

# Chemistry (CHEM)

## Courses

### **CHEM 402. Chemical Information Systems. 2 hours.**

Introduction to chemical information, including the use of databases for searching chemical information and the use of molecular modeling and related computational systems to determine calculated properties of chemical substances. Course Information: Previously listed as CHEM 302. Prerequisite(s): Grade of C or better in CHEM 234, or consent of instructor. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Discussion.

### **CHEM 414. Advanced Inorganic Chemistry. 2 or 3 hours.**

Introduction to the principles of inorganic chemistry. Structural and descriptive chemistry of the main-group elements. Course Information: 2 undergraduate hours. 3 graduate hours. Prerequisite(s): Grade of C or better in CHEM 314; and Grade of C or better in CHEM 340 or Grade of C or better in CHEM 342; or consent of the instructor.

### **CHEM 415. Inorganic Chemistry Laboratory. 0-4 hours.**

Advanced inorganic chemistry laboratory. Preparative methods, Schlenk techniques, dry box, Fourier-transform infra-red and UV-visible spectroscopy, crystal growth. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in CHEM 314. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

### **CHEM 416. Inorganic Chemistry II. 3 or 4 hours.**

Structural and descriptive chemistry of the transition elements. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CHEM 414.

### **CHEM 421. Instrumental Analysis. 0-4 hours.**

A survey of contemporary instrumentation for chemical analysis. Emphasis on fundamentals of instrumental methods with actual experience on typical equipment. Includes a weekly three-hour laboratory. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in CHEM 222; or Grade of C or better in CHEM 118. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

### **CHEM 432. Advanced Organic Chemistry. 3 or 4 hours.**

Rigorous treatment of the physical principles upon which modern organic chemistry is developed to understand the interplay between chemical structure and reactivity. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): Grade of C or better in CHEM 235.

### **CHEM 444. Spectroscopy in Chemistry and Biochemistry. 3 or 4 hours.**

Applications of theory and experiment to the spectroscopy of molecules and biological macromolecules. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in CHEM 346 or Grade of C or better in CHEM 344.

### **CHEM 448. Statistical Thermodynamics. 3 or 4 hours.**

Introduction to statistical mechanics, partition functions, chemical equilibrium, ensembles, fluctuations, real gases, Einstein and Debye models of solids, magnetic materials, electrolytes, introduction to liquids. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CHEM 346.

### **CHEM 452. Biochemistry I. 4 hours.**

Chemistry of proteins, nucleic acids, carbohydrates and lipids. Course Information: Same as BIOS 452. Prerequisite(s): Grade of C or better in CHEM 230; or Credit or concurrent registration in CHEM 234. Class Schedule Information: To be properly registered, students must enroll in one Discussion/Recitation and one Lecture.

### **CHEM 454. Biochemistry II. 4 hours.**

Continues Chemistry 452. Carbohydrate and lipid metabolism, electron transport. Metabolism of amino acids, nucleic acids, proteins. Biosynthesis of macromolecules and regulation of macromolecular synthesis. Course Information: Same as BIOS 454. Prerequisite(s): BIOS 452 or CHEM 452. Class Schedule Information: To be properly registered, students must enroll in one Discussion/Recitation and one Lecture.

### **CHEM 455. Biochemistry Laboratory. 3 hours.**

Introduction to modern biochemistry and molecular biology research. Includes recombinant DNA techniques, protein purification, site-directed mutagenesis, polymerase chain reaction, enzyme kinetics, protein structure data analysis and molecular graphics. Course Information: Prerequisite(s): CHEM 222 or CHEM 118; and CHEM 452 or BIOS 452. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Laboratory-Discussion.

### **CHEM 456. Natural Products. 3 or 4 hours.**

Biogenetic approach to secondary metabolites. General principles and selected studies of phenolic compounds, terpenes, alkaloids, and other interesting natural products. Course Information: Same as BIOS 416. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): One year of organic chemistry.

### **CHEM 458. Biotechnology and Drug Discovery. 3 or 4 hours.**

Molecular and gene therapy, using small molecules including antisense, aptamers, and proteins. Structure-based drug design. Structural bioinformatics and drug discovery program. High-throughput screening. Combinatorial chemistry technology. Course Information: Same as BIOS 458. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOS 352 or CHEM 352; or Credit or concurrent registration in BIOS 452 or Credit or concurrent registration in CHEM 452; or consent of the instructor.

