CHEMISTRY

Our chemistry department is doing some of the most impactful research at the university and around the world. The department's 21 regular research faculty comprise one of the highest external research grant-generating departments at S&T. Our emphasis on excellence in research and creativity has moved our programs to the forefront of science. The department supports a broad range of research performed by internationally recognized faculty competing at the leading edge of technological research.

The department provides programs in analytical, inorganic, organic, physical, and biochemistry, as well as in more specialized areas including polymer and coatings, electrochemistry, bioanalytical chemistry, cancer biology, colloids, corrosion, environmental chemistry, kinetics, organometallic chemistry, reaction mechanisms, atmospheric sciences, solid state chemistry, chemical instrumentation design and development, spectroscopy and theoretical chemistry. A number of our faculty are involved in efforts which have been organized into several centers or institutes including the Missouri S&T Coatings Institute, the Materials Research Center, the Cloud and Aerosol Sciences Laboratory and the Center for Single Nanoparticle, Single Cell, and Single Molecule Monitoring. Financial support is available from research grants for advanced students.

The department of chemistry, along with the department of biological sciences, is housed in Schrenk Hall complete with modern research, teaching and computer laboratories. The department has a number of support personnel to provide technical assistance with laboratory instrumentation, computers, laboratory hardware, and glassware. State-of-the-art research instrumentation in the department of chemistry includes a Nicolet Nexus 470 FT-IR FTIR, Varian INOVA 400 MHz FT/NMR spectrometer with multinuclear liquid, diffusion, and variable-temperature capabilities, Bruker 200 MHz FT/NMR with multinuclear liquid and toroidal cavity capabilities, Beckman DU 640B and Carey 50 UV-Visible spectrophotometers, Hewlett Packard 5989A Mass Spectrometer (GC/MS & DIP/MS inputs), Hitachi LaChrom Elite D-2000 HPLC with Diode Array & Refractive Index detectors, PerkinElmer 2380 Atomic Absorption spectrometer, Bruker-AXS D8 Single-crystal X-ray Diffraction, Beckman PACE/MDQ capillary-electrophoresis, Shimadzu HPLC/GPC, EG&G potentiostat/galvanostats, TA Instruments Q2000 Differential Scanning Calorimeter, TA Instruments Q50 Thermogravimetric Analyzer, NexION 300 ICP-MS, and AB SCIEX 4000 QTRAP mass spectrometer, Tecnai F20 TEM, S-570 SEM, PerkinElmer 2400 Elemental Analysis (C-H-N), PerkinElmer LS 30 Fluorescence spectrophotometer, Hewlett Packard 5890 series II Gas Chromatographs, Electrothermal Engineering Ltd. M-2341 Melting Point apparatus, Sartorius ME-5 series Ultra Micro Balance, Dymax Model 5000 UV Curing Oven, CEM MDS-2000 Microwave Reactor Oven, Nicolet Magna-IR 750, Bruker-AXS D8 Single-crystal X-ray Diffraction, Hitachi M-8000 mass spectrometer, EG&G low-temperature Mössbauer spectrometer, Applied Color Systems 1800 color-matching/formulating computing spectrophotometer, PerkinElmer, Par 272, Rame-Hart 250-F1 Goniometer/Tensiometer, Full-Spectrum Laser MLE-40 Laser Cutter, Netzsch LFA447 Flash Diffusivity Analyzer, TA Instruments AR2000 Rheometer with Small-Angle Light Scattering attachment, TA Instruments Q800 Dynamic Mechanical Analyzer, and Applied Separations Helix Super-Critical Fluid Processor. The department houses an extensive collection of additional mass spectrometers, a wide variety of additional chromatographs (GC, LC, IC), infrared spectrometers, dispersive optical spectrometers (UV/VIS, IR, AA), fluorescence/luminescence spectrophotometers, centrifugal partition chromatographs, refrigerated-ultra centrifuges, calorimeters, salt-spray chambers, and radiation counters, as well as access to the campus centralized computing facility which includes numerically-intensive computing support. Neutron diffraction is on hand at the High Flux Reactor of the Missouri S&T. This also supports nuclear chemistry. Facilities for studying very fast combustions and explosions, as well as a variety of new and innovative techniques for characterizing high-energy materials, are provided in the Rock Mechanics and Explosives Research Center.

