Students may pursue chemistry by following either the specialized curriculum in chemistry (leading to the Bachelor of Science in Chemistry), or one of two concentrations (Chemistry Concentration or Chemistry Teaching Concentration) in the Sciences and Letters Curriculum (leading to the Bachelor of Science in Liberal Arts and Sciences). Students within the specialized curriculum in Chemistry may choose the Environmental Chemistry concentration.

In addition, students may pursue chemistry as part of the LAS Major in Computer Science and Chemistry. The department also sponsors a minor in chemistry. These programs of study are administered by the Department of Chemistry.

The specialized curriculum in chemistry is a rigorous, specialized program suitable for those planning careers in chemistry. It meets standards prescribed by the American Chemical Society. The chemistry concentration (in the Sciences and Letters Curriculum) is used by some students planning chemistry careers, but it is more often chosen by students wishing to obtain chemistry backgrounds for use in related fields.

Cooperative Education Program: Students accepted into the School of Chemical Sciences Cooperative Education Program spend alternate periods of attendance at the University with periods of employment in industry or government. Transcript recognition is given as well as a certificate of participation at graduation. Additional information and applications are available in the School of Chemical Sciences Placement and Student Services office.

Chemistry Advising Information:

For the Chemistry Majors and Minor, contact SCS Academic Advising. Additional information and applications are available in the School of Chemical Sciences Placement and Student Services office.

For the Degree of Bachelor of Science in Chemistry

- Major in Specialized Curriculum in Chemistry (leading to the Bachelor of Science in Chemistry)
- Environmental Chemistry Concentration

For the Degree of Bachelor of Science in Liberal Arts and Sciences

Major in Sciences and Letters Curriculum

Students must select one concentration:

- Chemistry Concentration
- Chemistry Teaching Concentration

Minor in Chemistry

For advising see the Chemistry Overview Section. 

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>CHEM 102</td>
<td>General Chemistry I</td>
<td>8-10</td>
</tr>
<tr>
<td>CHEM 103</td>
<td>General Chemistry Lab I</td>
<td></td>
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<tr>
<td>CHEM 104</td>
<td>General Chemistry II</td>
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<tr>
<td>CHEM 105</td>
<td>General Chemistry Lab II</td>
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<td>CHEM 202</td>
<td>Accelerated Chemistry I</td>
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<tr>
<td>CHEM 203</td>
<td>Accelerated Chemistry Lab I</td>
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<td>CHEM 204</td>
<td>Accelerated Chemistry II</td>
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<tr>
<td>CHEM 205</td>
<td>Accelerated Chemistry Lab II</td>
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<tr>
<td>CHEM 232</td>
<td>Elementary Organic Chemistry I</td>
<td>3 or 4</td>
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<tr>
<td>or CHEM 236</td>
<td>Fundamental Organic Chem I</td>
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<tr>
<td>CHEM 233</td>
<td>Elementary Organic Chem Lab I</td>
<td>2</td>
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<tr>
<td>or CHEM 234</td>
<td>Structure and Synthesis</td>
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</tr>
</tbody>
</table>

Choose two 3-4 credit hour courses from the List of Advanced Courses Approved for Chemistry Minor Credit (300- and 400-level Chemistry courses, not research or independent study, 3 hours credit or more)

| Total Hours | 19-24 |

1. The following courses may not be used to complete the minor: CHEM 315, CHEM 397, CHEM 420, CHEM 445, CHEM 447, CHEM 492, CHEM 494, CHEM 496, CHEM 497 and CHEM 499.

Information listed in this catalog is current as of 03/2018
**Courses**

**CHEM 101  Introductory Chemistry  credit: 3 Hours.**
Introduction to the basic concepts and language of chemistry; lectures, discussions, and lab. Preparatory chemistry course for students who require additional background before enrolling in CHEM 102. This course has been approved for graduation credit for all students in the College of LAS. Students in other colleges should check with their college office. Additional fees may apply. See Class Schedule. Prerequisite: 2.5 years of high school mathematics, or credit or concurrent registration in MATH 112. This course satisfies the General Education Criteria for: Nat Sci Tech - Phys Sciences

