Bennett Department of Chemistry

Degrees Offered

• Bachelor of Arts
• Bachelor of Science

Nature of the Program

The Bennett Department of Chemistry offers the bachelor of science with a major in chemistry and the bachelor of arts with a major in chemistry. These programs are designed to meet the needs of all students who have an interest in the broad field of chemistry.

The Department of Chemistry is located in Clark Hall, a state-of-the-art teaching facility for chemistry. Clark Hall offers many new instruments, numerous safety features, excellent ventilation and ample hoods, and complete accessibility for the physically handicapped. The department also has modern research facilities in the adjacent Chemistry Research Laboratory building where advanced undergraduates may participate in research projects.

The bachelor of science with a major in chemistry is approved by the American Chemical Society. This program is for students who desire to qualify for professional positions in industrial and governmental laboratories as well as those who plan to do graduate work in chemistry or allied areas in preparation for research careers in industry or academia.

The bachelor of arts with a major in chemistry is for students who pursue careers requiring a good background in the basic principles of chemistry. Areas such as medicine, dentistry, or other health-related sciences; secondary school teaching; chemical laboratory technical work; law; or business may be pursued with a proper choice of electives.

The two programs are similar during the first two years. Students in the B.S. program should complete the calculus requirement as soon as possible as a prerequisite for both the physics and physical chemistry sequences. The two degree programs differ primarily in the chemistry requirements. The B.S. program requires more upper-level chemistry courses than the B.A. program.

Students who earn a degree in the Eberly College of Arts and Sciences must complete the University requirements, the College requirements for their specific degree program, and their major requirements.

Chemistry Scholarships

In addition to financial aid offered by the University, the department maintains seven scholarships specifically for chemistry majors. The John A. Moore Trust Scholarships, the Charles L. Lazzell Scholarship, the Carpenter Family Scholarship, the Robert L. and Patricia Miller Stultz Chemistry Scholarship, the Herbert and Hannah Seigel Chemistry Scholarship, the Willard W. Hodge Scholarship, the Morrissey-Ropp Chemistry Scholarships, the William R. and Phylis T. Moore Organic Chemistry Scholarship, the Joseph T. Green Memorial Scholarship, and the Bud and Patty Blizzard Scholarships are awarded to students in either the B.S. or B.A. programs with records of outstanding achievement and demonstrated financial need. Several of these scholarships are restricted to West Virginia residents. Scholarship recipients are expected to remain as chemistry majors and to maintain a 3.0 average in their degree programs in order to be eligible for continued support.

Minors

All students have the possibility of earning one or more minors; follow the link for a list of all available minors and their requirements (http://catalog.wvu.edu/undergraduate/minors). Please note that students may not earn a minor in their major field.

Certificate of Global Engagement

Students in the Eberly College, regardless of their major, can earn a Certificate of Global Engagement. Completion of the Certificate demonstrates the student’s knowledge of diverse cultures, as well as the ability to communicate and interact effectively with people of different cultural backgrounds. Students will be required to apply their knowledge of contemporary issues and global social contexts to their course work and their broader citizenship. For details regarding Certificate requirements, please visit the Eberly College page (http://catalog.wvu.edu/undergraduate/eberlycollegeofartsandsciences/#otherdegreeextext).

FACULTY

CHAIR
• Gregory Dudley - Ph.D. (MIT)
  Synthetic organic chemistry
PROFESSORS

- Terry Gullion - Ph.D. (William and Mary)
  Physical chemistry, Solid State NMR, Biological Materials, Polymers
- Lisa Holland - Ph.D. (U. North Carolina-Chapel Hill)
  Micro-separations, High throughput drug screening
- Glen Jackson - Ph.D. (West Virginia University)
  Mass spectrometry, Forensic science
- Fred L. King - Ph.D. (University of Virginia)
  Analytical chemistry, Mass spectrometry, Trace elements, Gas-phase chemistry
- Kenneth Showalter - Ph.D. (University of Colorado)
  Bennett Distinguished Professor, Physical chemistry, Chemical kinetics, Multi-stability and oscillating systems
- Bjorn Soderberg - Ph.D. (Royal Inst. of Tech., Sweden)
  Organic synthesis using transition metals
- Kung Wang - Ph.D. (Purdue University)
  Eberly Distinguished Professor of Chemistry, Organic chemistry, stereoselective synthesis