### **CHEM 470. Educational Practice with Seminar I. 6 hours.**

The first half of a two-segment sequence of practice teaching, including seminar, to meet certification requirements for teaching in grades six through twelve. Course Information: Graduate credit only with approval of the department. Prerequisite(s): Good academic standing in a teacher education program, completion of 100 clock hours of pre-student-teaching field experiences, and approval of the department. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Practice.

### **CHEM 471. Educational Practice with Seminar II. 6 hours.**

The second half of a two-segment sequence of practice teaching, including seminar, to meet certification requirements for teaching in grades six through twelve. Course Information: Graduate credit only with approval of the department. Prerequisite(s): Good academic standing in a teacher education program, completion of 100 clock hours of pre-student-teaching field experiences, credit or concurrent registration in CHEM 470, and approval of the department. Class Schedule Information: To be properly registered, students must enroll in one Conference and one Practice.

**CHEM 472. Teaching Methods in Chemistry. 2 or 3 hours.**

A course in the methods of teaching high school chemistry, including the integration of technology. Course Information: 2 undergraduate hours. 3 graduate hours. Extensive computer use required. Prerequisite(s): 24 semester hours of undergraduate chemistry, including two semesters of laboratory chemistry. Recommended background: ED 210.

**CHEM 474. Teaching Chemistry in High Schools. 1 hour.**

Modern ways to help beginning learners construct in their own minds an understanding of scientific concepts and scientific method. Emphasis on the concepts of chemistry. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Prerequisite(s): Approval of the department.

**CHEM 475. Learning and Teaching of Physical Sciences. 3 hours.**

Provides teacher candidates with the foundation and experience necessary to teach physical sciences in secondary schools. Course Information: Same as PHYS 475. Prerequisite(s): Senior standing or above; or approval of the department. Recommended background: Knowledge of first-year college physics and chemistry. Class Schedule: To be properly registered: Students must enroll in one Lecture-Discussion and one Laboratory.

**CHEM 480. Elements of Machining Scientific Equipment. 1 hour.**

Elements of machining scientific equipment, including the use of machine shop tools and technical drawing of scientific apparatus. Course Information: Same as EAES 478 and PHYS 480. Satisfactory/Unsatisfactory grading only. Prerequisite(s): Graduate standing; and approval of the department.

**CHEM 488. Cooperative Chemistry Practice. 1 hour.**

Off-campus participation in a governmental or industrial training program. Credit is contingent on the submission of a final report. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. A maximum of 6 hours of CHEM 488, CHEM 492 and CHEM 499 combined may be credited toward departmental undergraduate degree course requirements. Prerequisite(s): Concurrent registration in LAS 289 or consent of the instructor.

**CHEM 492. Independent Study. 1-2 hours.**

Individual study under supervision of a faculty member in areas not covered in standard courses. Credit is contingent on the submission of a final report. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. A maximum of 6 hours of CHEM 488, CHEM 492 and CHEM 499 combined may be credited toward departmental undergraduate degree course requirements. Prerequisite(s): 2.50 grade point average in science courses and consent of the instructor. Class Schedule Information: This course counts toward the limited number of independent study hours accepted toward the undergraduate degree and the major.

**CHEM 494. Special Topics in Chemistry. 1-4 hours.**

Course content is announced prior to each term in which the course is given. Course Information: May be repeated. Students may register in more than one section per term. Prerequisite(s): Approval of the department.

**CHEM 499. Supervised Research. 3 hours.**

Individual research performed under supervision of a faculty member. Credit is contingent on the submission of a final report. Research experience is strongly encouraged for career students. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated to a maximum of 6 hours. A maximum of 6 hours of CHEM 488, CHEM 492 and CHEM 499 combined may be credited toward departmental undergraduate degree course requirements. Prerequisite(s): Junior standing or above, approval of the department, consent of the instructor and a grade point average of 2.50 in science courses; or graduate standing. Recommended background: Credit in CHEM 333 or CHEM 314. Class Schedule Information: This course counts toward the limited number of independent study hours accepted toward the undergraduate degree and the major.

**CHEM 500. Faculty Research. 1 hour.**

Mandatory for first-year students. Faculty present their research interests to new graduate students. Course Information: Satisfactory/Unsatisfactory grading only.

**CHEM 501. Researching and Writing for Chemistry and Biochemistry Journals. 2 hours.**

Preparing (bio)chemistry manuscripts and learning writing strategies to increase the likelihood for publication. Includes conducting a literature review, defining the main idea, presenting and describing the results and discussing their implications. Course Information: Satisfactory/Unsatisfactory grading only. Extensive computer use required. Prerequisite(s): Graduate students who have advanced to candidacy for a Ph.D. from the LAS Department of Chemistry.