**CHEM 102  General Chemistry I  credit: 3 Hours.**
For students who have some prior knowledge of chemistry. Principles governing atomic structure, bonding, states of matter, stoichiometry, and chemical equilibrium. Credit is not given for both CHEM 102 and CHEM 202. CHEM 102 and CHEM 103 are approved for General Education credit only as a sequence. Both courses must be completed to receive Natural Science and Technology credit. Prerequisite: Credit in or exemption from MATH 112; one year of high school chemistry or equivalent. All students enrolled in CHEM 102 should also enroll in CHEM 103. This course satisfies the General Education Criteria for: Nat Sci Tech - Phys Sciences

**CHEM 103  General Chemistry Lab I  credit: 1 Hour.**
Laboratory studies to accompany CHEM 102. Additional fees may apply. See Class Schedule. Prerequisite: CHEM 102 or CHEM 202 or consent of instructor. This course satisfies the General Education Criteria for: Nat Sci Tech - Phys Sciences

**CHEM 104  General Chemistry II  credit: 3 Hours.**
Lecture and discussions. Chemistry of materials, including organic and biological substances, chemical energetics and equilibrium, chemical kinetics, and electrochemistry. Credit is not given for both CHEM 104 and CHEM 204. Prerequisite: CHEM 102 or CHEM 202 or advanced placement credit for one semester of college-level chemistry. This course satisfies the General Education Criteria for: Nat Sci Tech - Phys Sciences

**CHEM 105  General Chemistry Lab II  credit: 1 Hour.**
Laboratory studies to accompany CHEM 104. Additional fees may apply. See Class Schedule. Prerequisite: CHEM 102 and CHEM 103; credit or concurrent registration in CHEM 104 is required. This course satisfies the General Education Criteria for: Nat Sci Tech - Phys Sciences

**CHEM 108  Chemistry, Everyday Phenomena  credit: 3 Hours.**
Laboratory-based work in which students will evaluate products (such as antacids), synthesize materials (such as soap), and gain a better understanding of forensic chemistry. Additional fees may apply. See Class Schedule. Prerequisite: CHEM 108 does not count toward Chemistry requirements for students in the Specialized Curriculum in Chemistry, the Science and Letters Chemistry major, the Chemistry Teaching Option, or the Chemistry minor; however the course may be taken by students in any of these groups for general education hours. Prerequisite: Credit or concurrent registration in MATH 112. This course satisfies the General Education Criteria for: Nat Sci Tech - Phys Sciences

**CHEM 123  Teaching Elementary & Middle School Chemistry  credit: 3 Hours.**
Inquiry-based, hands-on study of chemistry for prospective elementary and middle school teachers. Next Generation Science Standards are emphasized. Credit is not given toward the hours of chemistry required for chemistry and related majors. Prerequisite: Preference given to students in Elementary Education.

**CHEM 197  Individual Study Freshman  credit: 1 to 2 Hours.**
Individual study of problems related to chemistry or research not necessarily leading to a senior thesis. May be repeated in separate terms to a maximum of 4 hours. A maximum of 2 hours may be used toward the major. A maximum of 18 hours of CHEM 197, CHEM 297, CHEM 397, CHEM 497 and/or CHEM 499 may be used toward the degree. Prerequisite: Chemistry faculty approval required to register.

**CHEM 199  Undergraduate Open Seminar  credit: 0 to 5 Hours.**
Approved for letter and S/U grading. May be repeated.

**CHEM 202  Accelerated Chemistry I  credit: 3 Hours.**
Lectures and discussions. Beginning chemistry course for students in the chemical sciences and others with strong high school chemistry and mathematics preparation. Chemical calculations, structure, bonding and equilibrium. Credit is not given for both CHEM 202 and CHEM 102. Prerequisite: Credit or concurrent registration in MATH 220 or MATH 221; concurrent registration in CHEM 203. This course satisfies the General Education Criteria for: Nat Sci Tech - Phys Sciences

**CHEM 203  Accelerated Chemistry Lab I  credit: 2 Hours.**
Companion laboratory course to CHEM 202. Comprehensive skills-oriented approach to learning laboratory technique and safety. Additional fees may apply. See Class Schedule. Students may receive no more than two credit hours for both this course and CHEM 103. Prerequisite: Concurrent registration or credit in CHEM 202 or consent of instructor.