Amitava Choudhury, Assistant Professor
PHD Indian Institute of Science
Cathode materials for Li-ion batteries; porous solids for hydrogen storage, thermoelectric materials.

Richard Dawes, Assistant Professor
PHD University of Manitoba
The spectroscopy and dynamics of small molecules primarily of interest to combustion and atmospheric

Nurán Ercal, Professor
PHD Hacettepe University, Turkey
Richard K. Vitek/FCR Endowed Chair in Biochemistry. The effect of N-acetylcysteineamide (NACA), in various oxidative stress related conditions, including metal toxicity, radiation, medicinal drug-induced toxicity, and degenerative eye disorders; developing NACA eye drops as an alternative to surgery for oxidative stress-induced eye disorders; developing HPLC techniques for thiol-containing compounds in biological samples.

Gary Grubbs, Assistant Professor
PHD University of North Texas
Physical chemistry in the area of rotational spectroscopy. Gas phase materials research, instrument design and construction, in situ

Shubhender Kapila, Professor
PHD Dalhousie University, Halifax
Missouri Soybean Research Professor of CEST. Environmental photochemistry of halogenated molecules; separations mass spectrometry; supercritical fluids; ultra trace determination of organics; chemistry of obscurant smokes.

Nicholas Leventis, Curators Professor
PHD Michigan State University
Nanostructured polymers; mechanically strong aerogels; electrochemistry in magnetic fields; redox active organic/inorganic polymers and composites for electrochromics, electrocatalysis and sensors.

Gary John Long, Professor
PHD Syracuse University
Synthesis, magnetic and electronic spectral properties of transition metal complexes; organoiron complexes and hard magnetic materials; neutron diffraction and x-ray crystallography.
Yinfa Ma, Curator Teaching Professor  
PHD Iowa State University  
Environmental analysis, bioanalysis and bioseparations; early cancer screening by using different markers and different techniques for early cancer diagnosis; single molecular detection of molecule-cell interactions; single molecule immunoassay; investigation of alternation of glycosylation of glycoproteins at cell surfaces.

Paul Ki Souk Nam, Associate Professor  
PHD University of Missouri-Columbia  
Biofuel and bioproduct development-microalgae and agricultural product utilization; environmental monitoring and remediation-endocrine disruptors, emerging contaminants, aerosol/particulate matter, carbon sequestration; supercritical fluid reaction, extraction and chromatography; explosive and chemical agent detection and neutralization; synthesis and characterization of enantio-enriched peptides and oligomers; thermal treatment for material characterization and recycle.

Manashi Nath, Assistant Professor  
PHD Indian Institute of Science  
Growth of functional nanowires and nanotubes of inorganic materials; exploring the semiconductor family with emphasis on making superconducting nanowires and nanotubes of type II superconductors; developing protocols for device fabrication with these functional nanowires.

V Prakash Reddy, Associate Professor  
PHD Case Western Reserve University  
Organofluorine chemistry, carbocations, superacids, asymmetric Friedel-Crafts reactions, environmentally benign (green) chemistry, and protein modifications.

Thomas Schuman, Associate Professor  
PHD University of Alabama-Huntsville  
Interface control; non-chrome, corrosion inhibitors are being developed for aluminum alloys and steel; adhesion promotion to plastic substrates; ink-receptive coatings for ink-jet papers; membranes for protection of acoustic sensors; organometallic nanocomposites; development of industrial agricultural products; high energy storage density dielectric.

Honglan Shi, Associate Research Professor  
PHD Missouri S&T  
Environmental analysis and bioanalytical techniques, including water emerging contaminants, soil contaminants, bioanalytical analysis, analytical instrument and test kits designs; analytical methods development by using state-of-the-art instruments including LC-MS, GC-MS, ICP-MS, ICP-OES, HPCE, HPLC, GC, and IC.

Chariklia Sotiriou-Leventis, Professor  
PHD Michigan State University  
Supramolecular chemistry; organic nanomaterials.