ASSOCIATE PROFESSORS

- Erin Battin - Ph.D. (Clemson University)
  Bioinorganic Chemistry
- Fabien Goulay - Ph.D. (U. Rennes)
  Physical chemistry, Laser spectroscopy
- Justin Legleiter - Ph.D. (Carnegie Mellon University)
  Biophysical chemistry, Atomic force microscopy
- Joshua Osbourn - Ph.D. (University of Pittsburgh)
  Organic chemistry
- Betsy Ratcliff - Ph.D. (U. Binghamton - SUNY)
  Physical chemistry
- Tabitha Razunguzwa - Ph.D. (West Virginia University)
  Physical chemistry
- Michelle Richards-Babb - Ph.D. (Lehigh University)
  Chemical education
- Stephen Valentine - Ph.D. (Indiana University)
  Mass spectrometric analysis of biomolecules
- Mingming Xu - Ph.D. (Ohio University)
  Analytical chemistry

ASSISTANT PROFESSORS

- Melissa Gayton Ely - Ph.D. (West Virginia University)
  Analytical chemistry
- Jessica Hoover - Ph.D. (University of Washington)
  Organometallic chemistry, Catalysis
- Peng Li - Ph.D. (Texas Tech University)
  Analytical chemistry, microfluidic devices
- Blake Mertz - Ph.D. (Iowa State University)
  Computational biophysics and chemistry
- Carsten Milsmann - Ph.D. (University of Bochum)
  Transition metal catalysis, organometallic chemistry
- Brian Popp - Ph.D. (University of Wisconsin - Madison)
  Organic and organometallic chemistry, Catalysis
- Mark Tinsley - Ph.D., Leeds University, England
  Nonlinear dynamics, chemical oscillators, moving precipitation patterns.

PART-TIME INSTRUCTOR

- Jennifer Robertson-Honecker - Ph.D. (West Virginia University)
  Analytical chemistry, Science education
LECTURER
• Mark Schraf - M.S. (West Virginia University)
  Analytical chemistry

PROFESSORS EMERITI
• Harry Finklea - Ph.D. (California Institute of Technology)
  Analytical/Physical Chemistry, Electron transfer kinetics, Solid oxide fuel cells, Gas phase sensors
• Robert S. Nakon - Ph.D. (Texas A&M University)
  Inorganic chemistry
• John Penn - Ph.D. (University of Wisconsin - Madison)
  Chemical education, On-line instruction methods in organic chemistry
• Jeffrey Petersen - Ph.D. (University of Wisconsin-Madison)
  Physical inorganic chemistry, electrophilic transition metal complexes, X-ray crystallography
• Ronald Smart - Ph.D. (University of Michigan)
  Electrochemistry, Environmental chemistry
• Alan Stolzenberg - Ph.D. (Stanford University)
  Inorganic chemistry, Bioinorganic chemistry, Organometallic chemistry
• Anthony Winston - Ph.D. (Duke University)
  Polymer chemistry

Admissions
• First Time Freshmen with a Math ACT score of 22, or a MATH SAT score of 540, or who place in College Algebra are admitted directly to the Chemistry majors.
• Students transferring from another major within WVU and students transferring from another institution are admitted into the major if they have completed CHEM 115/116 or 117/118 with C- or better in each and have earned a minimum overall GPA of 2.0.

Degree Progress
• By the end of the second semester in the major, completion of CHEM 115/116 or 117/118 with C- or better in each.
• By the end of the second year in the major, completion of Organic Chem with C- or better and a 2.0 in the major.
• All majors must meet with a Chemistry adviser each semester.

Students who do not meet their benchmark expectations may be removed from the major.

Major Learning Outcomes
CHEMISTRY
1. Will have sufficient knowledge of the fundamental chemical principles and an understanding of the methods of chemistry to be able to formulate solutions to problems of chemical relevance.
2. Will have acquired sufficient training to perform accurate and precise quantitative analyses, to utilize modern instrumental methods of analysis, to analyze and report the results of chemical experimentation, to work safely with chemicals, and to work effectively both as an individual and in a small group.
3. Will understand how to retrieve information from the chemical literature and be able to organize and communicate chemical information effectively in written reports and oral presentations.
4. Will possess the basic laboratory skills and chemical knowledge to qualify for entry level industrial or government laboratory positions or to be able to apply and gain admission to competitive graduate and professional schools.

