CHEMISTRY (CHEM)

CHEM 500: Seminar in Chemistry

1 Credits/Maximum of 99

No description. CHEM 500CHEM 500 Seminar in Chemistry (1)CHEM 500 is a course in which 1st and 2nd year Chemistry graduate students write about and present a seminar on current chemical research. During their first year of graduate study students are asked to write 6 or more brief reports summarizing and critiquing designated seminars in one of the department's five regular seminar series. These reports are graded for both their scientific content and writing quality. During their second year of graduate study students are asked to write a more lengthy report and give an oral presentation on a topic of current interest in chemistry, but one not closely related to research being done at Penn State. The written and oral portions of this exercise are also graded.Faculty: Andrew Ewing and Mark Maroncelli

CHEM 504: Numerical Methods for Chemists and Engineers

3 Credits

CHEM 504 is a 3-credit course designed to give graduate students an overview of basic numerical techniques. After completion of the course, the students will be able to perform simple computational tasks. The emphasis will be given to numerical solutions of ordinary and partial differential equations relevant to the chemical and biomedical research, such as reaction kinetics and transport phenomena. This 500-level course will contribute to the student¿s ability to expand the frontiers of knowledge, to perform independent research, work as a team, and make conference-style presentations.

Recommended Preparations: Working knowledge of calculus and familiarity with Matlab.
Cross-listed with: BME 504

CHEM 511: Chemical Nanoscience

3 Credits

Chemical aspects of matter at the nanoscale. CHEM 511 Chemical Nanoscience (3) This course covers chemical aspects of nanoscience. Topics to be covered include how nanoscale matter differs from bulk material; strategies for synthesis, characterization, purification, and chemical functionalization of nanostructures; forces involved in nanoparticle stabilization and assembly. Emphasis will be placed on wet chemical methods of nanostructure syntheses rather than traditional top-down nanofabrication. Properties of the resulting nanomaterials of interest for uses including biology and medicine, environmental remediation, electronics, optics, catalysis and solar energy conversion will be discussed. The course will emphasize both the primary scientific literature and review articles, and assumes prior knowledge of organic and physical chemistry.

Prerequisite: CHEM 452 and either CHEM 450 or CHEM 466

CHEM 516: Inorganic Chemistry

3 Credits

Overview of systematic inorganic chemistry including main group, transition metal, lanthanide, and actinide chemistry. CHEM 516 Inorganic Chemistry (3) The purpose of this course is to provide a graduate level foundation in the field of inorganic chemistry and its relationship to other areas of science and technology. The emphasis will be on atomic and molecular structure, synthesis methods, and structure-property relationships in a way that will prepare students for studies in more specialized areas such as environmental chemistry, catalysis, materials science, and the biological fields. Opportunities will be provided to integrate the learning experience with the organization of information through writing assignments and class discussions.

CHEM 517: Organometallic Chemistry

3 Credits

Organometallic compounds and their use in catalysis and organic synthesis. CHEM 517 Organometallic Chemistry (3) CHEM 517 provides a graduate-level foundation to a broad range of topics in organotransition metal chemistry with a particular emphasis oncatalytic applications in polymer chemistry and organic synthesis. The course assumes a B.S. level understanding of inorganic and organic chemistry. Topics to be covered include the following: basic principles of bonding and structure, elementary reaction mechanisms, and catalytic applications including olefin insertion reactions, cycloisomerization reactions, carbenoid chemistry including olefin metathesis, carbonylations, reactivity of metal allyl complexes, cross coupling and related C&C bond formations, oxidations, reductions and alkylations. Upon successful completion of this course, students can expect to: 1) understand basic concepts in bonding and molecular structure of organometallic compounds, 2) be able to connect electronic and molecularstructure with chemical reactivity, 3) describe organometallic reactivity in a mechanistically rigorous fashion, 4) be familiar with common catalytic paradigms that rely on organometallic catalysts, 5) be equipped to critically evaluate the modern primary literature in this field.