**CHEM 204  Accelerated Chemistry II  credit: 3 Hours.**
Continuation of CHEM 202. Lectures and discussions. Emphasizes chemical thermodynamics, equilibrium, chemical kinetics, and coordination chemistry. Prerequisite: CHEM 202 and/or CHEM 203 and concurrent registration in CHEM 205, or consent of instructor. This course satisfies the General Education Criteria for: Nat Sci Tech - Phys Sciences

**CHEM 205  Accelerated Chemistry Lab II  credit: 2 Hours.**
Laboratory and discussion. Includes experiments in qualitative analysis, inorganic synthesis, and kinetics as well as an individual project. Additional fees may apply. See Class Schedule. Credit is not given for both CHEM 205 and CHEM 223. Prerequisite: Concurrent registration in CHEM 204 or consent of department.

*Information listed in this catalog is current as of 03/2018*
CHEM 222  Quantitative Analysis Lecture  credit: 2 Hours.
Fundamentals of quantitative analysis, chemical equilibrium and kinetics. This lecture course is intended to accompany CHEM 223. Students with credit in CHEM 222 can receive credit for CHEM 203. Prerequisite: CHEM 104 and CHEM 105 or equivalent.

CHEM 223  Quantitative Analysis Lab  credit: 2 Hours.
Laboratory course covers the fundamentals of quantitative analysis, equilibrium and kinetics. Additional fees may apply. See Class Schedule. Credit is not given for both CHEM 223 and CHEM 205. Prerequisite: Credit or concurrent registration in CHEM 222.

CHEM 232  Elementary Organic Chemistry I  credit: 3 or 4 Hours.
Prepares students for the separation, isolation and purification of organic compounds. For students in agricultural, nutritional and biological sciences, as well as premedical, preprofessional, preprofessional and premedical programs. One-term survey course may be followed by CHEM 332. Credit is not given for both CHEM 232 and CHEM 236. 3 hours of credit is an option for those not registered in a discussion-recitation section. 4 hours of credit requires registration in a discussion-recitation section and a live lecture or an online section. Prerequisite: CHEM 104 and CHEM 105, or CHEM 204.

CHEM 233  Elementary Organic Chem Lab I  credit: 2 Hours.
Basic laboratory techniques in organic chemistry are presented with emphasis on applications of this material to closely related areas. For students in agricultural, nutritional and biological sciences, as well as premedical, preprofessional, and preprofessional and premedical programs. One-term survey course may be followed by CHEM 332. Credit is not given for both CHEM 232 and CHEM 236. 3 hours of credit is an option for those not registered in a discussion-recitation section. 4 hours of credit requires registration in a discussion-recitation section and a live lecture or an online section. Prerequisite: CHEM 104 and CHEM 105, or CHEM 204.

CHEM 236  Fundamental Organic Chem I  credit: 4 Hours.
Fundamental structural, synthetic, and mechanistic organic chemistry is presented. For students whose major is chemistry or for those in the specialized curricula in chemistry or chemical engineering. The first term of a two-semester sequence (to be followed by CHEM 436). This lecture course is intended to accompany CHEM 237. Credit is not given for both CHEM 236 and CHEM 232. Prerequisite: CHEM 204 or CHEM 222 through CHEM 223.

CHEM 237  Structure and Synthesis  credit: 2 Hours.
Laboratory course introduces synthesis and the basic techniques for the separation, isolation and purification of organic and inorganic compounds. Additional fees may apply. See Class Schedule. Credit is not given for both CHEM 237 and CHEM 233. Prerequisite: Credit or concurrent registration in CHEM 236.

CHEM 293  Cooperative Education Practice  credit: 0 Hours.
Off-campus cooperative practice of chemistry or chemical engineering in industrial or governmental facilities. Each chemistry or chemical engineering student participating in cooperative education must register for CHEM 293 for each off-campus term. Same as CHBE 202. Approved for S/U grading only. Prerequisite: Acceptance into the School of Chemical Sciences Cooperative Education Program.