Pericles Stavropoulos, Associate Professor  
PHD Imperial College, London, UK  
C1 interconversions catalyzed by transition metal compounds and metalloenzymes: methane activation and carbon dioxide reduction; inorganic materials with magnetic and catalytic properties.

Jay A Switzer, Professor  
PHD Wayne State University  
Electrodeposition of epitaxial thin films and superlattices; chiral surfaces; spintronic metal oxides; energy conversion and storage; semiconductor electrochemistry; materials for solid-state memory; catalysis.

Michael R Van De Mark, Associate Professor  
PHD Texas A&M University  
Colloidal unimolecular polymer (CUP) synthesis (a 3-9 nanometer diameter particle suspended in water), characterization, and utilization; polymer synthesis, micro-phase structure of ionomeric polymers, modification of oleophilic and hydrophilic micro-domains within gel structures; organic oxidative electrochemical synthesis and photochemistry.

Risheng Wang, Assistant Professor  
PHD New York University  
Biochemistry; structural DNA nanotechnology; nanomaterials; fabrication and characterization of nanostructures; DNA based biomedical; and electronic applications.

Philip D Whitefield, Professor  
PHD University of London (UK)  
Department Chair. Aerospace emissions. Chemical and physical characterization of aerosols; aerosols generated by aerospace and other civilian and military activities; environmental problems presented by aerosol production, e.g. local air quality at airports, rocket impact on stratospheric ozone, and their impact on power plant efficiency, e.g. evaluation of fuel additives.

Jeffrey G. Winiarz, Associate Professor  
PHD SUNY at Buffalo  
Development of polymeric photonic materials and devices using photosensitization by way of the inclusion of surface-passivated semiconductor nanocrystals.

Klaus Hubert Woelk, Associate Professor  
PHD University of Bonn-Germany  
In situ high-temperature and high-pressure NMR spectroscopy; properties of organic material in oil and gas shale; toroid-cavity rotating-frame NMR microscopy; hydrothermal biomass conversion.

CHEM 5000 Special Problems  
(IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Prerequisite: Preceded or accompanied by Chem 1100 or an equivalent training program approved by S&T. Consent of instructor required.

CHEM 5001 Special Topics  
(LEC 1.0 and LAB 2.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

CHEM 5099 Master Research  
(IND 0.0-6.0)  
Master level research with the intent to lead to the preparation of a master degree thesis. Not more than six (6) credit hours allowed for graduate credit. Subject and credit to be arranged with the instructor. Preparation of a written, detailed report culminating in a thesis is required of the student. Prerequisite: Must meet departmental training requirements for laboratory safety. Consent of instructor required.
CHEM 5100 Laboratory Safety & Hazardous Materials (LEC 1.0)
A systematic study of safe laboratory operations and pertinent regulations of state and federal agencies. Prerequisites: Graduate standing.

CHEM 5210 Fundamentals of Organic Reactions (LEC 3.0)
An advanced course designed to give the student a mastery of the fundamentals of organic chemical reactions and theory. Graduate students are required to demonstrate a higher level of learning on assessments. Prerequisite: Chem 2220.

CHEM 5220 Synthetic Organic Chemistry (LEC 3.0)
A systematic study of organic reactions, their mechanisms and synthetic applications. Graduate students are expected to demonstrate a higher level of proficiency during assessments. Prerequisite: Chem 2220.

CHEM 5250 Industrial Chemical Processes (LEC 3.0)
Detailed study of various industrial chemical manufacturing processes including underlying chemistry, reaction pathways and separation processes. Prerequisite: Chem Eng 3130 or Chem 2210, or graduate standing. (Co-listed with Chem Eng 5096).

CHEM 5310 Introduction to Inorganic Chemistry (LEC 3.0)
A study of inorganic chemistry with emphasis on physical methods. General subjects covered include: molecular structure, bonding, complexes, spectroscopy, and reaction rates. Graduate students are required to demonstrate a higher level of proficiency during assessments.

CHEM 5410 Advanced Chemical Thermodynamics (LEC 3.0)
A study of the laws of thermodynamics with application to chemical systems. Emphasis is placed on partial molal functions. Credit will not given for both Chem 5410 and Chem 4410. Prerequisites: Chem 3420.

