Chemistry

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Master of Science in Chemistry

Goals

1. Graduates will attain a broad knowledge in their focus area of chemistry.
2. Graduates will conduct novel research in chemistry.
3. Graduates will be prepared to continue their education in pursuit of a doctorate or to enter the workforce.

Combined BS/MS Program in Chemistry

Goals

1. Students will obtain a broad knowledge in the four major areas of chemistry.
2. Graduates will conduct research in a narrow part of one of the above.
3. Graduates will be prepared to continue their education in pursuit of a doctorate or to enter the workforce.

Application Process

All applications for Fall admission to Chemistry must be submitted by April 1, and should include the following components, uploaded within the application form:

1. Unofficial/Official transcripts describing all post-secondary work. All official transcripts will be required if admitted.
2. A letter of intent describing your reasons for choosing our program, and how your personal strengths and goals align with your expectations of the program.
3. Three letters of recommendation, submitted through the application system, from professionals in the sciences or mathematics attesting to your potential to succeed in a graduate chemistry program.

Applications for the BS/MS program should be submitted directly to the Chemistry Department, and should also include a summary of current courses and expected grades. Applications for the MS programs should be submitted to the graduate school, following their additional guidelines on pages 7-9. These include submission of GRE scores and payment of a processing fee.

Doctor of Philosophy in Engineering and Applied Science

A doctoral program in Engineering and Applied Science, administered through the College of Science and Engineering, is available to Chemistry students. The complete program description is provided elsewhere in the College of Science & Engineering section of the Graduate Catalog.

Master of Science in Chemistry

Admission Requirements

The student must meet all criteria for admission to the Graduate School.

In addition, each applicant must have a GPA of at least 3.0 for all upper-division credits taken in the previous degree program (a B.S. or B.A. in Chemistry). Graduate Record Examination (GRE) scores must be in the 35th percentile or higher in two of the exam's three sections.

Several courses are prerequisite for the M.S. degree programs; any student who has not yet met these requirements must take them as part of their M.S. program. These are:

1. one semester of calculus
2. one year of physics
3. one semester of inorganic chemistry
4. one year of organic chemistry
5. one semester of analytical chemistry
6. one year of physical chemistry

Many of these requirements must be completed prior to enrolling in specific MS-level courses. Credits earned in these undergraduate courses do not count toward the 30 credit requirement for the M.S. degree.

General Requirements

The M.S. program includes both thesis and non-thesis degree options, each of which requires a total of 30 graduate credits including 15 credits in 6600-level chemistry or chemistry-related courses. The latter set of credits are drawn primarily from among four core classes, CHEM 6609, CHEM 6630, CHEM 6655, and CHEM 6671, and all MS students are required to take 2 credits of seminar, CHEM 6601. Each program of study must be approved by the student's committee, the Chemistry Department, and the Graduate School.

Thesis Option

The thesis option emphasizes original research in a specific field, and requires a substantial, original research project that culminates in a thesis and defense. Timely completion of this degree typically involves summer research in addition to the formal coursework outlined below. At least one of the core advanced courses is required, but others may, with committee approval, be replaced by other electives more relevant to a specific student's field of study. A minimum total of 30 graduate credits is required, and a suggested schedule that maintains full-time status is outlined below:

First Year

Fall/Spring	Credits	Summer	Credits
CHEM 6630[1]	3	CHEM 6635	1-6
CHEM 6655[1]	3		
CHEM 6635	2-6		
CHEM 6601	1		

Electives and/or Prerequisites	6	
	15-19	1-6

Second Year

Fall/Spring	Credits
CHEM 6671[1]	3
CHEM 6609[1]	3
CHEM 6650	6
CHEM 6601	1
Electives	5
	18

Total Credits: 34-43

1 All but one of these courses may, with committee and chair approval, be replaced by other graduate electives.

Non-Thesis Option

The non-thesis option emphasizes accumulation of broad chemical knowledge through coursework encompassing all fields of the discipline. Students may count no thesis credits and limited research credits toward this degree, and complete a multi-part written exam and subsequent oral defense at the conclusion of the program. A minimum total of 30 graduate credits is required, and a suggested schedule that maintains full-time status is outlined below:

First Year

Fall/Spring	Credits
CHEM 6630[1]	3
CHEM 6655[1]	3
CHEM 5581[2]	2
CHEM 6601	1
Electives and/or Prerequisites[2]	11
	20

Second Year

Fall/Spring	Credits
CHEM 6671[1]	3
CHEM 6609[1]	3
CHEM 6601	1
Electives[2]	11
	18

Total Credits: 38

1 With the chair's approval these courses may be replaced by other 6600-level coursework electives; at least 15 6600-level CHEM credits are required in total.

