CHEMISTRY (CHEM)

CHEM 100
Introduction to the Profession
Introduction to the chemical sciences, scientific method, computing tools, and interrelations of chemical sciences with biology, physics and other professions.
Lecture: 2 **Lab:** 0 **Credits:** 2
Satisfies: Communications (C)

CHEM 122
Principles of Chemistry I Without Laboratory
An introduction to the foundations of chemistry, including: atoms and molecules; stoichiometry of chemical reactions; thermochemistry; properties of gases; states of matter, chemical solutions; the molecular basis for chemical reactivity; atomic structure; periodicity; and chemical bonding.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 123
General Chemistry Laboratory
General chemistry laboratory. The laboratory portion of CHEM 124.
Lecture: 0 **Lab:** 3 **Credits:** 1

CHEM 124
Principles of Chemistry I with Laboratory
An introduction to the foundations of chemistry, including: atoms and molecules; stoichiometry of chemical reactions; thermochemistry; properties of gases; states of matter, chemical solutions; the molecular basis for chemical reactivity; atomic structure; periodicity; and chemical bonding.
Lecture: 3 **Lab:** 3 **Credits:** 4
Satisfies: Communications (C)

CHEM 125
Principles of Chemistry II with Laboratory
A continuing introduction to the foundations of chemistry, including: chemical equilibria; the chemistry of acids and bases; solubility and precipitation reactions; kinetics; thermodynamics; electrochemistry; nuclear chemistry; and the basics of organic chemistry.
Prerequisite(s): [(CHEM 124) OR (IIT Chemistry Placement: 125)]
Lecture: 3 **Lab:** 3 **Credits:** 4
Satisfies: Communications (C)

CHEM 126
Principles of Chemistry II Without Laboratory
Same as CHEM 125 except without the laboratory.
Prerequisite(s): [(CHEM 122) OR (CHEM 124)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 140
Principles of Chemistry II Lab
Laboratory portion of CHEM 125 (Principles of Chemistry II) covering Chemical Equilibria, the chemistry of acids and bases, solubility, and precipitation reactions. Introduction to thermodynamics and electrochemistry. Chemistry of selected elements and their compounds.
Prerequisite(s): [(CHEM 126)]
Lecture: 0 **Lab:** 3 **Credits:** 1

CHEM 235
Organic Chemistry I-Lecture
The constitution and properties of the different classes of organic compounds with considerable attention to stereochemistry and reaction mechanisms.
Prerequisite(s): [(CHEM 125) OR (CHEM 126)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 236
Organic Chemistry I-Lab
Introduction to the major synthetic and analytical techniques of organic chemistry including the preparation of representative organic compounds from natural sources.
Prerequisite(s): [(CHEM 125) OR (CHEM 126)]
Lecture: 0 **Lab:** 4 **Credits:** 1

CHEM 237
Organic Chemistry I
The constitution and properties of the selected classes of organic compounds with considerable attention to stereochemistry and reaction mechanisms. The laboratory work involves the preparation of simple organic compounds using basic synthetic techniques.
Prerequisite(s): [(CHEM 125) OR (CHEM 126)]
Lecture: 3 **Lab:** 4 **Credits:** 4
Satisfies: Communications (C)

CHEM 239
Organic Chemistry II
Sequel to Organic Chemistry I with more emphasis on structure and reactivity of several classes of organic compounds including introductory discussion on common spectroscopic techniques.
Prerequisite(s): [(CHEM 235 and CHEM 236) OR (CHEM 237)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 240
Organic Chemistry Laboratory
Basic techniques for advanced organic preparations. Interpretation of scientific results including percent yield, melting point, boiling point, IR, and NMR spectra.
Prerequisite(s): [(CHEM 239*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 1 **Lab:** 4 **Credits:** 2
Satisfies: Communications (C)