CHEM 5420 Elemental Quantum Chemistry (LEC 3.0)
A study of molecular structures and spectroscopy, statistical thermodynamics, kinetic theory, chemical kinetics, crystals, and liquids. Prerequisites: Math 2222; Physics 2135 or Physics 2111.

CHEM 5430 Advanced Chemical Kinetics (LEC 3.0)
Introductory graduate treatment of special topics of physical chemistry including statistical mechanics and kinetics. Prerequisites: Chem 3430.

CHEM 5510 Introduction to Chemical Analysis (LEC 3.0 and LAB 1.0)
Principles and analytical applications of molecular spectroscopy, chromatographic separations, mass spectrometry, and radiochemistry. A brief overview of instrument electronics, signal generation and processing, and automated analysis is also provided. Graduate students are expected to achieve a higher level of proficiency on application and assessments compared to Chem 4510 students. Prerequisites: Chem 1100, Chem 2510, Chem 2220, Chem 3430.

CHEM 5610 Biochemistry (LEC 3.0)
A resume of the important aspects of quantitative and physical chemistry in biochemical processes. General subjects covered include: proteins, nucleic acids, enzymes, carbohydrates and lipids. Credit may not be given for both Chem 5610 and Chem 4610. Prerequisite: Chem 2220.

CHEM 5619 Biochemistry Laboratory (LAB 2.0)
Experiments are integrated with the lectures and cover the chemical and physical properties of proteins, enzymes, nucleic acids, carbohydrates and lipids. Credit may not be given for both Chem 5619 and Chem 4619. Prerequisites: Preceded or accompanied by Chem 5610 and Chem 1100 or an equivalent training program approved by S&T.

CHEM 5620 Biochemical Metabolism (LEC 3.0)
A continuation of Chem 5610. Catabolism and anabolism of carbohydrates, lipids, proteins, and nucleic acids. Photosynthesis, oxidative phosphorylation and membranes. Credit may not be given for both Chem 5620 and Chem 4620. Prerequisite: Chem 4610 or 5610.

CHEM 5630 Biochemical Nanotechnology (LEC 3.0)
This course will educate on the interdisciplinary areas of biotechnology. Student will investigate the potential of nanoscience in advanced applications including DNA/protein nanotechnology, drug delivery, environmental biosensor and emerging biotechnology industries. Credit may not be given for both Chem 5630 and Chem 4630. Prerequisite: At least junior standing.

CHEM 5710 Environmental Monitoring (LEC 3.0)
This course provides an overview of environmental monitoring methodologies. Discussion covers thermodynamic and kinetic processes that affect chemical transport and fate in the environment. Federal environmental regulations and remediation technologies are also covered with specific examples. Credit may not be given for both Chem 5710 and Chem 4710. Prerequisites: Chem 2210, Physics 2111.

CHEM 5810 Introduction to Polymeric Materials (LEC 3.0)
A basic study of the organic chemistry of natural and synthetic high polymers, their inherent properties and their uses in plastic, fiber, rubber, resin, food, paper and soap industries. Credit may not be given for both Chem 5810 and Chem 4810. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with MS&E 5810).

CHEM 5819 Polymer Synthesis and Characterization Lab (LAB 1.0)
Laboratory experiments dealing with polymerization syntheses and solution, bulk and solid properties will be presented. Each student will prepare polymers and carry out all characterization experiments on actual samples. Credit may not be given for both Chem 5819 and Chem 4819. Prerequisite: Chem 4810 or MS&E 4810 or Chem 5810 or Chem Eng 5310, preceded or accompanied by Chem 1100 or Chem 5100 or an equivalent training program approved by S&T. (Co-listed with MS&E 5819).

CHEM 5850 Introduction to Coating Chemistry (LEC 3.0)
Study of the basic principles of protective coatings with particular reference to the paint and varnish industry. Classifications, manufacture, properties and uses of protective coatings. Credit may not be given for both Chem 5850 and Chem 4850. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with MS&E 5850).