COURSES
CHEM 110. Introduction to Chemistry, 2 Hours.
PR: Satisfy the minimum ACT/SAT math score, or satisfactory performance on placement examination, or MATH 122 or higher with a minimum grade of C-. Required for students whose performance on ACT/SAT/placement examination indicates need for introductory work before enrolling in other chemistry courses. Elementary scientific terminology and concepts; simple chemical arithmetics; chemical symbols, formulae and equations; and mole concepts.
CHEM 110A. Introduction to Chemistry A. 1 Hour.
PR: Satisfy the minimum ACT/SAT math score, or satisfactory performance on placement examination, or C- in MATH 122 or higher. Students must register for CHEM 110A and CHEM 110B in the same term. Required for students whose performance on ACT/SAT/placement examination indicates need for introductory work before enrolling in other chemistry courses. Elementary scientific terminology and concepts; simple chemical arithmetic's; chemical symbols, formulae and equations; and mole concepts.

CHEM 110B. Introduction to Chemistry B. 1 Hour.
PR or CONC: CHEM 110A with a grade of C- or better. Required for students whose performance on the ACT/SAT/placement examination indicates need for introductory work before enrolling in other chemistry courses. Scientific terminology and concepts; chemical arithmetic's; chemical symbols, formulae and equations; and mole concepts.

CHEM 111. Survey of Chemistry 1. 4 Hours.
PR: WVU sections require MATH 122 or MATH 124S or MATH 126S with a minimum grade of C- or ALEKS Score of ML 20 or Math ACT Score of 22 or Math SAT Score of 540 or Math SAT (March 2016) Score of 570 or PR or CONC: MATH 126A or MATH 126B or MATH 126C or MATH 129 or MATH 150 or MATH 153 or MATH 155, WVUIT and PSC sections require MATH 122 or MATH 124S or MATH 126S with a minimum grade of C- or ALEKS Score of ML 10 or Math ACT Score of 19 or Math SAT Score of 460 or Math SAT (March 2016) Score of 500 or PR or CONC: MATH 126A or MATH 126B or MATH 126C or MATH 129 or MATH 150 or MATH 153 or MATH 155 and PR or CONC: CHEM 111L. Designed primarily for students taking only one year of college chemistry. Atomic structure; chemical bonding; acids, bases, and salts; periodicity; properties of gases, liquids, and solids; stoichiometry; oxidation-reduction. (3 hr. lecture) (Students may not receive credit for CHEM 115 or CHEM 117 and for CHEM 111.).

CHEM 111L. Survey of Chemistry 1 - Laboratory. 0 Hours.
PR or CONC: CHEM 111. Survey of Chemistry 1 - CHEM 111 Laboratory.

CHEM 112. Survey of Chemistry 2. 4 Hours.
PR: CHEM 111 and PR or CONC: CHEM 112L. Continuation of CHEM 111. Nuclear chemistry; air and water pollution; useful natural materials; consumer chemistry; introduction to organic and biochemistry. (3 hr. lec.) (Students may not receive credit for CHEM 116 or CHEM 118 and for CHEM 112.) (CHEM 111 and CHEM 112 cannot be used as pre-requisite courses for organic chemistry).

CHEM 112L. Survey of Chemistry 2 - Laboratory. 0 Hours.
PR or CONC: CHEM 112. Survey of Chemistry 2 - CHEM 112 Laboratory.

CHEM 115. Fundamentals of Chemistry. 3 Hours.
PR: Satisfactory ACT/SAT or placement exam performance, or WVU sections require CHEM 110B with a minimum grade of C- or MATH 129 or higher with a minimum grade of C-. PSC sections require MATH 124 or MATH 126 or PR or CONC: MATH 128 or higher with a minimum grade of C-, WVUIT sections require PR or CONC: MATH 126 or MATH 129, and PR or CONC: CHEM 115L. For students who need more than one year of college chemistry and quantitative relationships on which subsequent chemistry courses are built. (3 hr. lec.) (Students may not receive credit for CHEM 117 and CHEM 115.) Pre-requisite(s) and/or co-requisite(s) may differ on regional campuses.

CHEM 115L. Fundamentals of Chemistry 1 - Laboratory. 1 Hour.
PR or CONC: CHEM 115. Fundamentals of Chemistry 1 - CHEM 115 Laboratory.