CHEM 518: Symmetry and Spectroscopy in Inorganic Chemistry

3 Credits/Maximum of 99

Group theoretical methods and spectroscopies of importance in modern inorganic chemistry. CHEM 518 Symmetry and Spectroscopy in Inorganic Chemistry (3 per semester) CHEM 518 provides a graduate-level foundation in molecular group theory and its use in understanding the molecular orbital structure of organic and inorganic molecules. EPR, NMR, rotational, vibrational, and electronic spectra of molecules are considered with an eye towards using symmetry to simplify analysis. Other spectroscopies of interest to the modern inorganic chemist, such as XPS, PES, and x-ray crystallography are also discussed.

Prerequisite: CHEM 452

CHEM 519: Materials Chemistry

3 Credits

The goal of this course is to provide students with an understanding of the ways in which fundamental chemical principles are utilized in the field of materials science. The approach is to illustrate the crucial importance of synthesis and structure-property chemical relationships in the development of new materials and their utilization in devices. Topics include glasses, oxides and non-ceramics, polymers, metals, semiconductors, superconductors, hybrid materials, and nanomaterials together with the broad range of energy-related, electronic, biomedical, and optical devices on which modern civilization depends. Most of the different types of materials will be discussed, together with approaches to overcome their limitations.

CHEM 520: Polymer Science and Engineering

3 Credits

This course provides fundamental understanding of basic principles in polymer science and connects these to current research topics at Penn State as well as novel findings in soft material science at other institutions. Interdisciplinary in content, the curriculum spans from polymer synthesis (chemistry), to physical properties (physics), to characterization, to engineering (chemical engineering), to application of polymer materials (materials science). Two areas of focus will lie on (i) the environmental impact of commodity plastics and (ii) conductive polymers and their every-day use in display technology and energy harvesting. While polymers are versatile and broadly applicable, there lie significant dangers in their use for us as a society. For example, while the drive for flexible displays and solar cells is increasing, there is no clear pathway for efficient recycling of the resulting electronic polymeric materials. To this end, this course will engage students in discussions about industrial processing of polymers and the importance to find new pathways for their recycling.

Cross-listed with: CHE 520, MATSE 520

CHEM 524: Electroanalytical Chemistry

3 Credits

Electrochemical principles, techniques, and analytical applications. CHEM 524 Electroanalytical Chemistry (3) CHEM 524 covers the fundamental background and applications of electroanalytical methods. Potentiometric methods are discussed in the context of the basic principles of electrochemical equilibrium. Amperometric methods - chronoamperometry, chronocoulometry, stripping voltammetry, cyclic voltammetry, pulse and hydrodynamic techniques - are also discussed in the context of mathematical models for mass transport and electrode kinetics. Applications including spectroelectrochemistry, photoelectrochemistry, ultramicroelectrodes, corrosion, and scanning electrochemical microscopy are covered. The course involves solving differential equations relevant to electrochemical problems by analytical methods as well as by means of digital simulations, so prior knowledge of a programming language is recommended.

CHEM 525: Analytical Separations

3 Credits

Fundamentals and applications of modern chromatographic separations.

Cross-listed with: BMMB 525

CHEM 526: Spectroscopic Analysis

3 Credits

An overview of modern instrumental techniques including FTIR, optical spectroscopy, mass spectrometry, and electron spectroscopies.

CHEM 535: Physical Organic Chemistry

3 Credits

Reactive intermediates, reaction kinetics and thermodynamics, solvent effects, conformational analysis, reaction mechanisms, noncovalent interactions in synthesis, and stereochemistry.

Prerequisite: CHEM 212

CHEM 536: Medicinal Chemistry and Chemical Biology

3 Credits

The goal of this course is to provide a foundation in development and application of chemical technologies to the understanding and manipulation of biological systems. Chemical biology is a relatively new field that spans the traditional fields of chemistry and biology by applying chemical technologies to the understanding and manipulation of biological systems. As such, this course should be accessible and provide benefit to students working in both chemical and biological areas. Lectures include higher-level biological chemistry (assuming prior knowledge of biological chemistry at an undergraduate level, such as CHEM 476 or BMB 401) and synthetic chemistry and biology principles along with current literature in the field of chemical biology.