**CHEM 510. Literature Seminar in Inorganic Chemistry. 1 hour.**

Discussion of inorganic research from the current literature. Emphasis on student presentations. Course Information: Satisfactory/Unsatisfactory grading only. Prerequisite(s): Graduate standing or consent of the instructor.

**CHEM 514. Advanced Inorganic Chemistry I. 4 hours.**

The synthesis, structure, and bonding of selected main group and transition metal species. Describes materials science applications of these compounds. Course Information: Prerequisite(s): CHEM 416 or the equivalent.

**CHEM 516. Advanced Inorganic Chemistry II. 4 hours.**

Structural and descriptive chemistry of the transition elements; spectroscopy and magnetism Course Information: Prerequisite(s): CHEM 416 or the equivalent.

**CHEM 517. Organometallic Chemistry. 4 hours.**

The fundamental and basic principles of the structure and reactivity of transition metal complexes towards organic molecules. Course Information: Prerequisite(s): CHEM 432 or the equivalent, and credit or concurrent registration in CHEM 532.

**CHEM 518. Advanced Inorganic Chemistry III. 4 hours.**

Synthesis, structure, bonding, and properties of solid state materials. Course Information: Prerequisite(s): CHEM 416 or the equivalent or consent of the instructor.

**CHEM 519. Special Topics in Inorganic Chemistry. 3-4 hours.**

Lectures on topics not represented in regularly scheduled courses. Course Information: May be repeated. Prerequisite(s): Graduate standing or consent of instructor.

**CHEM 520. Literature Seminar in Analytical Chemistry. 1 hour.**

Discussion of analytical chemical research from the current literature. Emphasis upon student presentations. Course Information: Satisfactory/Unsatisfactory grading only. Course Information: May be repeated.

**CHEM 522. Techniques in Mass Spectrometry and Surface Analysis. 4 hours.**

Various methods in mass spectrometry. Non-optical applied surface analysis including x-ray photoelectron spectroscopy, Auger spectroscopy, and scanning probe microscopy. Instrumentation, applications and data analysis. Course Information: Prerequisite(s): CHEM 421 or the equivalent.

**CHEM 524. Optical Spectroscopies in Analytical Chemistry. 4 hours.**

Theory and experimental methods in infrared, ultraviolet and visible spectroscopies, both absorption and emission. Course Information: Prerequisite(s): CHEM 346 and CHEM 421; or consent of the instructor.

**CHEM 526. NMR Spectroscopy in Analytical Chemistry. 4 hours.**

Principles governing one- and multi-dimensional nuclear magnetic resonance (NMR) spectroscopy; applications of NMR to chemical analysis. Course Information: Prerequisite(s): CHEM 346 and CHEM 421; or the equivalent or consent of the instructor.

**CHEM 527. Electrochemistry. 4 hours.**

Covers electrochemistry from its thermodynamic and kinetic relationships to its application in analytical chemistry and energy technology. Course Information: Prerequisite(s): Grade of C or better in CHEM 346.

**CHEM 528. Chemical Separations. 4 hours.**

Fundamentals and recent advances in techniques and technologies for the separation of chemical substances, including both chromatographic and electrophoretic methods. Special emphasis on trace and microscale methods. Course Information: Prerequisite(s): CHEM 421; or approval of the department.

**CHEM 529. Special Topics in Analytical Chemistry. 3-4 hours.**

Lectures and readings in areas not normally treated in standard courses. Discussion of topics of current interest in analytical chemistry. Course Information: May be repeated. Students may register in more than one section per term. Prerequisite(s): Consent of the instructor.

**CHEM 530. Literature Seminar in Organic Chemistry. 1 hour.**

Discussion of organic chemical research from the current literature. Emphasis upon student presentations. Course Information: May be repeated. Satisfactory/Unsatisfactory grading only. Prerequisite(s): Consent of the instructor.

**CHEM 531. Spectroscopic Organic Structure Determination. 4 hours.**

Discussion of principles and modern practice in the elucidation of the structures of organic molecules using NMR, IR, UV, and mass spectrometry. With practical examples. Course Information: Prerequisite(s): CHEM 234 or the equivalent.

**CHEM 532. Advanced Organic Chemistry I. 4 hours.**

Introduction to advanced organic chemistry, drawing molecules and mechanisms, FMO theory, stereochemistry, conformational analysis, stereoelectronic effects, selected functional group interconversions. Course Information: Some computer use will be required. Prerequisite(s): CHEM 432 or the equivalent.