2 Only 4 total credits in graduate research (among CHEM 5581, 5582, and CHEM 6635) may be counted toward the non-thesis degree requirements. After taking CHEM 6635 students are required to maintain continuous registration, including summer semesters, until graduation.

Combined BS/MS Program in Chemistry

The BS/MS in Chemistry is administered as a combined program, but graduates will receive separate BS and MS degrees in chemistry on their transcripts. Students may opt to complete a BS in biochemistry instead of a BS in chemistry within this program, but the MS degree must be in chemistry.

Admission Requirements

Students may be admitted to the program after having completed 64 credit hours. Application for admission must be made to the Chemistry Department. In addition, the student should have completed the following courses or their equivalent:

Code	Title	Credits
CHEM 1111 & 1111L	General Chemistry I and General Chemistry I Lab	5
CHEM 1112 & 1112L	General Chemistry II and General Chemistry II Lab	4
CHEM 3301 & CHEM 3303	Organic Chemistry I and Organic Chemistry Laboratory I	4
CHEM 3302 & CHEM 3304	Organic Chemistry II and Organic Chemistry Laboratory II	4
MATH 1170	Calculus I	4
MATH 1175	Calculus II	4
PHYS 2211 & PHYS 2213	Engineering Physics I and Engineering Physics I Laboratory	5
PHYS 2212 & PHYS 2214	Engineering Physics II and Engineering Physics II Laboratory	5

Suggested Preparatory Courses

Students are encouraged, but not required, to complete the following courses prior to entering the program. These courses must be completed eventually to satisfy the BS degree requirements and also serve as prerequisites for advanced courses in the BS/MS degree.

Code	Title	Credits
CHEM 2211 & CHEM 2213	Inorganic Chemistry I and Inorganic Chemistry I Laboratory	4
CHEM 2232 & CHEM 2234	Quantitative Analysis and Quantitative Analysis Laboratory	4

General Requirements and Timeline

Students typically enter the BS/MS program after completing two years of college coursework. During the first semester each student is expected to select, subject to the approval of the Department Chair, three faculty members to serve

as their advisory committee. In the second semester, each student will work with a research advisor to devise their planned program of study, write an overview of their research project, and apply for admission to the Graduate School. The student is expected to begin research no later than their first summer in the program. Thereafter, individual sections of a research paper will be required as the student progresses through the program.

The student must complete a total of 150 credit hours, equivalent to 120 credit hours for a BS degree and 30 credit hours for an MS degree. The final course selection must be approved by the student's advisory committee. Students are required to complete all general education requirements by the end of their second year in the BS/MS program, and should complete the combined degree within 3 years of admission to the program. Successful completion of the program requires that the student write and defend an original research paper before their research committee.

The student must satisfy admission requirements and be admitted to the Graduate School prior to their fourth year. Continuation in the program requires that the student maintain a minimum GPA of 3.0 from date of admission, and make satisfactory progress as approved by their committee. Students failing to make adequate coursework or research progress will be asked to discontinue the program. Students choosing to withdraw from the program for any reason should notify the department in writing, and indicate the undergraduate degree toward which they intend to continue. A student wishing to apply their BS/MS progress towards a stand-alone MS degree (thesis or non-thesis) must reapply to that program following the steps in the above Application Process section.

Suggested Schedule

The following schedule shows how a typical chemistry student might progress through the BS/MS program if they enter it having already completed CHEM 2211, CHEM 2213, CHEM 2232, and CHEM 2234. Each student is required to meet all course requirements for either the BS degree in chemistry (except independent problems CHEM 4481 and CHEM 4482, which are replaced by a total of 8 credits of CHEM 4485), or the BS in biochemistry. Students should select between 4400 and 5500 levels in advanced courses depending on their specific needs to meet credit requirements equivalent to both BS and MS degrees. Each student is required to complete two credits of seminar (CHEM 6601), ten credits of MS research (CHEM 6635), two of the advanced chemistry courses (CHEM 6609, CHEM 6630, CHEM 6655, and CHEM 6671) and six additional credits from among these or other 6600 level lecture courses. These twenty credits of 6600 level courses are taken during the second and third years of the program.