CHEM 116. Fundamentals of Chemistry. 3 Hours.
PR: CHEM 115 and CHEM 115L and PR or CONC: CHEM 116L with a minimum grade of C- in all. Continuation of CHEM 115 & CHEM 115L. (3 hr. lec., 3 hr. lab.) (Students may not receive credit for CHEM 118 and for CHEM 112 or CHEM 116.) Pre-requisite(s) and/or co-requisite(s) may differ on regional campuses.

CHEM 116L. Fundamentals of Chemistry 2 - Laboratory. 1 Hour.
PR or CONC: CHEM 116. Fundamentals of Chemistry 2 - CHEM 116 Laboratory.

CHEM 117. Principles of Chemistry 1. 5 Hours.
PR: Satisfactory ACT/SAT and placement examination performance, or a score of four or five on AP Chemistry examination, and PR or CONC: CHEM 117L. A more advanced treatment of the principles and theories of chemistry than offered in CHEM 115 and CHEM 116. Primarily for students specializing in chemistry. (Students may not receive credit for CHEM 117 and for CHEM 111 or CHEM 115.).

CHEM 117L. Principles of Chemistry 1 - Laboratory. 0 Hours.
PR or CONC: CHEM 117. Principles of Chemistry 1 - CHEM 117 Laboratory.

CHEM 118. Principles of Chemistry 2. 5 Hours.
PR: CHEM 117 and CHEM 117L and PR or CONC: CHEM 118L. Continuation of CHEM 117. (3 hr. lec. plus recitation) (Students may not receive credit for CHEM 118 and for CHEM 112, CHEM 116 or CHEM 215.).

CHEM 118L. Principles of Chemistry 2 - Laboratory. 0 Hours.
PR or CONC: CHEM 118. Principles of Chemistry 2 - CHEM 118 Laboratory.

CHEM 191. First-Year Seminar. 1-3 Hours.
Engages students in active learning strategies that enable effective transition to college life at WVU. Students will explore school, college and university programs, policies and services relevant to academic success. Provides active learning activities that enable effective transition to the academic environment. Students examine school, college and university programs, policies and services.

CHEM 202A. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.
CHEM 202B. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202C. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202D. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202E. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202F. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202G. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202H. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202I. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202J. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202K. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202L. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202M. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202N. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202O. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202P. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202Q. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202R. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202S. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202T. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202U. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202V. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202W. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202X. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202Y. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 202Z. . 1-3 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.
CHEM 215. Introductory Analytical Chemistry. 3 Hours.
PR: CHEM 116 and CHEM 116L with a minimum grade of C- in each and PR or CONC: CHEM 215L. Volumetric analysis, gravimetric analysis, solution equilibria, spectrophotometry, separations, and electrochemical methods of analysis. (Students may not receive credit for CHEM 215 and for CHEM 117 and CHEM 118.).

CHEM 215L. Introductory Analytical Chemistry Laboratory. 1 Hour.
PR: CHEM 116 and CHEM 116L with a minimum grade of C- in each and PR or CONC: CHEM 215. Volumetric analysis, gravimetric analysis, solution equilibria, spectrophotometry, separations, and electrochemical methods of analysis.

CHEM 231. Organic Chemistry: Brief Course. 4 Hours.
PR: CHEM 116 and CHEM 116L and PR or CONC: CHEM 231L. Emphasis on biological applications for students in medical technology, agriculture, and family resources. Nomenclature, structure, reactivity, and stereochemistry are stressed. (3 hr. lec., 3 hr. lab.) (Students may not receive credit for CHEM 231 and for CHEM 233 and CHEM 234.).

CHEM 231L. Organic Chemistry: Brief Course - Laboratory. 0 Hours.
PR: CHEM 116 and CHEM 116L with a minimum grade of C- and PR or CONC: CHEM 231. Emphasis on biological applications for students in medical technology, agriculture, and family resources. Nomenclature, structure, reactivity, and stereochemistry are stressed.

CHEM 233. Organic Chemistry. 3 Hours.
PR: (CHEM 116 or CHEM 118) and PR or CONC: CHEM 235 with a minimum grade of C- in all. Basic principles of organic chemistry. Modern structural concepts, the effect of structure on physical and chemical properties, reactions and their mechanisms and application to syntheses. (3 hr. lec.) (Students may not receive credit for CHEM 233, CHEM 234, and for CHEM 231.).

