Chemistry Syllabus Audit (Fall 2008-Spring 2009)

Program Goal	**Course Goals & Objectives**
Skills **Oral/Written Communication and Library Use**	
1.1. To locate chemical information using print and electronic media (CHE 341, 342, 321, 422, 560).	CHE 321 – Shih • Find chemical information in reference books. CHE 341 – Wimpfheimer • (to) expose students to literature and online searching and methods of presentation CHE 442 – Comeford • Read and interact with the chemical literature. • Read journal articles with an emphasis on data tables, figures, and reaction schemes. • Discuss the differences between textbooks and journal articles. • Discuss the experiments described in journal articles. CHE 560 – Comeford • Use the chemical literature to research a given topic • Locate relevant three journal articles on this topic. • Locate relevant print resources and websites on this topic. • Read, understand and evaluate journal articles from the chemical literature.

1.2. To organize, present and explain chemical information using oral, written and electronic media (CHE 309, 321, 422, 341, 342, 560).	CHE 231 – Wimpfheimer • After completion of the course the student will be able to effectively convey laboratory results by: a short report, a well written laboratory report, and a poster presentation • write a short essay on various scientific topics CHE 341 – Wimpfheimer • After completion of the course the student will be able to effectively convey laboratory results by a well written laboratory report. CHE 422 – MacTaylor • Students will also learn to express scientific data, methods, and conclusions through oral and written formal reports. CHE 442 - Comeford • Summarize and explain chemistry in journal articles using plain English. CHE 560 – Comeford • Present a seminar on a given topic from the chemical literature • Clearly explain chemical concepts, data, reactions, instrumentation and other technical information. • Organize information in a clear and logical manner. • Make a clear oral presentation using standard methods of presentation. • Answer questions on the presentation. • Write an annotated bibliography of your resources including at least three journal articles.

2. Laboratory Skills	
2.1. To work safely in the chemical laboratory and follow standard chemical handling and disposal procedures (all, especially CHE 342, 422).	CHE 130 – Comeford • Read and follow a written laboratory procedure. • Make and record observations in the laboratory. CHE 231 – Wang • The students will have learned the basic lab technique to carry out experiments in the modern chemical lab. • The students will have learned the importance of proper chemical waste disposal. CHE 341 – Wimpfheimer • After completion of the course the student will be able to read and follow written experimental protocols CHE 342 – Comeford • Work safely and efficiently in the laboratory. • Keep a laboratory notebook. • Adhere to standard safety practices.

2.2. To synthesize, purify and characterize compounds (CHE 130, 212, 213, 340).	CHE 130 – Comeford • Purify a compound by recrystallization. • Find a melting point. CHE 212 – Wester • The student will learn the basic principles of organic chemistry. The student will apply some parts of this knowledge in the laboratory. CHE 213 – Rowland • By the end of the course you should be able to perform several different types of laboratory experiments, be able to solve common laboratory problems, and synthesize different types of organic compounds. You should be able to use an IR, NMR, and GC. You should be able to demonstrate the ability to perform synthesis of several different compounds and be able to correctly identify and characterize the products from the reactions. CHE 213 – Warner • Perform laboratory techniques associated with organic chemistry
2.3. To use of modern chemical instrumentation and have a working knowledge of their principles behind their operation (CHE 212, 213, 309, 422).	CHE 213 – Rowland • By the end of the course you should be able to perform several different types of laboratory experiments, be able to solve common laboratory problems, and synthesize different types of organic compounds. You should be able to use an IR, NMR, and GC. You should be able to demonstrate the ability to perform synthesis of several different compounds and be able to correctly identify and characterize the products from the reactions. CHE 213 – Warner • Understand spectroscopic techniques associated with organic chemistry. CHE 342 – Wimpfhiemer • (To) have students understand the connection between quantum mechanics and spectroscopy