Third Year

Fall/Spring	Credits	Summer	Credits
CHEM 3331[1]	2	CHEM 4485[2]	6
CHEM 3334[1]	2		
CHEM 3351[1]	3		
CHEM 3352[1]	3		
CHEM 4451	1		
CHEM 4452	1		
MATH 2240	3		
MATH 3360	3		
Electives	11		
	29		6

Fourth Year

Fall/Spring	Credits	Summer	Credits
BIOL 4432	3	CHEM 6635	6
OR			
BIOL 4445 & BIOL 4447			
OR			
CHEM 4445 & CHEM 4447			
CHEM 3365	2		
CHEM 3366	2		
CHEM 4407	2		
CHEM 4485[2]	2		
CHEM 4491	1		
CHEM 6609[3]	3		
CHEM 6655[3]	3		
Electives	8		
	26		6

Fifth Year

Fall/Spring	Credits
CHEM 6630[3]	3
CHEM 6671[3]	3
CHEM 6635	4
CHEM 6601	1
Electives	13
	24

Total Credits: 91

1. Must be completed by the end of the junior year.
2. CHEM 4485 Replaces CHEM 4481/4482 in the regular BS curriculum.
3. Two of these four classes are required; two may be replaced by other 6600-level lecture electives.

Courses

CHEM 5500 Practicum in Physical Science: 2 semester hours.
Practical problems associated with equipping, setting up, and operating laboratories in chemistry. PREREQ: Permission of the instructor.

CHEM 5507 Inorganic Chemistry II: 2 semester hours.
Structure and reactivity of inorganic compounds including coordination compounds; acid-base chemistry and nonaqueous solvent systems; organometallic chemistry and other special topics of current interest. PREREQ: CHEM 2211 and CHEM 3352 or permission of instructor.

CHEM 5533 Environmental Chemistry: 2 semester hours.
This course applies chemical principles and calculation to investigate environmental issues. Natural systems, environmental degradation and protection, and the methodology of chemical detection and monitoring. COREQ: CHEM 5537. PREREQ: CHEM 2232 and CHEM 2234 or permission of instructor.

CHEM 5537 Environmental Chemistry Laboratory: 1 semester hour.
This laboratory course utilizes both structured and self-designed field and classroom experiments to emphasize principles of environmental chemistry. COREQ: CHEM 5533 or permission of instructor.

CHEM 5538 Experimental Biochemistry: 1 semester hour.
Laboratory course including both qualitative and quantitative experiments. Equivalent to BIOL 5537. PREREQ or COREQ: BIOL 5532 or BIOL/CHEM 5545.

CHEM 5545 Biochemistry I: 3 semester hours.
Introduction to basic aspects of biochemical systems, including fundamental chemical and physical properties of biomolecules. Enzymology, including allosterism, metabolic regulation, bioenergetics, and carbohydrate metabolism. Equivalent to BIOL 5545. PREREQ: Introductory Biology and Organic Chemistry or permission of instructor.

CHEM 5547 Biochemistry II: 3 semester hours.
Functional continuation of CHEM 5545. Lipid, amino acid, and nucleotide metabolism. Emphasis is on regulation of metabolism, metabolic dysfunctions, biochemical mechanisms of hormone action, biochemical genetics, protein synthesis, and metabolic consequences of genetic defects. Equivalent to BIOL 5547. PREREQ: BIOL/CHEM 5545.

CHEM 5548 Advanced Experimental Biochemistry: 2 semester hours.
Advanced laboratory projects designed to emphasize techniques of qualitative and quantitative biochemical analysis. Equivalent to BIOL 5548. PREREQ: BIOL 5537/CHEM 5538. COREQ: BIOL/CHEM 5547.

CHEM 5570 Biorganic Chemistry: 3 semester hours.
Overview of basic principles of organic mechanisms, and overview of biochemistry principles, fundamentals of proteins and protein synthesis, enzymes and enzyme reaction mechanisms including group transfer, hydrolysis, animations, phosphorylation, reductions and oxidation, mono- and d-oxygenation, substitutions, carboxylations, and decarboxylations, isomerizations, and eliminations and addition reactions. Specific evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: CHEM 3302 and CHEM 4445 or BIOL 4445.