CHEM 247
Analytical Chemistry
This course introduces students to the theory and applications of quantitative analytical chemistry. Topics covered include: statistical data analysis; equilibrium constants expressions; acid-base reactions; volumetric analysis; and fundamentals of spectroscopy, electrochemistry, and of separations science. Laboratory experiments include learning about analytical process, calibration of glassware and equipment, wet chemical analysis, electrochemistry, spectroscopy, and chromatography.
Prerequisite(s): [(CHEM 125)]
Lecture: 3 **Lab:** 3 **Credits:** 3
Satisfies: Communications (C)

CHEM 321
Instrumental Analysis
This course introduces students to theory and application of modern instruments in chemical procedures. Standard spectroscopic methods including atomic spectrometry, molecular spectrometry, ultraviolet spectroscopy, molecular luminescence, Fourier transform infrared spectroscopy, and nuclear magnetic resonance spectroscopy. Separation techniques using high pressure liquid chromatography and gas chromatography. Other topics relevant to advanced chemical instrumentation.
Prerequisite(s): [(CHEM 247)]
Lecture: 2 **Lab:** 6 **Credits:** 4
Satisfies: Communications (C)

CHEM 343
Physical Chemistry I
Thermodynamic laws and relationships applied to chemical systems. Kinetic theory of gases. Equations of state for ideal and real gases. Calculation of state functions from arbitrary pathways using measurable partial derivatives. Chemical potential and the prediction of phase and reaction equilibria.
Prerequisite(s): [(CHEM 125)]AND[(MATH 251) OR (MATH 252)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 344
Physical Chemistry II
Introduction to quantum mechanics. Applying quantum mechanics to chemical systems. Atomic structure and spectra. Molecular structure and spectroscopy. Statistical mechanics. Chemical kinetics. The laboratory will include experiments dealing with thermochemistry, phase equilibria, chemical kinetics, spectra, molecular structure, and treatment of data.
Prerequisite(s): [(CHE 202) OR
(CHEM 247)]AND[(CHEM 343)]AND[(MATH 252)]AND[(PHYS 221)]
Lecture: 3 **Lab:** 4 **Credits:** 4
Satisfies: Communications (C)

CHEM 410
Science of Climate Change
This course will focus on the science underlying global warming/climate change. How can we continue to lead the good life while living in harmony with nature? Although obviously important, commercial/political aspects are not considered here. However, any serious debate about climate change issues eventually has to rest on the underlying scientific facts so we need to be informed. Ultimately the sun is our primary source of power. How do we responsibly access that power in the short, intermediate and long terms? Bio-fuels, carbon dioxide, polar ice caps, and solar power are some of the topics to be discussed. Class time will be divided between lectures and recitation. Permission of instructor required.
Prerequisite(s): [(CHEM 124) OR (PHYS 221)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 415
Inorganic Chemistry
In-depth introduction to the vast subfield of the discipline dealing with all of the elements in the periodic table. Presents balanced blend of facts and theories in modern inorganic chemistry. Emphasis is on bonding, electronic, magnetic, and structural features exhibited by inorganic and organometallic compounds and their reactivities. Modern concepts including symmetry and group theory and their relevance in solving chemical problems. Bioinorganic chemistry and high tech inorganic materials and solids are introduced.
Prerequisite(s): [(CHEM 239)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 416
Advanced Chemistry Laboratory
This advanced laboratory emphasizes chemical synthesis and characterization of inorganic and organometallic compounds. Air and moisture-sensitive techniques are introduced and employed. The synthesis and characterization of nanomaterials is also featured.
Prerequisite(s): [(CHEM 240 and CHEM 415*)]An asterisk (*) designates a course which may be taken concurrently.
Lecture: 1 **Lab:** 7 **Credits:** 3
Satisfies: Communications (C)

CHEM 434
Spectroscopic Methods in Identification and Analysis
Characterization and analysis by mass, vibrational, nuclear magnetic resonance, and electronic spectroscopy. Structure-spectra correlations applied to organic and inorganic compounds with examples drawn from diverse areas, e.g., pollutants, toxic materials, polymers, etc. The laboratory work includes characterization of prepared or separated organic compounds by chromatographic, chemical, and spectroscopic methods.
Prerequisite(s): [(CHEM 240 and CHEM 247)]
Lecture: 3 **Lab:** 4 **Credits:** 4

