DESCRIPTION OF GRADUATE COURSES

Master-level Courses

CHEM 511 **Seminar**. (0.5 Hour) Prerequisite: Permission of instructor. Presentation and discussion of current chemical topics and research by visiting speakers, faculty and students. General topics by the instructor or invited guests will be given on scientific ethics, writing, presentation, and careers. Students are required to give presentations on current chemistry publication and prepare a manuscript style research report each semester.

CHEM 521 **Chemical Instrumentation**. (4 Hours) Prerequisite: Courses in Analytical Chemistry and Physical Chemistry. A lecture and laboratory course covering the theory and practice of optical and electrical instrumentation, spectrophotometry, potentiometry, polarography, gas phase chromatography are among the techniques included.

CHEM 523 **Advanced Analytical Chemistry**. (3 Hours) Prerequisites: Courses in Analytical Chemistry and Physical Chemistry. Principles and application of selected analytical methods including electrochemistry, spectroscopy and selected topics of unusual current interest.

CHEM 526 **Electroanalytical Chemistry**. (3 Hours) Prerequisite: Advanced Analytical Chemistry. Discussion of potentiometric, conductometric, polarographic, amperometric, coulometric, controlled potential and stepping analysis and related techniques. Emphasis is also placed on theoretical considerations and applications to studies of chemical and charge transfer equilibria and kinetics.

CHEM 531, 532 **Biochemistry**. (3 Hours) Prerequisite: One year of Organic Chemistry. The chemical composition of living matter and the chemical mechanics of life processes.

CHML 531, 532 **Biochemistry Laboratory**. (1 Hour) Prerequisite: Chemistry 531 and 532. Basic purification and characterization techniques in Biochemistry.

CHEM 536 **Physical Organic Chemistry**. (3 Hours) Prerequisites: Physical Chemistry and Organic Chemistry. A study of organic molecular structure, Woodward Hoffmann Rules, substituents effects, intra-and intermolecular forces, kinetics and stereochemistry.

CHEM 541 **Advanced Inorganic Chemistry**. (3 Hours) Prerequisite: An undergraduate course in Physical Chemistry. A study of inorganic compounds with the application of Physical Chemistry principles to thermodynamic, kinetic and structural problems.

CHML 542 **Advanced Inorganic Laboratory**. (2 Hours) Prerequisite: A course in Advanced Inorganic Chemistry. Theoretical principles and laboratory techniques involved in the preparation and characterization of inorganic compounds.

CHEM 553 **Thermodynamics**. (3 Hours) Prerequisite: Physical Chemistry. Principles of thermodynamics and their application to chemical and phase equilibria.

CHEM 558 **Quantum Chemistry**. (3 Hours) Prerequisite: Physical Chemistry. Principles and applications of quantum theory.

CHEM 580 **Thesis Research**. (Variable 1-6 Hours) Prerequisite: Permission of adviser. Selected topics arranged in consultation with the staff; includes literature, research, and laboratory investigation of a problem.

Doctoral-Level Courses

CHEM 711 Seminar (0.5 Hour) Prerequisite: Permission of instructor. Presentation and discussion of current chemical topics and research by visiting speakers, faculty and students. General topics by the instructor or invited guests will be given on scientific ethics, writing, presentation, and careers. Students are required to give presentations on current chemistry publication and prepare a manuscript style research report each semester.

CHEM 721 Advanced Instrumental Analysis (3 Hours). Prerequisite: Analytical Chemistry and Physical Chemistry (two semesters). Theoretical principles and laboratory techniques involved in characterization of chemical systems using instrumental methods on following topics: absorption and emission spectrometry, mass spectrometry, liquid and gas chromatography, and electrophoresis. A laboratory series on spectrophotometry, fluorometry, atomic absorption spectrometry, inductively coupled plasma atomic emission spectrometry, FT-IR, gas chromatography-mass spectroscopy, and high performance liquid chromatography is included.