CHEM 6000 Special Problems (IND 0.0-6.0)
Problems or reading on specific subjects or projects in the department. Consent of instructor required.
CHEM 6001 Special Topics (LEC 0.0 and IND 0.0 and LAB 0.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

CHEM 6010 Seminar (RSD 1.0)
Discussion of current topics.

CHEM 6040 Oral Examination (IND 0.0)
After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

CHEM 6050 Continuous Registration (IND 1.0)
Doctoral candidates who have completed all requirements for the degree except the dissertation, and are away from the campus must continue to enroll for at least one hour of credit each registration period until the degree is completed. Failure to do so may invalidate the candidacy. Billing will be automatic as will registration upon payment.

CHEM 6099 Research (IND 0.0-15)
Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Prerequisite: Must meet departmental requirements for instruction in laboratory safety. Consent of instructor required.

CHEM 6101 Introduction to Chemistry Research (LEC 1.0)
An introduction to chemical research topics of interest to the department presented by different faculty members. Special emphasis will also be placed on a discussion of ethics, plagiarism, codes of conduct, research notebooks, publishing, and presentations. Prerequisite: Graduate Student Status.

CHEM 6220 Advanced Synthetic Organic Chemistry (LEC 3.0)
A discussion of a large number of synthetically useful reactions involving enolates and enamines; nucleophilic additions to carbonyl compounds; functional group interconversions, thermal pericyclic reactions; organometallic compounds; carbocations, carbenes and free radicals as reactive intermediates; aromatic substitutions; and multistep synthesis. Prerequisite: Chem 4210 or Chem 4220.

CHEM 6240 Physical Organic Chemistry (LEC 3.0)
An advanced course in theoretical organic chemistry treating molecular orbital theory, free energy relationships, transition state theory, and other fundamental topics. Prerequisite: Chem 4210.

CHEM 6250 Spectrometric Identification of Organic Compounds (LEC 3.0)
Overview of MS and IR techniques in the characterization of organic compounds; CD/ORD; 1H, 13C, and heteronuclear NMR spectroscopy in the structural analysis; applications of APT, DEPT, 1H-1H COSY, HETCOR, HMOC, HMB, INADEQUATE, TOCSY, NOE AND NOESY, and dynamic NMR. Prerequisite: Chem 2220.

CHEM 6260 Advanced Physical Organic Chemistry I (LEC 3.0)
A discussion of the large number of synthetically useful reactions involving enolates and enamines; nucleophilic additions to carbonyl compounds; functional group interconversions, thermal pericyclic reactions; organometallic compounds; carbocations, carbenes and free radicals as reactive intermediates; aromatic substitutions; and multistep synthesis. Prerequisite: Chem 4210 or Chem 4220.

CHEM 6320 Solid State Chemistry (LEC 3.0)
The aim of this course is to build a comprehensive understanding of the chemistry of solids and its application to the materials world. Emphasis will be given on the synthesis, crystal structure and various properties of solids including electrical, optical and magnetic. Students will gain knowledge about how to correlate a property with structure. Prerequisites: Chem 2310, Chem 2320, and Chem 3410.

CHEM 6330 Nanomaterials Synthesis, Properties and Applications (LEC 3.0)
Chemistry of nanomaterials. Understanding the fundamentals of nanoscience and technology. Studying the different synthesis strategies for nanomaterials and their characterization. Understanding the properties of nanomaterials and their possible applications. Introducing the concept for device fabrication. Prerequisite: Chem 4310.

CHEM 6350 X-ray Crystallography (LAB 2.0 and LEC 2.0)
Molecular and crystal structure determination by single crystal x-ray diffraction methods. Brief coverage of relation to neutron and electron diffraction.

CHEM 6360 Bioinorganic Chemistry (LEC 3.0)
Metallobiomolecules, including metalloenzymes and other metalloproteins; oxygen carriers; iron transport and other iron proteins; copper proteins; cancer agents and cures; nitrogen fixation, etc. Prerequisite: Chem 4310.

CHEM 6380 Inorganic Materials Chemistry (LEC 3.0)
Chemical processing of solid materials. Introduction to point groups, space groups, and x-ray diffraction. Bonding in solids - from molecular orbital theory to band theory. Nonstoichiometric materials and Kroger-Vink notation. Optical and electrical properties of semiconductors. Epitaxial growth. Quantum effects in nanophase materials. Prerequisite: Chem 4310 or permission of instructor.