CHEM 450
Introduction to Research
Required for chemistry majors. Designed to give research experience in a faculty research laboratory.
Lecture: 0 **Lab:** 8 **Credits:** 3
Satisfies: Communications (C)

CHEM 451
Undergraduate Seminar
An overview of a variety of chemical information tools and major scientific databases for navigating primary scientific literature. There will be a focus on the written and oral presentation of scientific research and the critical evaluation of the same types of scientific communication. Professional development with discussions of behavior, ethics, and career paths.
Prerequisite(s): [(CHEM 125)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 454
Chemical Modeling and Simulation
Basics of quantum mechanics. Perturbation theory. Self-consistent field approximation. Pauli principle. Hartree-Fock method. Born-Oppenheimer and adiabatic approximations. Concept of orbital interactions (two- and three-atom problems). Perturbational molecular orbital (MO) theory. Intermolecular perturbations (constructing MO from fragment orbitals). Electronegativity perturbations. Geometry perturbations. Walsh diagrams. First and second order Jahn-Teller effects.
Prerequisite(s): [(CHEM 344, CS 105, and MATH 152)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 455
Advanced Organic Chemistry
This course provides knowledge on classical and modern organic chemistry at the advanced undergraduate and graduate level. Mechanism and theory of organic reactions, synthetic methodology, and total synthesis will be covered.
Prerequisite(s): [(CHEM 239)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 470
Introduction to Polymers
Introductory course covering fundamental aspects of polymers with major emphasis on synthesis, polymerization mechanisms, chain architecture, relationship between polymer structures and properties, measurement and control of molecular weights, thermal and mechanical properties, and polymer processing.
Prerequisite(s): [(CHEM 239)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 485
Chemistry Colloquium
Lectures by prominent scientists. This course exposes students to current and active research in chemistry both within and outside the IIT community. It helps prepare students for a career in research. It is complementary to the academic courses and provides examples of professional/scientific presentations. This course may not be used to satisfy the natural science general education requirement.
Prerequisite(s): [(CHEM 239)]
Lecture: 0 **Lab:** 0 **Credits:** 1

CHEM 487
Senior Thesis in Chemistry
Original work carried on by the student under the guidance of a staff member. A careful search of the literature is required before the study is begun, and continued reference to the chemical literature is expected as the work progresses. A written report is required.
Prerequisite(s): [(CHEM 450)]
Lecture: 0 **Lab:** 12 **Credits:** 4
Satisfies: Communications (C)

CHEM 497
Special Projects
For juniors and seniors.
Credit: Variable
Satisfies: Communications (C)

CHEM 500
Advanced Analytical Chemistry
An overview of analytical chemistry with discussions of complex ionic equilibria, electro analytical techniques including potentiometric, voltametric, coulometric and conductometric methods, ion chromatography, capillary electrophoresis and sensor technology.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 501
Capstone Project
This course will educate students in the area of quality process and quality manufacturing. Student will work with the instructor to plan and conduct research on a project that is relevant to the analytical chemistry program of study. The project must be approved by the Master of Chemistry in Analytical Program Director.
Lecture: 1 **Lab:** 3 **Credits:** 2