CHEM 723 Advanced Analytical Chemistry (3 hours) Prerequisite: Analytical Chemistry and Physical Chemistry (two semesters). Theory of chemical equilibria relevant to acid-base, metal-ligand complexes, solubility of precipitates, and biochemical reactions; theory, instrumentation, and application of electroanalytical methods, absorption, emission, ICP-MS, and chromatographic methods; Current trend and recent developments in analytical and bioanalytical chemistry using recent publications; Assignments of advanced laboratory experiments in spectroscopic, electroanalytical, and chromatographic analyses.

CHEM 726 Electroanalytical Chemistry (4 hours) Prerequisite: Advanced Analytical Chemistry. Principles and application of all modern electrochemical methods such as voltammetrics, chronoamperometry, spectroelectrochemistry, and thin layer electrochemistry etc. Electrode kinetics and mass transfer are discussed in detail.

CHEM 729 Spectroscopic Methods for Structural Determination (3 hours). Prerequisite: Analytical Chemistry (CHEM320) and Organic Chemistry (CHEM242). Using of modern spectroscopic methods, mainly Nuclear Magnetic Resonance, Mass Spectrometry, X-Ray Crystallography, and Infrared Spectroscopy for elucidation of simple to complex

structures of chemical compounds. Topics on new developments in modern NMR, X-Ray, MS, and IR will be updated and included.

CHEM 731 Advanced Biochemistry I (3 hours) Prerequisite: Biochemistry 431. Introductory topics on proteins, enzymology, bioenergetics, chemistry and intermediary metabolism of carbohydrates, lipids, proteins and nucleic acids; Advanced topics on storage, transmission, and expression of genetic information, molecular immunology, membrane transport and hormone action.

CHEM 732 Experimental Biochemistry (3 hour) Pre-requisite: Biochemistry 431. Advanced techniques will be covered for the analysis of cellular function including cell culture and related microscopic techniques, cytotoxicity and cytostatic assays, characterization of kinase activity using immunostaining and electrophoretic methods. This course is consisting of 1 hour lectures and 3 hours of laboratory work.

CHEM 733 Advanced Molecular Biology (3 hours) Molecular mechanisms of DNA replication, damage and repair, recombination, and restriction-modification. Gene expression, transcription and RNA processing. Recombinant DNA technology, plasmids and transposons.

CHEM 734 Physical Biochemistry (3 hours) Characterization of macromolecules, hydrodynamic methods, multiple equilibria, maromolecule-ligand interactions.

CHEM 736 Physical Organic Chemistry (3 hours) Prerequisite: Organic Chemistry (two semesters). A study of organic molecular structure, reactive intermediates, molecular recognition, substituent effects, intra- and intermolecular forces, kinetics, catalysis, stereochemistry, and photochemistry.

CHEM 738 Organic Synthesis (3 hours) Prerequisite: Organic Chemistry (two semesters). The course covers the formation of carbon-carbon and carbon-heteroatom bonds, functionalization and interconversion of functional groups, reactions of organic reagents, protective groups, total synthesis and asymmetric synthesis in organic synthesis.

CHEM 741 Advanced Inorganic Chemistry (3 hours) Prerequisite: Inorganic Chemistry (CHEM 340). A study of symmetry and group theory, bonding and structures of inorganic compounds, coordination chemistry, and acid-base chemistry.

CHEM 743 Structural Inorganic Chemistry (3 hours). A study included concepts of the solid state as explored by crystallography. It covers symmetry, polyhedral, sphere packing, tetrahedral and octahedral structures of inorganic compounds.

CHEM 747 Inorganic Reaction Mechanisms (3 hours) Prerequisite: Consent by Instructor. The topics include mechanism of reactions of inorganic compounds, stereochemical changes in complexes, redox reactions, homogeneous and heterogeneous catalysts.

CHEM 749 Organometallic Chemistry (3 hours) Prerequisite: Physical Organic Chemistry (CHEM 736) or equivalent. A study of formation, stability and reactivity of metal-carbon bond of main group and transition metals and the usage of organometallics in organic synthesis and catalysis.