CHEM 295  Chemistry Internship  credit: 0 Hours.
Full-time practice of chemical science in an off-campus industrial setting or research laboratory environment. Summary report required. Approved for S/U grading only. May be repeated. Prerequisite: Completion of freshman year or equivalent, or consent of Director of Cooperative Education in Chemistry.

CHEM 297  Individual Study Sophomore  credit: 1 to 3 Hours.
Individual study of problems related to chemistry or research not necessarily leading to a senior thesis. May be repeated in separate terms. A maximum of 6 hours may be used toward the major. A maximum of 18 hours of CHEM 197, CHEM 297, CHEM 397, CHEM 497 and/or CHEM 499 may be used toward the degree. Prerequisite: Chemistry faculty approval required to register.

CHEM 312  Inorganic Chemistry  credit: 3 Hours.
Basic chemical bonding in molecules, introduction to symmetry, chemistry of the main group elements, coordination chemistry of the transition elements, organometallic chemistry, solid state chemistry, bioinorganic chemistry, chemistry of the lanthanide and actinide elements. Prerequisite: CHEM 232 or CHEM 236.

CHEM 315  Instrumental Chem Systems Lab  credit: 2 Hours.
Laboratory course emphasizes the application of modern instrumental techniques for characterizing the kinetic behavior and equilibrium properties of chemical systems. Prerequisite: Either CHEM 237 or both CHEM 223 and CHEM 233.

CHEM 317  Inorganic Chemistry Lab  credit: 3 Hours.
Emphasizes techniques for the synthesis, purification, and characterization of inorganic and organometallic compounds. There are three components to the course: lectures on laboratory methodology and reporting, laboratory experiments, and report writing. The final third of the course is dedicated to special individualized projects. Additional fees may apply. See Class Schedule. Prerequisite: CHEM 312; completion of campus Composition I general education requirement. This course satisfies the General Education Criteria for: Advanced Composition

CHEM 332  Elementary Organic Chem II  credit: 4 Hours.
Continuation of CHEM 232 focuses on organic chemistry and its applications to biochemistry, enzyme mechanisms and the life sciences. Credit is not given for both CHEM 332 and CHEM 436. This course should not be taken by students who have completed CHEM 236. Prerequisite: CHEM 232 and CHEM 233.

CHEM 360  Chemistry of the Environment  credit: 3 Hours.
Study of the chemistry of the atmosphere, the chemistry of soil and minerals in the Earth's crust, chemistry of natural waters, agricultural chemicals and organic pollutants, and topics related to energy use. Prerequisite: One year of general chemistry (CHEM 102-105 or CHEM 202-205) and one semester of organic chemistry (CHEM 232 or CHEM 236). The organic chemistry may be taken concurrently with CHEM 360.

CHEM 397  Individual Study Junior  credit: 1 to 3 Hours.
Individual study of problems related to chemistry or research not necessarily leading to a senior thesis. May be repeated in separate terms. A maximum of 6 hours may be used toward the major. A maximum of 18 hours of CHEM 197, CHEM 297, CHEM 397, CHEM 497 and/or CHEM 499 may be used toward the degree. Prerequisite: Chemistry faculty approval required to register.

CHEM 420  Instrumental Characterization  credit: 2 Hours.
Lecture course covers the fundamentals of instrumental characterization including: nuclear magnetic resonance spectroscopy, potentiometry, voltammetry, atomic and molecular spectroscopy, mass spectrometry, and gas and liquid chromatography. 2 undergraduate hours. 2 graduate hours. Prerequisite: CHEM 440; or credit or concurrent registration in CHEM 442; or consent of the instructor.
CHEM 346  **Fundamental Organic Chem II**  credit: 3 Hours.
Course is the second term of a two-term integrated sequence and should be taken the term following enrollment in CHEM 236. 3 undergraduate hours. 3 graduate hours. Credit is not given for both CHEM 436 and CHEM 332. Prerequisite: CHEM 236 and CHEM 237; or CHEM 232 and CHEM 233 with consent of instructor.