2.4. To make precise, accurate measurements in the laboratory and use standards to validate data (CHE 212, 213, 231, 309, 342, 442)	CHE 231 – Wang • How to calibrate common analytical instrument and collect and analyze data to determine results quantitatively. CHE 231 – Wimpfheimer • After completion of the course the student will be able to extract qualitative and quantitative information from graphs and data tables CHE 309 – Warner • Explore biochemical principles in the laboratory setting. • Perform common laboratory techniques associated with biochemistry. CHE 341 – Wimpfheimer • (to) train students to critically analyze data CHE 342 – Comeford • Apply the laws of thermodynamics to physical and chemical systems. • Use calorimetry to find the heat of combustion for a compound and compare your results to known values. • Use osmometry to find the equilibrium constant for the formation of a complex • Use chemical kinetics to probe the information that can be gained from the rate of chemical reaction. • Find the rate constant and activation energy of a reaction. CHE 422 – MacTaylor • This course aims to teach the skills involved in chemical analysis and incorporates mathematical tools to help students gage and improve their precision and accuracy. By the end of this course all students should feel more comfortable and confident with their laboratory work and have an understanding of how analytical instrumentation is used.

2.5. To calculate results using data collected in the laboratory, discuss the limitations of that data and present it in a formal written report (CHE 309, 341, 342, 321, 422).	CHE 231 – Wimpfheimer • After completion of the course the student will be able to effectively convey laboratory results by: a short report, a well written laboratory report, and a poster presentation • write a short essay on various scientific topics CHE 321 – Shih • Use the concepts presented in lecture to make calculations, make predictions and interpret data • Familiarize with titration technique. • Create standard concentration graph to determine unknown concentrations. • Understand conversions for pressure, volume, temperature and moles. CHE 341 – Wimpfheimer • After completion of the course the student will be able to effectively convey laboratory results by a well written laboratory report. CHE 342 – Comeford • Calculate physical quantities using laboratory data and discuss the limitations of that data • Interpret ambiguous or unexpected experimental results • Present your results in a formal laboratory report CHE 422 – MacTaylor • Students will also learn to express scientific data, methods, and conclusions through oral and written formal reports.
2.6. To develop independence in the laboratory in planning and performing experiments (all).	CHE 341 – Wimpfheimer • (to) help students develop important laboratory skills, including experimental design

3. Problem Solving	
3.1. To derive chemical equations, choose the appropriate equation for a given set of conditions and make meaningful calculations (CHE 212, 213, 309, 341, 342, 321, 422).	CHE 342 - Comeford • Understand the way that we use models in physical chemistry and the limitations of those models. • Derive equations in thermodynamics and chemical kinetics. • Choose the appropriate equation for a given set of conditions. • Account for the differences between theoretical predictions and experimental results.
3.2. To evaluate and analyze trends in data, to calculate quantities of interest, and draw conclusions based on theoretical models and experience (CHE 309, 321, 341, 342, 422).	CHE 231 – Wang • Examine, correlate and interpret experimental data, do quantitative analysis, develop problem-solving and critical thinking skill. CHE 321 – Shih • Use the concepts presented in lecture to make calculations, make predictions and interpret data. CHE 341 – Wimpfheimer • (to) train students to critically analyze data CHE 342 – Comeford • Calculate physical quantities using laboratory data and discuss the limitations of that data • Understand the way that we use models in physical chemistry and the limitations of those models. • Interpret ambiguous or unexpected experimental results CHE 422 – MacTaylor • In this course you will gain knowledge of a variety of analytical techniques (Spectrometry) and when to use them. You will learn how to collect, interpret, present data, and graph results of laboratory work

3.3. To demonstrate critical thinking by the application of previously acquired knowledge to new chemical problems (all).	CHE 231 - Wang • Develop the ability to apply the facts, concepts and models learned to real world chemistry problem solving. The new situations also include biological science, geological science, engineering and medicine. • Examine, correlate and interpret experimental data, do quantitative analysis, develop problem-solving and critical thinking skill. CHE 342 – Comeford • Suggest appropriate experiments to answer a given problem. CHE 422 – MacTaylor • This course will improve critical thinking skills by having students form broad conclusions based on analyzing quantitative problems. CHE 442 – Comeford • Identify and evaluate the information given by different experimental techniques. • Evaluate conflicting data.
4. Applications and Historical Perspectives	
4.1. To work in a courteous, professional manner with fellow students and faculty in a diverse environment (all).	
4.2. To serve the community through outreach events (CHE 321, 422).	