CHEM 6420 Quantum Chemistry I (LEC 3.0)
A rigorous introduction to the fundamental concepts and principles of quantum chemistry. Application to translational, vibrational, and rotational motion; one-electron systems. Prerequisite: Chem 3420 or equivalent.

CHEM 6430 Chemical Kinetics (LEC 3.0)
An introduction to the deduction of mechanisms of homogeneous chemical reactions from rate data. Selected topics, such as photochemistry, free-radical mechanisms, catalysis, and explosion reactions. Prerequisite: Chem 3430.

CHEM 6450 Spectroscopy (LEC 3.0)
Introduction to the interaction of electromagnetic radiation with matter. Emphasis on the ultraviolet, visible, and radio portions of the spectrum. Prerequisite: Chem 3450 or equivalent.

CHEM 6480 Physical Chemistry Of Surfaces (LEC 3.0)
Adsorption at liquid interfaces and properties of surface films. Physical and chemical adsorption on solid surfaces. Catalysis.
**CHEM 6510 Separations** (LEC 3.0)
An in-depth study of all types of analytical and preparativescale separations. A special emphasis will be placed on chromatography and chromatographic theory. Prerequisite: Chem 4510 or equivalent.

**CHEM 6550 Chemical Spectroscopy** (LEC 3.0)
A study of the electronic, vibrational, rotational and nuclear magnetic resonance spectra of atoms and molecules. A basic understanding of the underlying theoretical principles and the interpretations of results is stressed. Prerequisite: Chem 4510, Chem 3420 or equivalent courses.

**CHEM 6555 Principles And Applications Of Mass Spectrometry** (LEC 3.0)
The course covers fundamental physical principles of mass spectrometry, instrumentation, interpretation of spectra, and applications in environmental, polymer, biomedical, and forensic fields. Prerequisite: Chem 4510 or equivalent.

**CHEM 6570 Electrochemistry** (LEC 3.0)
Introduction to the fundamentals, methods and applications of electrochemistry. Fundamentals cover the thermodynamics/kinetics of electrode reactions, and the modes of mass transport in the electrolyte. Methods cover potentiometric, amperometric, and a.c. techniques. Applications focus on analysis and study of materials. Prerequisite: Chem 3430.

**CHEM 6580 Mass Spectrometry of Macromolecules** (LEC 3.0)
This course will provide an overview of mass spectrometric applications in biomacromolecules and synthetic polymers; particular areas of emphasis are proteomics, genomics, pharmaceutical screening, characterization of biochemical complexes and synthetic polymers. Prerequisite: Chem 4510 or equivalent.

**CHEM 6620 Intermediary Metabolism And Biosynthesis** (LEC 3.0)
The course covers the biosynthesis and metabolism of nucleic acids, carbohydrates, lipids and proteins. Prerequisite: Chem 4620.

**CHEM 6650 Free Radicals In Biochemistry** (LEC 3.0)
The study of the basic principles of free radical chemistry and biochemistry. Prerequisites: Chem 2210, Chem 2220 and Bio Sci 2113.

**CHEM 6820 Polymer Synthesis** (LEC 3.0)
The methods of organic monomer and polymer syntheses will be explored. Mechanistic and structural components, modern and current industrial methods for polymer syntheses will be discussed. Topics include linear, branched, graft, and dendritic polymers, nano-technology and macromers. Prerequisites: Chem 4810 or MS&E 4810 or Chem 5810 or MS&E 5810; Chem 2220 or Chem 4210 or Chem 4220 or Chem 5210 or Chem 5220. (Co-listed with MS&E 6820).

**CHEM 6840 Polymer Physical Chemistry and Analysis** (LEC 3.0)
A study of the physical properties of macromolecular systems including polymer solutions, gels, bulk polymers and rubbers. The chemical characterization of polymers based on their thermal, spectroscopic, microstructure and molecular weight is also discussed. Prerequisite: Chem 4810 or MS&E 4810 or Chem 5810 or MS&E 5810; thermodynamics. (Co-listed with MS&E 6840).