Prerequisite: CHEM 476 or B M B401
Cross-listed with: BMMB 536

CHEM 537: Organic Synthesis

3 Credits

Organic synthesis including both classical and modern synthetic methodology as well as applications to construction of complex molecules.

Prerequisite: CHEM 535

CHEM 538: Spectroscopic Methods in Bioinorganic Chemistry

3 Credits

Foundations in spectroscopic methods employed for the determination of the geometric and electronic structure of transition metal clusters in nature.

Cross-listed with: BMMB 538

CHEM 539: Biochemical Reaction Mechanisms

3 Credits

Mechanisms of the most important biochemical reactions, with emphasis on enzyme catalysis.

Prerequisite: CHEM 476 or B M B401
Cross-listed with: BMMB 539

CHEM 540: Biophysical Chemistry

3 Credits

This three-credit course will cover the key theories and experimental methods of contemporary biophysics and biophysical chemistry. The course discusses the structures and dynamics of biomolecules (such as proteins, DNAs, and RNAs), the statistical mechanical models to describe the behaviors of biopolymers and the biophysical methods to analyze the structures of biopolymers in solution, the biophysical theories for protein folding/unfolding and the experimental methods to measure the kinetics of protein folding/unfolding and the protein structural dynamics, the principles of biomolecule structure determination by X-ray crystallography and cryogenic electron microscopy, and fluorescence microscopes, as well as the theories to describe ligand binding to biological macromolecules (such as receptors, protein complexes, aptamers, etc.) and the experimental methods to measure ligand binding. For all the topics covered by this course, emphasis will be laid on both theoretical models and experimental methods will be discussed. Classic and modern biophysical and biochemical techniques ranging from spectroscopy and FRET to optical microscopy, including super-resolution and micromanipulation techniques, will be covered. Applications of these biophysical techniques will also be discussed.

Prerequisite: CHEM 450
Cross-listed with: BME 540

CHEM 543: Polymer Chemistry

3 Credits

This graduate course discusses the new advances in polymer chemistry that leads to new polymeric materials with interesting structures and properties. CHEM (MATSE) 543CHEM (MATSE) 543 Polymer Chemistry (3) This course provides advance level of polymer chemistry and materials taught in MATSE 441 - Polymeric Materials. Students are able to know the versatility that is inherent in polymer chemistry and the new research results and activities, especially controlling polymerization, polymer structures, designing polymers with desirable properties, etc. Students shall also understand the major economic and environmental concerns and solutions in producing commercial-scale polymers.This polymer chemistry course provides important links between chemistry and polymeric materials. The course will focus on recent advances in polymer chemistry that affords new polymer materials with controlled polymer structures, compositions, and properties, as well as economic and "green" processes.This course is designed for graduate students having basic knowledge in organic, inorganic, and organometallic principles. For Chemistry major, this course offers students with the knowledge to apply chemical principles and methods to design and prepare the desirable polymers (no prerequisite for Chemistry graduate students). For Material Science and other majors, this course provides advance level of polymer chemistry and materials taught in MATSE 441 (a prerequisite course).In addition, each student will be required to review (presentation and term-paper) a contemporary subject relative to polymer chemistry, which will help student self-education, and presentation and writing skills. Students will be evaluated by quizzes and examinations, a term-paper and presentation, and class participation.

Prerequisite: MATSE441 or approval of program
Cross-listed with: MATSE 543

CHEM 545: Statistical Thermodynamics

3 Credits

Basic principles of statistical mechanics with application to the calculation of thermodynamic properties of gases and condensed phases.

Prerequisite: CHEM 450 , CHEM 452

CHEM 565: Quantum Chemistry I

3 Credits

A foundation in the principles of quantum mechanics and their applications to chemistry.

Prerequisite: CHEM 452

CHEM 566: Quantum Chemistry II

3 Credits

Additional techniques in quantum mechanics, with applications to problems in molecular structure and light-matter interactions.

Prerequisite: CHEM 565

CHEM 567: Molecular Spectroscopy

3 Credits

Principles and applications of classical and modern spectroscopic methods.