4.3. To apply chemical principles to practical problems and societal issues (CHE 321, 422, 560).	CHE 212 – Rowland • You should be able to demonstrate the ability to draw and recognize the structures and properties of hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, carboxcylic acids, esters, amines, and amides. You should also be able to describe the importance of the compounds listed above and what they are used for. CHE 213 – Rowland • You should be able to explain the importance of organic compounds and how they apply to everyday life CHE 231 - Wang • Develop the ability to apply the facts, concepts and models learned to real world chemistry problem solving. The new situations also include biological science, geological science, engineering and medicine.
4.4. To understand how new theories are developed accordance with the scientific method (CHE 321, 422, 342).	CHE 342 – Comeford • Reflect on the historical development of thermodynamics as an example of the way scientific models and theories are formed.

Content	
5. Atomic and Molecular Structure and Bonding:	
5.1. To derive and explain the quantum mechanical basis for the structure of atoms and molecules (CHE 130, 212, 213, 341).	• CHE 130 - Comeford • Predict the reactivity and physical properties of the elements using the periodic table. • Write the electron configuration for atoms and monatomic ions. CHE 130 – Warner • Understand atomic structure • Introduction to periodic table CHE 231 – Wang • Master the more advanced concepts and theories of modern chemistry which include molecular modeling, solution properties, equilibrium, kinetics, acids and bases and thermodynamics. CHE 341 – Wimpfheimer • After completion of the course the student will be able to show that a wavefunction is a solution to Schrodinger's equation. • After completion of the course the student apply the particle in a box, harmonic oscillator, and rigid rotor models to understand atomic and molecular spectroscopy. • (to) train students to use computer modeling software CHE 441 – Wang • The objectives of offering this course are to promote the unification of descriptive inorganic chemistry with the concepts of structure, bonding and reaction mechanisms. The course shall provide a firm foundation in inorganic chemistry theories and lead the students to the exciting insight of not only traditional inorganic chemistry but the new and rapidly advancing fields of study such as bioinorganic compounds, nanotechnology, superconductors.

5.2. To use Lewis theory, valence bond theory, molecular orbital theory to predict molecular geometry, bond order, bond strength and related quantities (CHE 130, 212, 213, 308, 309, 340, 341, 441, 442).	CHE 130 - Comeford • Identify and name ionic and molecular compounds. • Write the Lewis structures for molecular compounds and polyatomic ions, and predict their bond order. • Predict the geometry of molecular compounds and polyatomic ions. CHE 212 – Rowland • By the end of the course you should be able to recognize and draw organic structures and functional groups. • You should also be able to name organic compounds and determine the properties of organic compounds. • You should be able to demonstrate the ability to draw and recognize the structures and properties of hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, carboxcylic acids, esters, amines, and amides. CHE 213 – Rowland • By the end of the course you should be able to draw organic structures and functional groups, name organic compounds, and be familiar with the properties of organic compounds. CHE 309 – Warner • Understand the general structure of amino acids, amino acid derivatives and proteins. CHE 341 – Wimpfheimer • After completion of the course the student will be able to create, minimize the energy, and visualize molecules using PC Spartan software CHE 441 – Wang • The objectives of offering this course are to promote the unification of descriptive inorganic chemistry with the concepts of structure, bonding and reaction mechanisms. The course shall provide a firm foundation in inorganic chemistry theories and lead the students to the exciting insight of not only traditional inorganic chemistry but the new and rapidly advancing fields of study such as bioinorganic compounds, nanotechnology, superconductors.