**CHEM 533. Advanced Organic Chemistry II. 4 hours.**

Continues CHEM 532. Chemical literature, chemical bonding, pericyclic reactions, physical organic chemistry, reactive intermediates, organic reaction mechanisms with an emphasis on physical principles. Course Information: Prerequisite(s): CHEM 532 or the equivalent.

**CHEM 534. Advanced Organic Chemistry III. 4 hours.**

Continues CHEM 533. The major reactions in organic chemistry and their uses in organic synthesis. Course Information: Prerequisite(s): CHEM 533 or the equivalent.

**CHEM 535. Advanced Synthetic Chemistry. 4 hours.**

Topics include: control of stereochemistry (cyclic + acyclic), synthesis of complex natural and unnatural products (such as alkaloids, terpenes) and new methodologies. Course Information: Prerequisite(s): CHEM 533.

**CHEM 536. Physical Organic Chemistry. 4 hours.**

Theoretical and experimental methods of studying reaction mechanisms, with an emphasis on kinetic methods and linear free energy correlations. Course Information: Prerequisite(s): CHEM 533 or consent of the instructor.

**CHEM 537. Molecular Medicine. 4 hours.**

A series of case studies are explored to better understand the role of organic chemistry in the science of drug discovery and modern medicine. A major focus is the development of a molecular understanding of biological systems and how small molecules. Prerequisite(s): Grade of C or better in CHEM 230; or Grade of C or better in CHEM 232 and Grade of C or better in CHEM 234 Grade of C or better in CHEM 230 or grade of C or better CHEM 232 and CHEM 234. Recommended background: CHEM 352; or CHEM 452.

**CHEM 539. Special Topics in Organic Chemistry. 3-4 hours.**

Discussion of topics of current interest. Course Information: May be repeated. Students may register in more than one section per term. Prerequisite(s): CHEM 533.

**CHEM 540. Current Problems in Physical Chemistry. 1 hour.**

Student seminars presented on varied topics in physical chemistry. Special emphasis on the application of quantum mechanics and statistical mechanics to the solving of problems in molecular structure, dynamics and spectroscopy. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated.

**CHEM 541. Introduction to Surface Chemistry and Catalysis. 4 hours.**

The physical chemistry of reactions on solid surfaces as they relate to current problems in heterogeneous catalysis. Experimental techniques and methods of data analysis used in modern surface chemistry research. Course Information: Prerequisite(s): Grade of C or better in CHEM 342 and Grade of C or better in CHEM 346; or Grade of C or better in CHEM 340 and Grade of C or better in CHEM 344; and consent of the instructor. Recommended Background: CHEM 542.

**CHEM 542. Quantum Chemistry. 4 hours.**

Exact solutions of the Schrodinger equation for simple systems; variational principle and perturbation theory; many-electron atoms and diatomic molecules and their electronic structures; angular momentum. Course Information: Grade of C or better in CHEM 346.

**CHEM 543. Molecular Spectroscopy and Group Theory. 4 hours.**

Group theory and molecular symmetry. Rotations and vibrations of diatomics and polyatomics. Time-dependent quantum mechanics and UV, IR, and NMR spectroscopy. Course Information: Prerequisite(s): CHEM 542.

**CHEM 544. Angular Momentum in Quantum Mechanics. 4 hours.**

Quantum-mechanical theory of angular momentum. Application to spectroscopy, reaction dynamics, coupling of angular momenta, rotational transformations, graphical methods, Wigner-Eckart theorem, spherical tensors, rotational spectroscopy. Course Information: Prerequisite(s): CHEM 542 or consent of the instructor.

**CHEM 548. Equilibrium and Nonequilibrium Statistical Mechanics. 4 hours.**

Statistical mechanics of molecular systems focused on fundamental principles, theorems, and applications (ensembles, partition functions, distributions, and thermodynamic functions), extended by broad discussions of elementary transport methods. Course Information: Prerequisite(s): One year of undergraduate physical chemistry (342/346 level: thermodynamics, introductory quantum mechanics and statistical mechanics). Recommended background: credit in CHEM 542.

**CHEM 549. Special Topics in Physical Chemistry. 3-4 hours.**

Lectures and readings in areas not normally treated in standard courses. Discussion of topics of current interest in physical chemistry. Course Information: Prerequisite(s): Consent of the instructor.