CHEM 234. Organic Chemistry. 3 Hours.
PR: CHEM 233 and CHEM 235 and PR or CONC: CHEM 236 with a minimum grade of C- in all. Continuation of CHEM 233 and its study of basic principles of organic chemistry. Modern structural concepts, the effect of structure on physical and chemical properties, reactions and their mechanisms and application to syntheses. (3 hr. lec.).

CHEM 235. Organic Chemistry Laboratory. 1 Hour.
PR or CONC: CHEM 233 with a minimum grade of C-. Fundamental organic reactions and the preparation of organic compounds. (3 hr. lab.).

CHEM 236. Organic Chemistry Laboratory. 1 Hour.
PR: CHEM 233 and CHEM 235 and PR or CONC: CHEM 234 with a minimum grade of C- in all. Continuation of CHEM 235 and its study of fundamental organic reactions and the preparation of organic compounds. (3 hr. lab.).

CHEM 293. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 310. Instrumental Analysis. 3 Hours.
PR: (CHEM 215 or CHEM 118) and (CHEM 341 or CHEM 346). Lectures and demonstrations. Fundamentals of instrumental methods applied to chemical analyses: electrochemistry, spectroscopy, mass spectrometry, and chromatography. (2 hr. lec., 1 hr. demonstration.).

CHEM 312. Environmental Chemistry. 3 Hours.
PR: CHEM 215 and CHEM 234 and physical chemistry. Study of the nature, reactions, transport, and fates of chemical species in the environment. (2 hr. lec., 1 hr. demonstration.).

CHEM 313. Instrumental Analysis Laboratory. 1 Hour.
PR: CHEM 310. Practical application of modern instrumental methods to problems in chemical analysis. (3 hr. lab.).

CHEM 335. Methods of Structure Determination. 4 Hours.
PR: CHEM 234 and CHEM 236. Use of chemical methods and UV, IR, NMR, and mass spectroscopy to elucidate structures of organic compounds. For students in chemistry and related fields who may need these methods in research and applied science. (2 hr. lec., 2 hr. lab.).

CHEM 337. Polymer Chemistry. 3 Hours.
PR: CHEM 234 and physical chemistry. Methods, mechanisms, and underlying theory of polymerization. Structure and stereochemistry of polymers in relation to chemical, physical, and mechanical properties. (3 hr. lec.).

CHEM 339. Organic Syntheses. 3 Hours.
PR: CHEM 234 and CHEM 236. Modern synthetic methods of organic chemistry. (1 hr. lec., two 3 hr. lab.).

CHEM 341. Physical Chemistry: Brief Course. 3 Hours.
PR: (CHEM 116 with a minimum grade of C- and CHEM 215) or CHEM 118 and MATH 156 and (PHYS 102 or PHYS 112). Beginning physical chemistry covering the subjects of chemical thermodynamics, chemical dynamics, and the structure of matter. (Students may not receive credit for CHEM 346 and 348 and for CHEM 341.).

CHEM 342. Experimental Physical Chemistry. 1 Hour.
PR or CONC: CHEM 341. Laboratory work in physical chemistry designed to accompany CHEM 341. (One 3 hr. lab.).

CHEM 346. Physical Chemistry. 3 Hours.
PR: CHEM 234 and MATH 156 and PHYS 112. A first course in physical chemistry. Topics include a study of thermodynamics and chemical equilibria. (3 hr. lec.) (Students may not receive credit for CHEM 346 and for CHEM 341.).
CHEM 347. Physical Chemistry Laboratory. 1 Hour.
PR: (CHEM 118 or CHEM 215) and CHEM 346. Experimentation illustrating the principles of physical chemistry and offering experience with chemical instrumentation. (One 3 hr. lab.).

CHEM 348. Physical Chemistry. 3 Hours.
PR: CHEM 346 and MATH 251. Continuation of CHEM 346. Chemical dynamics and the structure of matter. (3 hr. lec.) (Students may not receive credit for CHEM 348 and for CHEM 341.).

CHEM 349. Physical Chemistry Laboratory. 2 Hours.
PR: CHEM 346 and CHEM 347 and CHEM 348. Continuation of CHEM 347. (Two 3 hr. lab.).

CHEM 376. Research Methods. 3 Hours.
PR: (CHEM 118 or CHEM 215) and PR or CONC: ARSC 220. An introduction to the tools and mathematics that scientists use to solve scientific problems. Mathematical modeling, experimental design, hypothesis formulation, data collection, use of statistics, reading and evaluating the scientific literature, writing and reviewing scientific papers, and oral presentation of scientific research.