CHEM 503
Survey of Analytical Chemistry
This course covers modern aspects of chemical analysis. It is designed to give the student a solid conceptual ground to understand how a given analytical technique works including its limits and advantages. The emphasis is on solutions analysis and the course is roughly divided into: (i) Basic measurements and concepts; (ii) spectroscopy; and (iii) chromatography and mass spectrometry. Upon completion of this course, the student will be able to: describe the basic setup and operation of separation, mass spectrometric, and spectroscopic instrumentation; interpret spectra from various instruments as a means for qualitative and quantitative analysis; apply basic knowledge of separation technique, mass spectrometry, and spectroscopy for practical problem solving; relate the use of separation technique, mass spectrometry, and spectroscopy to his or her own research interests; and compile, present, and explain modern techniques for analytical research. Topics includes high-performance liquid chromatography, gas chromatography, atomic spectrometry, molecular spectrometry, UV/vis spectroscopy, molecular luminescence, infrared spectrometry, mass spectrometry, radio chemistry, raman spectroscopy, nuclear magnetic resonance spectroscopy, etc.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 505
Spectroscopic Methods I
Theories of spectroscopic transitions and their applications in structural elucidations and quantitative analysis. Topics include ultraviolet/visible, infrared, Raman and nuclear magnetic resonance spectroscopy and mass spectrometry.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 506
Sampling and Sample Preparation
Techniques and devices for sampling in diverse media will be treated, followed by a discussion of sample treatment prior to analysis including isolation, concentration, and fractionation of analytes and classes of analytes.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 508
Analytical Methods Development
A seminar course presenting analytical methods in complex matrices with emphasis on methods development and validation.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 509
Physical Methods of Characterization
A survey of physical methods of characterization including x-ray diffraction and fluorescence surface techniques including SEM, TEM, AES and ESCA, thermal methods and synchrotron radiation methods.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 510
Electronics and Interfacing
Elementary circuit analysis, operational amplifiers, digital electronics, signal processing and interfacing of instruments using modern computer software and hardware.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 512
Spectroscopic Methods II
A continuation of the study of optical methods covering atomic absorption spectroscopy, atomic and flame emission spectroscopy, chemiluminescence, fluorescence, phosphorescence, light scattering and refractometry.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 513
Statistics for Analytical Chemists
A survey providing sufficient statistical background for scientists. The topics covered include probability, statistics, sampling estimation, regression analysis, experimental design, data analysis and signal enhancement.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 515
Gas Chromatography -- Theory and Practice
This course will cover theory and concepts of gas chromatographic analysis and its practical application in solving analytical problems. Topics include basic theory of chromatographic separation, separation dynamics, instrumentation, column selection, quantitative techniques, and practical applications.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 516
Liquid Chromatography -- Theory and Practice
This course will cover the operating principles and applications of state-of-the-art LC/HPLC instrumentation and analysis. Topics include basic theory of liquid chromatography, instrumentation, optimization of LC separation, quantitative techniques, and the diverse range of analytical applications amenable to LC analysis.
Prerequisite(s): [(CHEM 515)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 518
Understanding the International Conference on Harmonization Guidelines
The International Conference on Harmonization (ICH) was revolutionized in the 1980's to provide a forum for the pharmaceutical industry to discuss regulatory requirements for registration of new chemical entity. These guidelines have been significantly influenced the content of FDA draft guidelines to develop the scientific information and manufacturing controls. Thus, proper understanding of these guidelines is essential in the drug development process. This course will be designed to focus exclusively on guidelines associated with the registration of small molecules. Completing this course, students will understand the expectations set forth in various FDA and ICH quality topics in order to implement these guidelines and/or engage the regulatory agencies in dialogue in order to provide justification of data or present clear scientific rationale.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 519
Good Manufacturing Practices
This course provides an introduction to current good manufacturing practices (GMP) regulations and their implementation to different areas of the manufacturing process such as laboratory records, equipment, personnel, facilities, etc. The course will help students to recognize the regulatory actions and financial risks for non-compliance.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 520
Advanced Inorganic Chemistry
Selective treatment of the chemistries of main group and transition elements with emphasis on coordination complexes, organometallic compounds and inorganic cages and clusters. Discussions of molecular symmetry, stereochemistry, bonding, electronic spectra, magnetic properties, reactions, kinetics and reaction mechanisms are included.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 521
Structural Inorganic and Materials Chemistry
This course covers structure and bonding and structure-property relationships in inorganic molecules and solids. Descriptions of crystal structures, spectroscopic and x-ray diffraction techniques for structure determination and properties of solids are included.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 522
Efficient Chemical and Materials Synthesis
The design and development of environmentally benign chemical pathways: challenges and opportunities. High-yield and zero-waste chemical processes. Representative processes.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 524
Synthesis and Intellectual Property Management
This course focuses on the management of intellectual property. Professionals will lead discussions on the control and dissemination of materials concerning intellectual property. This will be combined with the technical presentations by the students in the classroom. Topics of discussion will include invention disclosures, intellectual property rights, proprietary materials, justification for patents, types of patents, the terms of a patent, patents procedure, licensing procedure and security considerations. Access to patented materials and disclosure of materials under patent process will be covered.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 526
Graduate Chemistry Laboratory
An advanced laboratory with emphasis on synthesis and characterization of inorganic and organometallic compounds.
Lecture: 1 **Lab:** 7 **Credits:** 3

