CHEMISTRY

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Chair
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Faculty with Research Interests
For information regarding faculty visit the Department of Chemistry website.

The chemistry program at Illinois Institute of Technology provides rigorous education in the fundamental areas of chemical theory and chemical experimentation. It roots students in the discipline and provides them with a firm foundation so that they can take many paths from here.

Our undergraduate degree is accredited by the American Chemical Society and is excellent preparation for a career in industry or for advanced degrees. Recent graduates have begun industry careers or are now in medical school, graduate school, and pharmacy programs. Dual-degree, major-plus-minor, combined bachelor's/master's, premedical, and honors law options are also available.

Details of the traditional programs, as well as the specialized degree programs, can be found on the following pages and in the Special Programs section.

Degree Programs

- Bachelor of Science in Bioanalytical Chemistry
- Bachelor of Science in Chemistry
- Bachelor of Science in Computational Chemistry and Biochemistry
- Bachelor of Science in Environmental Chemistry
- Bachelor of Science in Forensic Chemistry
- Bachelor of Science in Medicinal Chemistry

Co-Terminal Options

The Department of Chemistry also offers the following co-terminal degrees, which enable a student to simultaneously complete both an undergraduate and graduate degree in as few as five years:

- Bachelor of Science in Chemistry/Master of Science in Biology for the Health Professions
- Bachelor of Science in Chemistry/Master of Chemical Engineering
- Bachelor of Science in Chemistry/Master of Food Safety and Technology
- Bachelor of Science in Chemistry/Master of Science in Environmental Management and Sustainability

Co-terminal degrees allow students to gain greater knowledge in specialized areas while, in most cases, completing a smaller number of credit hours with increased scheduling flexibility. For more information, please visit the Department of Chemistry website (science.iit.edu/chemistry).

Other Degree Programs in Chemistry

Beyond the traditional degree programs, the department offers several specialized programs designed for students who are interested in studying science and who wish to pursue a postgraduate education. Detailed programs of study for each of the programs listed below are available from the department.

Research Honors Program

This program is specifically designed for students who plan to pursue an advanced research degree. The program of study is based on the traditional degrees but is accelerated to include a full year of research experience in a faculty research lab, culminating in a senior thesis.

In addition, students selected for this program may have guaranteed stipends for the summers after their sophomore and junior years in addition to any other scholarships that have been awarded.

Combined B.S./M.D. Program

For detailed information, see the Special Programs section.

Honors Law Program

Students in any of the chemistry programs are eligible for this program. For students in chemistry, this is a seven-year program which can be accelerated under special conditions approved by the student's adviser.

Minors

- Minor in Chemistry

Course Descriptions

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.
Prerequisite(s): CHEM 122
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 122 and CHEM 123) or CHEM 124 or IIT Chemistry Placement score of 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 and CHEM 123) 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:** 4 **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 237 or (CHEM 236 and CHEM 235)
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: 3 **Lab:** 4 **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): (MATH 251 or MATH 252) and CHEM 125
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 or Graduate standing
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*) or Graduate standing, 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 247 and CHEM 240
Lecture: 3 **Lab:** 4 **Credits:** 4