CHEM 750 Chemistry Teaching Practicum (1 hour) This course is designed to provide Graduate Teaching Assistants (TAs) with information which can be used to enhance and improve their teaching effectiveness and to learn about teaching approaches that are effective at the college level and to practice and discuss aspects of their teaching assignments.

CHEM 752 Atomic and Molecular Spectroscopy (3 hours) Prerequisite: Physical Chemistry (two semesters). A comprehensive course covering concepts and methods of modern atomic and molecular spectroscopy. Subjects covered include electric phenomena, absorption and emission of radiation, atomic spectroscopy, rotational spectroscopy, vibrational spectroscopy, electronic spectroscopy, and magnetic resonance spectroscopy.

CHEM 753 Thermodynamics (3 hours) Prerequisite: Physical Chemistry (two semesters). Laws of thermodynamics and their chemical applications. Introduction to chemical kinetics and statistical mechanics.

CHEM 754 Kinetics (3 hours) Prerequisite: Physical Chemistry (two semesters). Mechanics of chemical reactions, cross sections, and rate constants. Elastic, inelastic, and rearrangement channels are discussed, using quantum and semiclassical techniques.

CHEM 755 Mechanisms of Organic Chemistry (3 hours) Prerequisite: Organic Chemistry (two semesters). A study of mechanistic aspects of organic reactions included the rate theory, and reaction mechanism, experimental methods and treatment of data.

CHEM 758 Quantum Chemistry (3 hours) Prerequisite: Physical Chemistry (two semesters). Important concepts of quantum chemistry at the intermediate level, including angular momentum, perturbation theory, electronic structure of molecules, and radiation matter interaction. Applications will vary from year to year.

CHEM 763 Statistical Mechanics (3 hours) Prerequisite: Physical Chemistry (two semesters) A study of statistical mechanical ensembles, partition functions and their relationship to thermodynamics, lattice statistics, molecular distribution and correlation functions, the theories of liquids and solutions, phase transitions, and cluster theory.

CHEM 768 Molecular Quantum Mechanics (3 hours) Prerequisite: Quantum Chemistry (CHEM 758) or equivalent. Theoretical, algorithmic, and practical aspects of the methods of molecular quantum mechanics and their applications to chemical systems. Topics covered include Hartree-Fock theory, perturbation theory, configuration interaction, coupled-cluster theory, and density-functional theory.

CHEM 780 Dissertation - (1 - 9 hours). This course involves original research in one of the sub-disciplines of Chemistry of the faculty. Enrollment in the course must be continuous until the student produces, presents, and defends a written Dissertation of the

approved quality. The research topic will be selected by the graduate advisor and approved by the Graduate Advisory Committee.

CHEM 782 Special Topics in Analytical Chemistry - (3 hours) Selected topics not covered in regularly scheduled courses, and current research topics in analytical chemistry.

CHEM 783 Special Topics in Biochemistry - (3 hours) Selected topics not covered in regularly scheduled courses, and current research topics in biochemistry.

CHEM 784 Special Topics in Organic Chemistry - (3 hours) A course in a specific area of organic chemistry not covered in regularly scheduled courses presented to fit the interests of advanced students.

CHEM 785 Special Topics in Inorganic Chemistry - (3 hours) Topics include subjects of current research in inorganic chemistry, but not covered in regularly scheduled courses.

CHEM 786 Special Topics in Physical Chemistry - (3 hours) Topics vary from year to year will include subjects such as photochemistry, solid state, surface chemistry, and radiation chemistry.

CHEM 787 Nanoscience and Nanotechnology (3 hours) Prerequisites: Physical Chemistry (CHEM 342) and Organic Chemistry (CHEM 242). A comprehensive course provides an introduction to the rapidly developing field of Nanoscience and Nanotechnology with special emphasis on general and material chemistry, environmental science, biotechnology and modeling**.** The topics include properties of individual nanoparticles, bulk nanostructures, carbon nanotubes, quantum wells, wires and dots; the tools and methods for measuring these properties; methods for growing and synthesizing nanomaterials; applications in biological materials and the fabrication of nanomachines and devices.