520 (Grade C or higher). FA (odd).

CHEM 4800R. Independent Research. 1-3 Hours.
An independent research course that allows the students to explore science through the scientific method, and allows close interaction between the student and faculty member to address scientific problems through experiment design and execution. Projects are at the discretion of the faculty member, in line with the student's interests in the various scientific areas. Repeatable up to 6 credits subject to graduation and program restrictions. Variable credit: 1-3. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Use the scientific method to develop hypotheses, design experiments, and draw conclusions from results. 2. Design and modify experiments during the progress of a research project. 3. Interpret results from experiments, modify the hypothesis. 4. Draw conclusions according to research goals. 5. Perform research independently, and interact with other students and faculty that are engaged in the project. 6. Utilize outside resources (scientific databases, literature, etc) to interpret results and compare to existing and previous work in the field of your research project. Prerequisites: CHEM 2320 and CHEM 2325 (all Grade C or higher); and ENGL 2010 or ENGL 2010A; and Instructor permission. FA,SP, SU.

CHEM 4910. Chemistry Senior Seminar. 1 Hour.
A seminar course where students will share their research results or literature searches with fellow students and faculty in written and oral formats. **COURSE LEARNING OUTCOMES (CLOs) At the successful conclusion of this course, students will be able to: 1. Use the scientific method to develop hypotheses, search literature or utilize results from experimentation, and defend in an oral presentation to faculty and students. 2. Use literature to support a topic or idea and discuss pros/cons and scientific validity of prior results. 3. Communicate results and discuss relevant scientific topics in oral presentations in a scientific group setting. 4. Interact with other students and faculty that are engaged in scientific discussion to analyze data, results, and different perspectives, participate in scientific discussion. 5. Utilize outside resources (scientific databases, literature, etc.) to help interpret results and compare to existing and previous work in the field. 6. Prepare written reports that effectively summarize a chosen scientific topic using the vast literature and compiled data. Prerequisites: CHEM 2320 and CHEM 2325 (all Grade C or higher); and ENGL 2010 (Grade C or higher); Advanced Standing; and Instructor Permission. SP.