CHEM 438
Physical Biochemistry
The principles and techniques of thermodynamics, kinetics and spectroscopy applied to biological macromolecules will be introduced. Contents to be covered include: interpretation of entropy and enthalpy driven processes, intra- and intermolecular interactions, biochemical equilibrium, free energy driven protein and ion transport, DNA and protein stability, derivation of rate of reaction from reaction mechanism, enzyme kinetics, and principles and applications of spectroscopy in identifying the structures of proteins and nucleic acids.
Prerequisite(s): (CHEM 239 and CHEM 343) or Graduate standing
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 450
Introduction to Research
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 452
Cheminformatics
This course provides an introduction to chemical informatics and an overview of computer technology and computational methods for search, visualization, analysis, management, and mining of chemical and biochemical data and information. Potential topics include: representation of 2D and 3D chemical structures and chemical reactions; molecular coding; chemical structure database; chemical data and structure descriptors; data visualization and non-linear mapping; database design and management; chemical and biological data analysis and mining; cluster and diversity analysis; and software design and programming; cheminformatics in chemical reaction and property, analytical chemistry, and spectral analysis.
Prerequisite(s): CHEM 343 and CHEM 237
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 454
Computational Quantum Chemistry
A project-based introduction to modern quantum chemistry tools and approaches. Basics of quantum mechanics and Perturbation Theory. Self-Consistent Field Approximation (Hartree-Fock and density functional approximations, post-HF-methods). Concept of orbital interactions (perturbational MO theory. intermolecular perturbations, constructing MO from fragment orbitals). Electronegativity and geometry perturbations. Walsh Diagrams. First and second order Jahn-Teller effects. Analysis of chemical reactivity, clarification of reaction mechanisms, and predicting physical properties associated with molecules. This course will include laboratory work.
Prerequisite(s): (CS 105 and MATH 152 and CHEM 344) or Graduate standing
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 or Graduate standing
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 456
Computational Biochemistry and Drug Design
A project-based introduction to computer-aided drug design tools and the principles behind them. Molecular docking and molecular mechanics force fields for binding enthalpies. Continuum dielectric models of electrostatics and solvation. The Boltzmann distribution and alchemical binding free energy calculations. Quantitative structure property relationships, including for activity and membrane permeability. This course will include laboratory work.
Prerequisite(s): CHEM 343 and CHEM 237
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 460
Bioanalytical Chemistry
This course will provide an introduction to analysis of biomolecules and biologically active molecules and cover analytical and spectroscopic methods for characterization, separation, and detection of biomolecules and biologically active molecules. Students will learn chemical, biochemical, biophysical, chromatographic, electrochemical, and instrumental techniques for detection, qualitative and quantitative analysis, and characterization of small drugs, biomolecules, bioconjugates, biosimilars, and biopharmaceuticals including protein, antibodies, nucleic acid, and enzymes. Potential topics includes acid-base chemistry, chemical kinetics and thermodynamics, biomolecular structure, enzyme and protein chemistry, bioconjugate chemistry, spectroscopy, mass spectrometry, fluorescence microscopy, chromatography, electrochemistry, and analysis and characterization of proteins and nucleic acids.
Prerequisite(s): CHEM 237 and CHEM 343 and CHEM 247
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 461
Bioanalytical Chemistry Laboratory
In this laboratory course of bioanalytical chemistry, students will learn chemical, biochemical, and instrumental lab techniques for detection, analysis, separation, and characterization of small drugs, bioactive agents, and biomolecules. Students will gain hands-on lab experience in the biochemical assays, microscopic, and spectroscopic analysis of biologically active molecules including small drugs, proteins, and DNAs. Potential topics include instrumental and spectroscopic analysis using FTIR, Raman, UV-visible, fluorescence, NMR, AFM, ICP, HPLC, calorimetry, fluorescence microscope, and mass spectrometry; DNA and protein electrophoresis; chromatographic separation; immunoassay; DNA profiling; peptide sequencing; PCR; centrifugation; and microdialysis; and statistical analysis.
Prerequisite(s): CHEM 237 and CHEM 343 and CHEM 247
Lecture: 1 **Lab:** 7 **Credits:** 3

CHEM 463
Analytical Method Development Laboratory
In this laboratory course, students will learn about method development and assessment for analysis of chemicals, organic compounds, polymers, drugs, pharmaceuticals, and biopharmaceuticals. Students will gain hands-on experience in quantitative analysis and quality assurance and control of diverse chemicals and bioactive agents. This course will foster students to develop quantitative and technical analysis techniques, literature comprehension, critical thinking, problem-solving, and communication skills. The literature and guidance on analytical method development and validation reported by the industry and government agencies will be studied. Potential topics include: analytical separation; instrumental analysis; chromatographic and electrophoretic methods; quality assurance and control; analytical method validation; sampling, preparations and storage of samples and standard solutions; physiochemical characterization; statistical analysis; good laboratory practice (GLP) requirement; and validation, verification, and documentation of analytical testing methods and procedure.
Prerequisite(s): CHEM 237 and CHEM 343 and CHEM 247
Lecture: 1 **Lab:** 7 **Credits:** 3