CHEM 347  **Organic Chemistry Lab**  credit: 3 Hours.
Laboratory experiments in organic chemistry with emphasis on synthesis, purification and spectroscopic identification of organic compounds. Additional fees may apply. See Class Schedule. 3 undergraduate hours. 3 graduate hours. Prerequisite: CHEM 233 or CHEM 237 and credit or concurrent registration in CHEM 332 or CHEM 436. This course satisfies the General Education Criteria for: Advanced Composition

CHEM 348  **Advanced Organic Chemistry**  credit: 3 Hours.
Advanced topics in structure, synthesis and reactions of organic chemistry. Lecture only course. 3 undergraduate hours. 3 graduate hours. Prerequisite: CHEM 332 or CHEM 436.

CHEM 440  **Physical Chemistry Principles**  credit: 4 Hours.
One-term course in physical chemistry emphasizing topics most important to students in the biological and agricultural sciences. Not open to students in the specialized curricula in chemistry and chemical engineering. Laboratory experience in this area provided by CHEM 315 to be taken preferably after CHEM 440. Same as BIOL 440. 4 undergraduate hours. 4 graduate hours. Prerequisite: CHEM 222 and CHEM 232; or equivalent; PHYS 102; and MATH 241 or equivalent calculus including partial derivatives.

CHEM 442  **Physical Chemistry I**  credit: 4 Hours.
Lectures and problems focusing on microscopic properties. CHEM 442 and CHEM 444 constitute a year-long study of chemical principles. CHEM 442 focuses on quantum chemistry, atomic and molecular structure, spectroscopy and dynamics. 4 undergraduate hours. 4 graduate hours. Credit is not given for both CHEM 442 and PHYS 485. Prerequisite: CHEM 204 or CHEM 222; MATH 225 or MATH 415, and a minimal knowledge of differential equations, or equivalent; and PHYS 211, PHYS 212, and PHYS 214 or equivalent.

CHEM 444  **Physical Chemistry II**  credit: 4 Hours.
Continuation of CHEM 442, focusing on thermodynamics, statistical mechanics and kinetics from single molecules to the bulk, in gases and in the condensed phase. 4 undergraduate hours. 4 graduate hours. Credit is not given for CHEM 444 and MATH 401 or PHYS 427. Prerequisite: CHEM 442.

CHEM 445  **Physical Principles Lab I**  credit: 2 Hours.
Laboratory course features experiments concerning the fundamental physical nature of chemical phenomena. Experiments include infrared spectroscopy, protein folding, x-ray diffraction and laser induced fluorescence. 2 undergraduate hours. 2 graduate hours. Prerequisite: CHEM 315, and credit or concurrent registration in CHEM 444; or consent of instructor.

CHEM 447  **Physical Principles Lab II**  credit: 2 Hours.
Laboratory course features advanced experiments concerning the fundamental physical nature of chemical phenomena. This course is a continuation of CHEM 445. Experiments include low-energy electron diffraction from surfaces, raman spectroscopy and ion cyclotron resonance mass spectroscopy. 2 undergraduate hours. 2 graduate hours. Prerequisite: CHEM 445 or consent of instructor.

CHEM 450  **Astrochemistry**  credit: 4 Hours.
Covers the foundations of astrochemistry, a young field at the intersection between chemistry and astronomy. Topics to be discussed include the interstellar medium, atomic and molecular physics, interstellar chemistry, molecular astronomy, and unresolved enigmas in the field. Same as ASTR 450. 4 undergraduate hours. 4 graduate hours. Prerequisite: CHEM 442 and CHEM 444, or PHYS 427 and PHYS 486, or equivalent experience in quantum mechanics, thermodynamics, and statistical mechanics.

CHEM 451  **Astrochemistry Laboratory**  credit: 3 or 4 Hours.
An active, hands-on introduction to observational astrochemistry, laboratory astrochemistry and theoretical astrochemistry. Activities will include astronomical observations of interstellar molecules at the Observatory, spectroscopy of molecules in the laboratory, quantum chemical calculations and simulations of molecular spectra, and modeling of interstellar chemistry. Same as ASTR 451. 3 or 4 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CHEM 450.

CHEM 460  **Green Chemistry**  credit: 3 or 4 Hours.
This course seeks to reduce the environmental consequences of the chemical industry. It includes modifying engineering practices, the development of new catalytic processes, modification of existing chemical processes, and bioremediation. 3 undergraduate hours. 4 graduate hours. Prerequisite: CHEM 312, CHEM 332, CHEM 360, or consent of instructor.