CHEM 530
Organic Reaction Mechanisms
A study of important mechanism classes and their relationship to the major reactions of organic chemistry. Emphasis will be placed on the study of reaction intermediates and on the methods used to characterize reaction pathways. Topics will include chemical bonding, aromaticity, stereochemistry, substitution, elimination, carbanion chemistry, free radical reactions, photochemistry and concerted reactions.
Prerequisite(s): [(CHEM 455)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 531
Tactics in Organic Synthesis
A study of modern synthetic strategies used in the preparation of complex organic molecules. Synthetic planning using the disconnection approach and the selection of reagents to solve regiochemical and stereo chemical problems will be the underlying themes. Synthetic strategies to be discussed include tandem reactions, template and chelation effects, biomimetic tactics and the use of chiral terpenes, carbohydrates and amino acids in enantioselective syntheses. Target molecules will include natural products, pharmaceuticals and smart organic materials.
Prerequisite(s): [(CHEM 530)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 534
Advanced Spectroscopic Methods
Characterization and analysis by mass, vibrational, nuclear magnetic resonance, and electronic spectroscopy. Structure spectra correlations applied to organic and inorganic compounds with examples drawn from diverse areas, e.g., pollutants, toxic materials, polymers, etc.
Lecture: 3 **Lab:** 4 **Credits:** 4

CHEM 535
Polymer Synthesis
This course will cover the basics of polymer synthesis including traditional polymerization techniques, such as free-radical and ionic chain polymerizations, and step-growth polymerization. Newer methods of polymer synthesis, such as ring-opening metathesis and controlled free-radical polymerizations, will also be discussed. Students will be introduced to the methods of preparation of advanced polymer structures, such as block, star and brush copolymers, dendrimers, and hyperbranched polymers.
Prerequisite(s): [(CHEM 239)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 537
Polymer Chemistry Laboratory
This course will include the synthesis of a variety of polymers and their characterization using instrumental methods. Emphasis will be placed on factors that control polymer formation, methods for obtaining molecular weights and distributions of polymers, as well as thermal and mechanical characteristics of polymers.
Prerequisite(s): [(CHEM 470)]
Lecture: 1 **Lab:** 6 **Credits:** 3