Prerequisite: CHEM 565

CHEM 572: Nucleic Acids Chemistry

3 Credits

Biophysical and biochemical approaches for studying structure-function relationships in nucleic acids. BMMB (CHEM) 572 Nucleic Acids Chemistry (3) The goal of this course is to provide a foundation in biophysical approaches for studying the quantitative and structure-function relationships in nucleic acids systems, including DNA, RNA, and their interactions with proteins, salt, and water. Lectures include basic physical chemistry and statistical mechanics principles along with current literature in the biochemical sciences. At the end of the course, you should be able to meaningfully dissect molecular biological papers at the level of the physical chemistry of these processes. Current topics are introduced through reading and presenting papers from the literature.

Prerequisite: CHEM 212 , CHEM 450
Cross-listed with: BMMB 572

CHEM 573: NMR Spectroscopy for Synthetic and Biological Chemistry

3 Credits

Nuclear magnetic resonance approaches for characterizing the structure and dynamics of synthetic compounds, natural products, and biological macromolecules.

Prerequisite: CHEM 452
Cross-listed with: BMMB 573

CHEM 574: Metals in Biology: Structure and Mechanism

3 Credits

The goal of this course is to acquaint students with the many important roles that metal ions play in biological systems (bioinorganic chemistry). We will explore how structural biology, enzymology, spectroscopy, cell biology, and chemical biology methods have been used to understand how metal ions are used in biological molecules. These approaches have enabled discovery of the chemistry of these systems, and an understanding of how that chemistry fits into the broader biological context. We will apply bioinorganic chemistry in solving important challenges in energy, health, and the environment. Course activities include application of basic inorganic chemistry and biochemical principles, discussion of current literature in the biochemical sciences, implementation of biomolecular structure visualization software, and problem solving. At the end of the course, students will be able to critically engage with the bioinorganic literature and propose experimental approaches to unresolved questions in the field.

Prerequisite: CHEM 476 or BMB 401 Recommended Preparations: CHEM 412
Cross-listed with: BMMB 574

CHEM 589: Studies in Chemistry

1-9 Credits/Maximum of 9

Theoretical research, experimental research, or a critical survey of the literature in an area of chemistry.

CHEM 597: Special Topics

1-9 Credits/Maximum of 9

Formal courses given on a topical or special interest subject which may be offered infrequently.

CHEM 600: Thesis Research

1-15 Credits/Maximum of 999

No description.

CHEM 601: Ph.D. Dissertation Full-Time

0 Credits/Maximum of 999

No description.

CHEM 602: Supervised Experience in College Teaching

1-3 Credits/Maximum of 6

Teaching of chemistry undergraduate laboratory and recitation classes with senior faculty instruction supervision.

CHEM 610: Thesis Research Off Campus

1-15 Credits/Maximum of 999

No description.

CHEM 611: Ph.D. Dissertation Part-Time

0 Credits/Maximum of 999

No description.

CHEM 810: Liquid Chromatography I

1 Credits

The course specifically caters to the needs of the analytical chemical industry and individuals newly hired into entry-level sample management/preparation and quality assurance/quality control positions within companies using liquid chromatographic techniques. The course material is designed to increase student understanding of both the liquid chromatography instrument used in the laboratory and the principles underlying the measurements.

CHEM 811: Liquid Chromatography II

1 Credits

The course specifically caters to the needs of the analytical chemical industry and individuals hired into, or transitioning into, technician level positions within companies using liquid chromatographic techniques. The course material is designed to increase student understanding of both the liquid chromatography instrument used in the laboratory and the principles underlying the measurements.

Prerequisite: CHEM 810

CHEM 812: Liquid Chromatography III

1 Credits

The course specifically caters to the needs of the analytical chemical industry and individuals hired into, or transitioning into, development-level, or senior-level, chemist positions within companies using liquid chromatographic techniques. The course material is designed to increase student understanding of both the liquid chromatography instrument used in the laboratory and the principles underlying the measurements.

Prerequisite: CHEM 811