**CHEM 550. Literature Seminar in Biochemistry. 1 hour.**

Presentation of student papers on current research topics in biochemistry. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated.

**CHEM 551. Advanced Biochemistry I. 4 hours.**

Basic and current topics on proteins, including protein structure, protein stability, and protein folding and misfolding, and proteomics. Course Information: Prerequisite(s): CHEM 454; and CHEM 346 or CHEM 344.

**CHEM 552. Chemical Biology. 4 hours.**

Major trends and recent developments in research at the interface of chemistry and biology. Course Information: Same as BIOS 552.

**CHEM 554. Bioinorganic Chemistry. 4 hours.**

Structure, function and properties of metal ion coordination centers in metalloproteins, as well as the function of metal ions in enzyme activation and membrane transport. Course Information: Prerequisite(s): CHEM 415 or CHEM 452.

**CHEM 555. Advanced Biochemistry II. 4 hours.**

The structure of nucleic acids and the role and processing of nucleic acids in various aspects of genetic regulation. Course Information: Prerequisite(s): CHEM 454.

**CHEM 557. Current Biophysical Techniques. 4 hours.**

Basic principles and practical applications of a wide-range of state-of-art biophysical methods, including structural analysis and imaging, which are essential in current biological research and biotechnology. Course Information: Prerequisite(s): CHEM 340 or CHEM 342.

**CHEM 558. Biophysical Chemistry. 4 hours.**

The role of molecular interactions in determining the structure and function of complex biological systems, and the use of modern experimental techniques to study these interactions and systems. Course Information: Prerequisite(s): CHEM 452 or consent of the instructor.

**CHEM 559. Special Topics in Biochemistry. 3-4 hours.**

Selected topics of current interest in biochemistry. Course Information: Same as BIOS 559. May be repeated. Students may register in more than one section per term. Prerequisite(s): CHEM 454 or BIOS 454 or consent of the instructor.

**CHEM 570. Seminar in Chemistry Education Research. 1 hour.**

Discussion of chemistry education research from the current literature. Emphasis on student presentations. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Prerequisite(s): Graduate standing; and consent of the instructor.

**CHEM 571. Research in Chem Ed. 4 hours.**

Basic principles and practical applications chemistry education research, including the selection and use of appropriate theoretical and methodological frameworks, illustrated in the context of major issues in current chemistry education research. Course Information: Prerequisite(s): Graduate standing; and consent of the instructor.

**CHEM 572. Teaching Methods in Chemistry. 3 hours.**

Special problems and techniques, including audio-visual methods, lecture demonstrations, the use of computers and the design of experiments. Course Information: May be repeated. A maximum of 3 hours may be credited toward departmental course requirements for the M.S. or Ph.D. in Chemistry. Prerequisite(s): Approval of the department.

**CHEM 573. Design-based Research in Chemistry Education Contexts. 4 hours.**

Focuses on the current research and philosophies motivating the design and study of learning environments in chemistry education contexts. Learning environments include both formal and information settings. Course Information: Prerequisite(s): Graduate standing; and consent of the instructor.

**CHEM 574. Cultural, Social, and Gender issues in Chemistry Education. 4 hours.**

Review the current chemistry education research that addresses cultural, ethnic, social, and gender issues related to chemistry education and teaching chemistry for English learners; discuss different theoretical frameworks to examine questions. Course Information: Prerequisite(s): Graduate standing; and consent of the instructor.

**CHEM 579. Special Topics in Chemistry Education. 4 hours.**

Discussion of topics of current interest in chemistry education. Course Information: May be repeated. Prerequisite(s): Graduate standing; and consent of the instructor.

**CHEM 590. Current Problems in Chemical Research. 2 hours.**

In-depth discussion and analysis of selective aspects of contemporary research with particular emphasis on research carried out in the department. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Prerequisite(s): Consent of instructor.

**CHEM 592. Introduction to Chemical Research Methods. 3-6 hours.**

Guided research on selected topics in analytical, inorganic, organic, or physical chemistry or biochemistry. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Prerequisite(s): Consent of the instructor. Recommended Background: BA or BS in Chemistry or Biochemistry.

**CHEM 598. Master's Thesis Research. 0-16 hours.**

Master's thesis work under the supervision of a faculty member. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Prerequisite(s): Approval of the department.

**CHEM 599. Ph.D. Thesis Research. 0-16 hours.**

Ph.D. thesis work under the supervision of a faculty member. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Prerequisite(s): Approval of the department.