CHEM 538
Physical Biochemistry
The course will cover the principles and techniques of physical chemistry applied to biological macromolecules. Topical concepts include thermodynamics, kinetics, and quantum chemistry. Applications to areas such as interpretation of entropy and enthalpy driven processes, biochemical equilibrium, phase transitions in lipid, bilayers and membranes, enzyme kinetics, intra- and intermolecular interactions, and spectroscopy of proteins and nucleic acids will be introduced.
Prerequisite(s): [(CHEM 239 and CHEM 344)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 539
Introduction to Pharmaceutical Chemistry
Fundamental concepts will be discussed, including modern principles of drug design; drug absorption, distribution and metabolism; theories of drug-receptor interactions; approaches to structure-activity relationships; chemical, physicochemical and structural considerations. The various classes of therapeutic agents will be surveyed with emphasis on possible modes of action. Methods of synthesis will be considered.
Prerequisite(s): [(CHEM 239)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 542
Polymer Characterization and Analysis
This course will provide an overview of the common techniques for polymer characterization, studying structure-property relationships, and polymer morphology. The course will focus on thermal and mechanical characterization of polymers as well as polymer rheology. Examples and uses of major commercial polymers and advanced functional polymers will be introduced.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 543
Analytical Chemistry in Pharmaceutical Laboratories
This course is designed to compliment the current curriculum of the professional master degree in analytical chemistry. It is a review of the requirements a student may face as a professional chemist in a regulated industry. The course focus is on the requirements and common topics facing today's pharmaceutical industry. While individual agencies have specific regulations, the fundamental ideas of these regulations are largely consistent across the board. For example, an analytical chemist versed in Good Laboratory Practices (GLP) under FDA can quickly pick up the GLP's required by EPA.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 544
Colloids and Colloid Analysis
This course will begin a general overview of colloid science. This part of the course will introduce various types of colloids, touch on factors and conditions leading to their stability or instability, consider their evolution and will include a very limited discussion of the conditions under which they can form. The second part of the course will consist of a series of discussions of specific analytical techniques used to characterize colloidal systems, with particular emphasis on the physical characterization of the dispersed phase.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 548
Electrochemical Methods
Thermodynamics and potential, charge-transfer kinetics and mass transfer. Potential step and potential sweep methods, including hydrodynamic methods. Bulk electrolysis methods. Electrode reactions coupled with homogeneous chemical reactions. Double-layer structure and absorbed intermediates in electrode processes. Digital simulation of electrochemical processes. Students are expected to have some background in the physical chemistry of solutions and electroanalytical chemistry at the level of CHEM 500.
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 550
Chemical Bonding
Review of the postulatory basis of quantum mechanics and application to 1-D and 3-D systems. Hydrogenic and symmetry-adapted spin orbitals and bond formation. Ground and excited states. Commonly used semiempirical molecular orbital methods.
Prerequisite(s): [(CHEM 344)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 552
Chemical Kinetics
Types of reactions, reaction order, activation energy, transition states, isotope effects and the mechanism of reactions. Determination of the rates of free radical reactions. Primary processes in thermal, photochemical and other radiation-induced reactions.
Prerequisite(s): [(CHEM 550 and CHEM 553)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 553
Chemical Statistical Thermodynamics and Molecular Simulation
Statistical interpretation of the fundamental properties and laws of thermodynamics. Ensembles, partition functions, and principles of molecular simulation. Applications to chemical and phase equilibria including case studies from contemporary literature.
Prerequisite(s): [(CHEM 343 and CHEM 344)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 560
Advanced Chemistry Projects
Advanced chemistry projects to be carried out under the direction of a faculty member. These projects may involve computational, theoretical, experimental work or a combination of these. Projects based on experimental work may be carried out in the research lab of the instructor. Topics of the advanced projects will be selected by the faculty member offering the course and will not necessarily be related to the dissertation topic of the student. May be taken more than once and up to 12 credit hours.
Credit: Variable

CHEM 584
Graduate Seminar in Chemistry
To foster scientific communications skills, students are required to present seminars based on the scientific literature. Required of all first year M.S. and PhD students.
Lecture: 0 **Lab:** 0 **Credits:** 1

CHEM 585
Chemistry Colloquium
Lectures by invited scientists in areas of chemistry generally not covered in the department. Must be taken two time by M.S. students and four time by PhD. students.
Lecture: 0 **Lab:** 0 **Credits:** 1

CHEM 591
Research and Thesis
(Credit: Variable)
Credit: Variable

CHEM 594
Special Problems
Designed for non-thesis M.S. only. (Credit: Variable)
Credit: Variable

CHEM 596
Chemistry for Teachers-Elementary
Certification as chemistry teacher or approval of instructor. An in-service workshop for pre-college teachers emphasizing the phenomenological approach to the teaching of chemical science. (Credit: variable)
Credit: Variable