	CHE 442 - Comeford • Draw Lewis structures for organic molecules including nonbonding pairs and formal charges. • Write organic reaction mechanisms clearly showing the movement of electrons. • Perform and interpret simple molecular modeling calculations using Hückel and Spartan. • Apply molecular orbital theory to problems in photochemistry and pericyclic reactions.
5.3. To explain the principles and limitations of spectroscopic methods (UV/Vis, IR, NMR, AA) and interpret spectra collected in the laboratory (CHE 212, 213, 309, 340, 341, 422).	CHE 212 – Rowland • You should understand the importance spectroscopy, determine the structure of organic compounds from IR spectra. CHE 213 – Rowland • You should also understand the importance of spectroscopy and determine the structure of organic compounds from spectral data. From NMR, IR, and MS data you should be able to demonstrate the ability to determine the structures of molecules given only a molecular formula. CHE 213 – Warner • Understand spectroscopic techniques associated with organic chemistry CHE 309 – Warner • Understand chromatographic and spectroscopic techniques associated with biochemistry. CHE 342 – Wimpfhiemer • (To) have students understand the connection between quantum mechanics and spectroscopy CHE 422 – MacTaylor • In this course you will gain knowledge of a variety of analytical techniques (Spectrometry) and when to use them. You will learn how to collect, interpret, present data, and graph results of laboratory work

6. Intermolecular Interactions	
6.1. To interpret phase diagrams and make predictions using phase diagrams (CHE 212, 231, 342).	CHE 130 – Warner • Understand differences between gases, liquids and solids • Use gas laws CHE 231 – Wang • Master the more advanced concepts and theories of modern chemistry which include molecular modeling, solution properties, equilibrium, kinetics, acids and bases and thermodynamics. CHE 342 - Comeford • Use the concept of equilibrium to make qualitative predictions and apply quantitative equations for chemical reactions, one-component phase diagrams, and two component mixtures.
6.2. To identify the intermolecular forces in a system (London, dipole/dipole, ionic, hydrogen bonding) (CHE 130, 212, 213, 231, 309, 342, 442).	CHE 231 – Wang • Master the more advanced concepts and theories of modern chemistry which include molecular modeling, solution properties, equilibrium, kinetics, acids and bases and thermodynamics.

6.3. To explain the role of intermolecular forces in solubility, chromatography, and the structure of biological molecules (CHE 130, 212, 213, 309, 342, 422).	CHE 212 – Rowland • You should also be able to name organic compounds and determine the properties of organic compounds. • You should be able to demonstrate the ability to draw and recognize the structures and properties of hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, carboxcylic acids, esters, amines, and amides. CHE 213 - Rowland • By the end of the course you should be able to draw organic structures and functional groups, name organic compounds, and be familiar with the properties of organic compounds. CHE 309 – Warner • Understand the chemical properties of water as applied to biological species. • Explore the relationship between 3D structure of proteins and function. • Understand the biochemical properties of enzymes, carbohydrates, lipids and membranes. CHE 422 – MacTaylor • In this course you will gain knowledge of a variety of analytical techniques (Kinetic Plate Theory, Chromatography) and when to use them. You will learn how to collect, interpret, present data, and graph results of laboratory work

7. Chemical Reactivity	
7.1. To predict the products of chemical reactions: acid/base, redox, precipitation, addition, elimination (CHE 130, 212, 213, 231, 308, 309, 321, 340).	CHE 130 - Comeford • Identify precipitation and acid/base reactions. • Identify redox reactions. • Balance chemical reactions. • Predict the products of precipitation and acid/base reactions. CHE 130 - Warner • Write and balance chemical reactions • Understanding of basic types of chemical reactions CHE 212 – Wester • The student will learn the basic principles of organic chemistry CHE 212 – Rowland • You should be able to determine organic reaction products. You should also be able to write out chemical reactions with all of the different types of organic compounds and draw mechanisms for the reactions. CHE 213 – Rowland • You should be able to demonstrate the ability to draw reaction mechanisms and determine the products of reactions. CHE 213 – Warner • Understand reactions of general classes of organic compounds CHE 308 – Wang • Introduce students to the study of descriptive chemistry of elements so that a balanced curriculum between the coverage of chemical principles, theories and the descriptive part of selected important inorganic, biomolecules and medical compounds can be reached.