CHEM 5581 Independent Problems in Chemistry: 1-4 semester hours.
Directed library and laboratory research. Courses may be repeated to a maximum of 6 credits. PREREQ: CHEM 3352.

CHEM 5582 Independent Problems in Chemistry: 1-4 semester hours.
Directed library and laboratory research. Courses may be repeated to a maximum of 6 credits. PREREQ: CHEM 3352.

CHEM 5591 Seminar: 1 semester hour.
A formal introduction to the chemical literature including electronic methods of literature searching. A detailed treatment of methods for presenting scientific seminars including a full-length student presentation on selected library or laboratory research. COREQ: CHEM 5581 or CHEM 5582 or CHEM 4485 or permission of instructor.

CHEM 5599 Experimental Course: 1-6 semester hours.
This is an experimental course. The course title and number of credits are noted by course section and announced in the class schedule by the scheduling department. Experimental courses may be offered no more than three times. May be repeated.

CHEM 6601 Seminar: 1 semester hour.
Oral reports of current literature and research in chemistry. This course may be taken multiple times as determined by degree requirements. Graded S/U.

CHEM 6609 Advanced Inorganic Chemistry: 3 semester hours.
Synthesis, reactions, spectroscopic characterization methods, and application of transition metal complexes. Foci will vary and may include metal carbon bond transformations, bioinorganic chemistry, or materials chemistry. PREREQ: CHEM 4407 or CHEM 5507 or permission of instructor.

CHEM 6610 Special Topics in Chemistry: 1-3 semester hours.
Detailed consideration of a limited phase of chemistry; course content will vary with current demand and with the instructor; may be repeated with departmental approval for non-repetitive course content.

CHEM 6615 Neutron Activation Analysis: 4 semester hours.
Theory and use of neutron activation methods for quantitative chemical analysis of natural and synthetic materials. Applications in geologic systems will be emphasized. Equivalent to GEOL 6615 and PHYS 6615. PREREQ: Permission of instructor.

CHEM 6617 Environmental Geochemistry: 3 semester hours.
Geochemistry of environmental systems. Emphasis given to low-temperature water-rock interactions, including sorption processes, retardation, reaction kinetics and reaction-mass transport modeling. Equivalent to GEOL 6617. PREREQ: GEOL 5520 or CHEM 3351.

CHEM 6621 Organic Reactions: 3 semester hours.
Advanced study of organic chemical reactions with emphasis on synthetic applications. PREREQ: CHEM 3302.

CHEM 6625 Quantitative Geochemistry Lab: 3 semester hours.
Applications of instrumental methods for geochemical analysis. Equivalent to GEOL 6625.

CHEM 6630 Advanced Analytical Chemistry: 3 semester hours.
Advanced treatment of standards, sampling, special methods of analysis, and methods of separation. PREREQ: CHEM 3302, CHEM 3304, CHEM 3334 and CHEM 3352 or permission of instructor.

CHEM 6635 Masters Research: 2-6 semester hours.
A continuation of CHEM 4435 to improve ability of students to solve chemical problems independently and pursue research at an advanced level. 2-6 credits. May be repeated for up to 12 credits. PREREQ: CHEM 4485 or permission of instructor.

CHEM 6640 Research Techniques in Chemistry: 2-6 semester hours.
Designed to improve the ability of students to solve chemical problems independently in the laboratory; special emphasis on development of manipulative skills, instrumental methods and supporting library research; nature of the projects dictated by students' needs; may be repeated with departmental approval for non-repetitive course content. Limit 12 credits.

CHEM 6650 Thesis: 1-10 semester hours.
Thesis. 1-10 credits. May be repeated. Graded S/U.

CHEM 6655 Advanced Physical Chemistry: 3 semester hours.
Introductory material from quantum chemistry and statistical mechanics with applications in chemical thermodynamics. PREREQ: CHEM 3302 and CHEM 3352 or permission of instructor.

CHEM 6671 Advanced Organic Chemistry: 3 semester hours.
Kinetics and mechanisms in organic reactions. PREREQ: CHEM 3302 and CHEM 3352 or permission of instructor.

CHEM 6699 Experimental Course: 1-6 semester hours.
This is an experimental course. The course title and number of credits are noted by course section and announced in the class schedule by the scheduling department. Experimental courses may be offered no more than three times. May be repeated.

CHEM 8850 Doctoral Dissertation: 1-12 semester hours.
Research toward and completion of the dissertation. May be repeated. Graded S/U.