CHEM 472  **Physical Biochemistry**  credit: 3 Hours.
Same as MCB 446 and BIOL 446. See BIOL 446.

CHEM 474  **Drug Discovery & Development**  credit: 3 Hours.
Lecture course on fundamentals of drug discovery and development. Topics include case studies of top-selling, mechanistically diverse drugs, chemistry of drug contraindications, structural biology of drug targets, mechanisms of drug resistance, and drug metabolism and toxicity. 3 undergraduate hours. 3 graduate hours. Prerequisite: CHEM 332 or CHEM 436; and MCB 354 or MCB 450, or consent of instructor.

CHEM 480  **Polymer Chemistry**  credit: 3 or 4 Hours.
Same as MCB 446. See MCB 446.

CHEM 482  **Polymer Physics**  credit: 3 or 4 Hours.
Same as MCB 458. See MCB 458.

CHEM 483  **Solid State Structural Analys**  credit: 4 Hours.
Lectures and laboratory on various aspects of X-ray diffraction studies of solids; topics include the properties of crystals, symmetry, diffraction techniques, data collection methods, and the determination and refinement of crystal structures. 4 undergraduate hours. 4 graduate hours. Prerequisite: CHEM 442 or consent of instructor.

CHEM 488  **Surfaces and Colloids**  credit: 3 or 4 Hours.
Same as MCB 480. See MCB 480.

CHEM 492  **Special Topics in Chemistry**  credit: 1 to 3 Hours.
Open to advanced undergraduates and graduate students. Deals with subjects not ordinarily covered by regularly scheduled courses. 1 to 3 undergraduate hours. 1 to 3 graduate hours. Approved for letter and S/U grading. Prerequisite: Credit or concurrent registration in any 400-level course in chemistry.

CHEM 494  **Lab Safety Fundamentals**  credit: 1 Hour.
Same as MCB 492. See MCB 492.
CHEM 495  Teaching Secondary Chemistry  credit: 4 Hours.
Intended for undergraduates working toward certification to teach high
school chemistry and graduate students working towards a Master's
degree in the Teaching of Chemistry. Course aims to provide future
teachers with hands-on experience in conducting laboratory experiments,
demonstrations, and teaching strategies. 4 undergraduate hours. 4
graduate hours. Course does not count toward the eleven advanced
hours in chemistry required in the specialized curriculum, nor does it
apply to coursework required for the Ph.D. in Chemistry. Prerequisite:
Undergraduate background in general chemistry and credit or concurrent
enrollment in CI 403.

CHEM 496  Undergraduate Research Abroad  credit: 1 to 4 Hours.
Students assist in research under faculty supervision at a location
outside of the United States. Topics and type of assistance vary. 1 to 4
undergraduate hours. No graduate credit. May be repeated in separate
terms up to 6 hours. Prerequisite: Evidence of adequate preparation
for such study; consent of faculty member supervising the work (who
will have examined the proposed research plan); and approval of the
department. Not available to freshman.

CHEM 497  Individual Study Senior  credit: 1 to 3 Hours.
Individual study of problems related to chemistry or research not
necessarily leading to a senior thesis. Course Information:1 to 3
undergraduate hours. No graduate credit. May be repeated in separate
terms. A maximum of 6 hours may be used toward the major. A maximum
of 18 hours of CHEM 197, CHEM 297, CHEM 397, CHEM 497 and/or
CHEM 499 may be used toward the degree. Prerequisite: Chemistry
faculty approval required to register.

CHEM 499  Senior Thesis  credit: 2 to 6 Hours.
Research with thesis, under the direction of a senior staff member in
chemistry. Normally the student takes two terms of CHEM 499 in the
senior year. 2 to 6 undergraduate hours. No graduate credit. May be
repeated up to 10 hours in separate terms. CHEM 499 is recommended
for all those who plan to do research and graduate study and it is a
prerequisite for graduation with distinction in chemistry. In the term
preceding their initial enrollment, those interested in taking the course
should consult with their advisers and with the graduate adviser for the
area of interest in which they plan to work. A maximum of 10 hours may
be counted toward graduation and a thesis must be presented for credit
to be received.