7.2. To propose reasonable syntheses for target compounds (CHE 212, 213, 340).	CHE 212 – Wester • The student will learn the basic principles of organic chemistry CHE 213 – Rowland • You should be able to demonstrate the ability to draw reaction mechanisms and determine the products of reactions. You should be able work backwards and develop syntheses of organic compounds.
7.3. To identify the role of nucleophiles and electrophiles in organic and biochemical reactions (CHE 212, 213, 309, 340).	CHE 212 – Wester • The student will learn the basic principles of organic chemistry CHE 213 – Warner • Understand reactions of general classes of organic compounds
7.4. To make □toichiometry calculations (all).	CHE 130 – Comeford • Calculate the molar mass for a compound. • Make the calculations necessary to prepare a solution from a solid or by dilution. • Make stoichiometric calculations for reactions including simple □toichiometry, limiting reactant, reactions in solution and titration. CHE 130 – Warner • Perform chemical calculations

8. Kinetics and Thermodynamics	
8.1. To explain the effect of catalysts and reaction conditions for organic, inorganic and biochemical reactions (CHE 231, 309, 342).	CHE 231 – Wang • Master the more advanced concepts and theories of modern chemistry which include molecular modeling, solution properties, equilibrium, kinetics, acids and bases and thermodynamics. CHE 309 – Warner • Understand the general function of coenzymes and vitamins.
8.2. To use experimental data to establish a rate law, derive the rate law predicted by a given mechanism and propose a reasonable reaction mechanism given an experimental rate law (CHE 212, 213, 321, 342, 442).	CHE 212 – Rowland • You should draw detailed mechanisms for the formation of products. You should also be able to write out chemical reactions with all of the different types of organic compounds and draw mechanisms for the reactions. CHE 213 – Rowland • You should be able to demonstrate the ability to draw reaction mechanisms and determine the products of reactions. CHE 231 – Wimpfheimer • After completion of the course the student will be able to determine kinetic orders of reaction by several methods CHE 231 – Wang • Master the more advanced concepts and theories of modern chemistry which include molecular modeling, solution properties, equilibrium, kinetics, acids and bases and thermodynamics. CHE 342 – Comeford • Use chemical kinetics to probe the information that can be gained from the rate of chemical reaction. • Use experimental data to determine the order of a reaction. • Calculate the rate constant, half life and activation energy for a given chemical reaction.

	• Use your knowledge to experimental methods to propose an experimental method to find the rate law for a reaction • Draw and label the reaction coordinate diagram for a given mechanism. • Derive the predicted rate law from a proposed mechanism. CHE 442 – Comeford • Propose and evaluate organic reaction mechanisms for various types of organic reactions. • Propose reasonable experiments to differentiate between possible mechanisms. • Propose reasonable mechanisms given experimental data.
8.3. To calculate and explain the enthalpy, entropy, free energy, heat and work for chemical and physical changes (CHE 130, 212, 213, 231, 342).	CHE 130 – Comeford • Calculate the heat given off or taken up by a chemical reaction CHE 130 - Warner • Understand basic thermodynamics CHE 231 – Wimpfheimer • After completion of the course the student will be able to analyze chemical equilibrium in a qualitative and quantitative manner • After completion of the course the student will be able to perform pH calculations, including buffer solutions and the use of the Henderson-Hasselbalch equation CHE 231 – Wang • Master the more advanced concepts and theories of modern chemistry which include molecular modeling, solution properties, equilibrium, kinetics, acids and bases and thermodynamics. CHE 342 - Comeford • Apply the laws of thermodynamics to physical and chemical systems. • Recall the definitions thermodynamic vocabulary words. • Make calculations using the first and second laws of thermodynamics and explain the significance of your answers. • Calculate thermo-chemical quantities and make predictions using those results.

8.4. To calculate the equilibrium constant for a reaction and predict the effect of changes in pressure, temperature and reaction or product concentration (CHE 212, 213, 309, 342).	CHE 231 – Wimpfheimer • After completion of the course the student will be able to analyze chemical equilibrium in a qualitative and quantitative manner CHE 342 – Comeford • Use the concept of equilibrium to make qualitative predictions and apply quantitative equations for chemical reactions, one-component phase diagrams, and two component mixtures