CHEM 597
Reading and Special Problems
Independent study to meet the special needs of graduate students in department-approved graduate degree programs. Requires the written consent of the instructor. May be taken more than once. Receives a letter grade. (Credit: Variable)
Credit: Variable

CHEM 598
Chemistry for High School Teachers
Certification as teacher or approved of instructor. An in-service workshop for pre-college teachers emphasizing the phenomenological approach to teaching of chemical science at the high school level. (Credit: variable)
Credit: Variable

CHEM 600
Continuation of Residence
Lecture: 0 **Lab:** 0 **Credits:** 1

CHEM 610
Special Topics in Analytical Chemistry
Topics of current interest in analytical chemistry including advanced electro-chemistry, surface spectroscopy of electrode surfaces, separations, laboratory automation and new spectroscopic techniques.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 611
Special Topics in Analytical Chemistry
Topics of current interest in analytical chemistry including advanced electro-chemistry, surface spectroscopy of electrode surfaces, separations, laboratory automation and new spectroscopic techniques.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 620
Special Topics in Inorganic Chemistry
Topics of current interest in inorganic chemistry, including organometallic chemistry, homogeneous catalysis, inorganic reaction mechanisms, inorganic stereochemistry, materials chemistry, x-ray crystallography, synthetic and physical methods in inorganic and materials chemistry and chemical applications of group theory.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 621
Special Topics in Inorganic Chemistry
Topics of current interest in inorganic chemistry, including organometallic chemistry, homogeneous catalysis, inorganic reaction mechanisms, inorganic stereochemistry, materials chemistry, x-ray crystallography, synthetic and physical methods in inorganic and materials chemistry and chemical applications of group theory.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 630
Special Topics in Organic Chemistry
Topics of current interest in organic chemistry including photochemistry, fluorine chemistry, heterocyclic chemistry, pharmaceutical chemistry and electro optical organic chemistry.
Prerequisite(s): [(CHEM 455)]
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 631
Special Topics in Organic Chemistry
Topics of current interest in organic chemistry including photochemistry, fluorine chemistry, heterocyclic chemistry, pharmaceutical chemistry and electro optical organic chemistry.
Prerequisite(s): [(CHEM 455)]
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 635
Heterocyclic Chemistry
Of the vast array of structures which organic compounds adopt, many contain ring systems as a component. When the ring is made up of carbon and at least one other element, the compound is classified as a heterocycle. The aims of this course are to identify the effects that the presence of such ring systems have on the chemistry of a molecule; to show how the rings can be made, and to describe some of the uses of the compounds in organic synthesis, in medicine and in other contexts. The chemistry of aromatic five-, six- and seven-membered ring compounds with one or more nitrogen, oxygen and/or sulfur atoms will be emphasized.
Prerequisite(s): [(CHEM 239 and CHEM 455)]
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 650
Special Topics in Physical Chemistry
Topics of current interest in physical chemistry, including atmospheric chemistry, ion molecule reactions, laser chemistry, theories of gas phase reactions, scattering theory, interaction of radiation with matter and time-dependent relaxation methods.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 651
Special Topics in Physical Chemistry
Topics of current interests in physical chemistry, including atmospheric chemistry, ion molecule reactions, laser chemistry, theories of gas phase reactions, scattering theory, interaction of radiation with matter and time-dependent relaxation methods.
Lecture: 2 **Lab:** 0 **Credits:** 2

CHEM 684
Graduate Seminars in Chemistry
To foster scientific communications skills, students are required to present seminars based on the scientific literature. Required of all Ph.D. students who have passed the written qualifying examination.
Lecture: 1 **Lab:** 0 **Credits:** 1

CHEM 685
Chemistry Colloquium
Lectures by invited scientists in areas of chemistry generally not covered in the department.
Prerequisite(s): [(CHEM 585)]
Lecture: 0 **Lab:** 0 **Credits:** 1

CHEM 691
Research and Thesis Ph.D.
(Credit: Variable) Instructor permission required.
Credit: Variable