CHEM 467
Medicinal Chemistry
This course will provide an introduction to medicinal chemistry. Potential topics include organic chemistry in drug design and drug action; structure-activity relationship (SAR); mechanism of drug action; pharmaceutical analysis and formulation; binding affinity, selectivity, and specificity; drug efficacy, toxicity, and oral bioavailability; drug absorption, distribution, metabolism and excretion (ADME); pharmacokinetics (PK); pharmacodynamics (PD); interaction of drugs with enzymes, protein receptors, DNAs, and RNAs; protein-protein interaction; enzyme inhibition and mechanism; molecular target identification and detection; prodrugs; biologics; antibody-drug conjugate (ADC) chemistry; drug discovery process; development of therapeutics, diagnostics, and theranostics; pharmaceutical and clinical data analysis; case studies of preclinical and clinical trials.
Prerequisite(s): CHEM 343 and 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 or Graduate standing
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 472
Environmental Chemistry
This course provides an introduction to environmental chemistry and is focused on application of chemical principles and theories to the study of environmental phenomena and issues and covers matters related to environment and earth. Potential topics include aquatic chemistry, water pollution and purification, atmospheric chemistry, air pollution, hydrology and geochemistry, soil chemistry and pollution, natural resource and cycle, energy and sustainability, climate change, chemical bonding and reactions, thermodynamics and kinetics, acid-base chemistry, redox chemistry, bio-inorganic chemistry on earth and living systems, organic and inorganic toxicants and pollutants, hazardous heavy metals, nuclear wastes, waste and recycling, green chemistry, environmental toxicology, and chemical and environmental health and safety.
Prerequisite(s): (CHEM 125 or CHEM 126) and CHEM 247
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 473
Environmental Analytical Chemistry
This course provides an overview of applications of analytical chemistry to environment and environmental problems. Students will learn spectrometric, chromatographic, electrochemical measurement methods and concepts for analysis of environmental samples and tracing and monitoring of environmental problems. Potential topics include: quality assurance (QA) and quality control (QC) in environmental sampling and analysis; determination of trace elements, toxicants, organics, pollutants, heavy metals, and radionuclides in environmental samples and drinking water; analytical tools for tracing and monitoring of pollution and contamination; instrumental analysis of environmental samples using ICP-MS (inductively coupled plasma-mass spectrometry), ICP-AAS (atomic absorption spectroscopy), ICP-AES (atomic emission spectrometry), ion chromatography, and gas chromatography (GC), GC-MS, high performance liquid chromatography (HPLC); chemometrics; electrochemical methods; GC/LC separation methods, liquid-liquid and solid phase extraction; statistical data analysis.
Prerequisite(s): (CHEM 125 or CHEM 126) and CHEM 247
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 475
Forensic Chemistry
This course will provide an introduction to forensic chemistry and prepare students to build a sound knowledge in chemical, biochemical, and instrumental methods for forensic analysis and statistical analysis of forensic data. The class will cover principles and applications of chemical, biochemical, spectroscopic, and chromatographic methods for analysis and characterization of forensic samples. Potential topics include forensic applications of UV-Visible, IR, Raman, NMR, atomic absorption (AA) spectroscopy, fluorescence microscopy, X-ray, mass spectrometry; chromatographic methods (GC, HPLC, and TLC) and capillary electrophoresis for separation of forensics; analysis and identification of enforced drugs; colorimetric methods; microscopy and immunoassays for forensic examination; chemistry in examination and analysis of chemical, biological, and physical forensic samples (alcohol, carbon monoxide, papers, hair, gunpowder, inks, fibers, paints, firearms, fingerprint, palmprint, documents, and body fluid and blood samples); crime lab services; forensic statistics; introduction to international forensic databases.
Prerequisite(s): CHEM 237 and CHEM 343 and CHEM 247
Lecture: 3 **Lab:** 0 **Credits:** 3

CHEM 476
Forensic Chemistry Laboratory
This lab course will cover chemical, spectroscopic, and chromatographic methods for analysis and characterization of forensic samples. Students will gain hands-on lab experience in instrumental, colorimetric, and microscopic analysis of forensic samples, controlled substances, and standards. Potential topics include: colorimetric assay for identification and quantification of illicit drugs; fingerprint chemistry; IR, Raman, Fluorescence, and NMR-based spectroscopic analysis of controlled substances, forensic samples, and gold standards; GC-MS, HPLC, and TLC for detection and separation of forensic samples; spot testing and microscopic analysis and characterization of biologic fluids and forensic samples; construction of calibration curves; analysis of forensic samples using an international database including paint data query (PDQ), NIST's Forensic database trace evidence table, international ink library, glass evidence reference; introduction to visualization software.
Prerequisite(s): CHEM 237 and CHEM 343 and CHEM 247
Lecture: 1 **Lab:** 7 **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:** 1 **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 491
Undergraduate Research
Student participation in undergraduate research, usually during the junior or senior year.
Credit: Variable
Satisfies: Communications (C)

CHEM 495
Seminar in Special Topics
This seminar course is designed to provide students with opportunities to learn about recent development in specialized chemistry areas including bioanalytical chemistry, environmental chemistry, forensic chemistry, medicinal chemistry, and computational chemistry and biochemistry. Students are expected to develop written and oral communication skills on the advanced and specialized topics. Prerequisites or Instructor Approval.
Prerequisite(s): CHEM 125 or CHEM 126
Lecture: 1 **Lab:** 0 **Credits:** 1

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