CHEM 393. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 401. Chemical Literature. 1 Hour.
PR: CHEM 234 and (CHEM 341 or CHEM 346). Study of techniques for locating, utilizing, and compiling information needed by the research worker in chemistry. (1 hr. lec.).

CHEM 403. Undergraduate Seminar. 1 Hour.
PR: CHEM 401. Instruction in design and presentation of topics of current chemical interest. (1 hour individual instruction and/or lecture.).

CHEM 411. Intermediate Analytical Chemistry. 3 Hours.
PR: CHEM 215 and physical chemistry. Concepts underlying modern analytical procedures and their application to the solution of contemporary problems; presented at the intermediate level. (3 hr. lec.).

CHEM 422. Intermediate Inorganic Chemistry. 3 Hours.
PR: Physical chemistry. Structure, bonding, and reactivity of compounds of main-group and transition metal elements. Molecular structure and symmetry, solid state chemistry, ligand field theory, and coordination chemistry. (3 hr. lec.).

CHEM 423. Inorganic Synthesis Laboratory. 2 Hours.
PR: CHEM 422. Application of modern synthetic and spectroscopic methods of analysis to the preparation and characterization of main group, solid-state, transition metal, and organometallic compounds. (Two 3 hr. lab.).

CHEM 440. Quantum Chemistry. 3 Hours.
PR: CHEM 348. Introduction to the principles of quantum mechanics and its application to atoms, molecules, solids, spectroscopy, and computational chemistry.

CHEM 444. Colloid and Surface Chemistry. 3 Hours.
PR: Physical chemistry. Selected topics in the properties and physical chemistry of systems involving macromolecules, lyophobic colloids, and surfaces. (3 hr. lec.).

CHEM 449A. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled course.

CHEM 460. Forensic Chemistry. 3 Hours.
PR:CHEM 115 and CHEM 116 and CHEM 117 and CHEM 118 and CHEM 233 and CHEM 236 and CHEM 215 or instructor permission. Analytical chemistry as applied in forensic science. Drug analysis, toxicology, arson, paints, polymers, fibers, inks, and gunshot residue.

CHEM 462. Biochemistry 2. 3 Hours.
PR: AGBI 410. Second semester of undergraduate biochemistry with a focus on the molecular level processes that enable life and the integration of multiple hierarchies of mechanistic regulation.

CHEM 463. Forensic Chemistry Lab. 1 Hour.
PR: (CHEM 115 and CHEM 116) or (CHEM 117 and CHEM 118) and CHEM 233 and CHEM 236 required and CHEM 215 or instructor permission and PR or CONC: CHEM 460. Analytical chemistry as applied in forensic science. Drug analysis, toxicology, arson, paints, polymers, fibers, inks, and gunshot residue.

CHEM 464. Biochemistry 2 Laboratory. 1 Hour.
PR: AGBI 410 and AGBI 412 and PR or Conc:CHEM 462. Second semester of undergraduate biochemistry lab, familiarizes students with biochemical techniques used in the analysis of biological species/processes.

CHEM 490. Teaching Practicum: Peer-Led Team Learning. 1-3 Hours.
PR: Consent. Teaching practice as a tutor or assistant.

CHEM 490A. Teaching Practicum-CLC. 1-3 Hours.
PR: Consent. Teaching practice as a tutor or assistant.
CHEM 490B. Teaching Practicum - TA. 1-3 Hours.
PR: Consent. Teaching practice as a tutor or assistant.

CHEM 491. Professional Field Experience. 1-18 Hours.
PR: Consent. (May be repeated up to a maximum of 18 hours.) Prearranged experiential learning program, to be planned, supervised, and evaluated for credit by faculty and field supervisors. Involves temporary placement with public or private enterprise for professional competence development.

CHEM 492. Directed Study. 1-3 Hours.
Directed study, reading, and/or research.

CHEM 493. Special Topics. 6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CHEM 494. Seminar. 1-3 Hours.
PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

CHEM 496. Senior Thesis. 1-3 Hours.
PR: Consent.

CHEM 497. Research. 1-6 Hours.
Independent research projects.

CHEM 498. Honors. 1-3 Hours.
PR: Students in Honors Program and consent by the honors director. Independent reading, study, or research.