

# DEPARTMENT OF CHEMISTRY

## Mission statement

The mission of the Department of Chemistry is to expand the frontiers of the molecular sciences by promoting discovery and collaboration through high-impact, internationally recognized research, to inspire and educate the next generation to be excellent, responsible, and ethical chemists, and to maintain a respectful and collegial environment for the sharing of ideas among our students and colleagues, and with the greater community.

## General Information

The faculty, students, and staff of the Department of Chemistry study how reactions occur, make new materials to enhance current technologies, develop compounds that fight disease, create cleaner and more efficient processes for industry, and make many other fundamental discoveries that benefit society. Our research covers all of the major areas, including: analytical chemistry, bioorganic chemistry, biophysical chemistry, biochemistry, bioinorganic chemistry, environmental chemistry, inorganic chemistry, organic chemistry, and physical chemistry. The goal of the program is to produce independent and creative scientists who have discipline-specific knowledge, technical and analytical training, and strong critical thinking and communication skills so that they are prepared to succeed in the multitude of careers available to graduates in the chemical sciences. Our award-winning faculty and state-of-the-art laboratory facilities provide students with opportunities for personal mentorship during individualized research projects.

## Degrees

The Master of Science (M.S.) in Chemistry and the Doctor of Philosophy (Ph.D.) in Chemistry programs offer opportunities for advanced study and research designed to prepare students for roles in industry, government, research institutes, or educational institutions. For the M.S. program, the thesis option is recommended for students who are planning a career in research or who are contemplating pursuing a doctorate in their program of study. A non-thesis option is available for students with other goals. The Ph.D. program is broad-based and will prepare students for a variety of options in chemistry and related fields upon graduation.

Faculty expertise in each area of chemistry offers the opportunity for direct student-faculty interaction for thesis or dissertation development through coursework and research. Additional cooperative projects and programs are also available with local research institutions.

Teaching and/or research assistantships and fellowships are available to qualified students. Financial assistance is awarded on a competitive basis.

- M.S. in Chemistry (p. 1)
- Ph.D. in Chemistry (p. 2)

## Master of Science Degree in Chemistry

The purpose of the Master of Science (M.S.) degree program in Chemistry is to offer students the opportunity to acquire a sound preparation of the fundamentals in several areas of chemistry, to introduce students to recent advances in chemical theory and methods, and to encourage research in a specific area of study.

Qualified students are encouraged to apply for teaching and/or research assistantships and fellowships. Requests should be sent to the Graduate

Advisor of Record for Chemistry when application is made for admission to UTSA.

The complete set of requirements for the M.S. degree in Chemistry is described in the Chemistry M.S. Program Handbook, which can be accessed on the department website.

## Admission Requirements

In addition to satisfying the University-wide graduate admission requirements, applicants must have earned a Bachelor of Arts or a Bachelor of Science degree from an accredited university with a minimum grade point average of 3.0 (on a 4.0 scale) in upper-division work, preferably in chemistry. All undergraduate chemistry courses must be completed with a minimum grade point average of 3.0.

A minimum of two letters of recommendation from persons familiar with the applicant's undergraduate scholastic record, together with a meaningful personal statement of interests and career goals, and a curriculum vitae must be sent to Graduate Admissions at the same time application is made for admission to UTSA. Background or remedial courses in chemistry may be required to remove deficiencies.

International applicants are required to prove proficiency in the English language by taking either the Test of English as a Foreign Language (TOEFL (<http://www.ets.org/toefl/>)), the International English Language Testing System (IELTS (<http://www.ielts.org/>)), or the Duolingo English Test (DET) (<https://englishtest.duolingo.com/applicants/>). See International Graduate Student Admission (<https://catalog.utsa.edu/policies/admission/graduate/internationalgraduatestudents/>) policies, for details.

## Thesis Option in Chemistry

### Degree Requirements

The Master of Science in Chemistry program (Thesis Option) requires the successful completion of a minimum of 30 semester credit hours. The student must have a grade point average of 3.0 or greater (on a 4.0 scale) in the core lecture courses and elective courses combined.

Candidates must complete the following:

Code	Title	Credit Hours
A. Required courses (21 semester credit hours):		21
Core curriculum. 9 semester credit hours selected from the following:		
CHE 5263	Advanced Analytical Chemistry	
CHE 5313	Advanced Biochemistry	
CHE 5453	Advanced Inorganic Chemistry	
CHE 5643	Advanced Organic Chemistry	
CHE 5843	Advanced Physical Chemistry	
Graduate Seminar in Chemistry (3 semester credit hours):		
CHE 5981	Graduate Seminar in Chemistry (repeated for a total of 3 hours) <sup>1</sup>	
Master's Thesis (6 semester credit hours):		
CHE 6983	Master's Thesis (including an oral defense of the written thesis, repeated for a total of 6 hours)	
Directed Research (3 semester credit hours):		
CHE 6991	Directed Research	
CHE 6992	Directed Research	

CHE 6993	Directed Research	
Registration for CHE 5921 Research and Teaching Practice and Ethics is required for all students who are Teaching Assistants.		
B. A minimum of 9 semester credit hours of electives in chemistry, as approved by the M.S. Research Advisor and the Graduate Curriculum Committee.		9
C. Students must pass a final oral comprehensive examination, scheduled during the student's last semester of work, for completion of the degree program.		
D. Students must successfully defend their thesis research results before their Graduate Committee prior to the submission of the thesis to the Dean of the Graduate School for approval.		
<b>Total Credit Hours</b>		<b>30</b>

<sup>1</sup> Registration for CHE 5981 Graduate Seminar in Chemistry is required for each semester of residence, although no more than 3 semester credit hours may be applied to the master's degree.

## Non-Thesis Option in Chemistry Degree Requirements

This Non-Thesis Option program requires the successful completion of a minimum of 30 semester credit hours. The student must have a grade point average of 3.0 or greater (on a 4.0 scale) in the core lecture courses and elective courses combined.

Candidates for the degree must complete the following:

Code	Title	Credit Hours
A. Required courses (21 semester credit hours):		21
Core curriculum. 9 semester credit hours selected from the following:		
CHE 5263	Advanced Analytical Chemistry	
CHE 5313	Advanced Biochemistry	
CHE 5453	Advanced Inorganic Chemistry	
CHE 5643	Advanced Organic Chemistry	
CHE 5843	Advanced Physical Chemistry	
Graduate seminar (repeated for a total of 3 hours) <sup>1</sup>		
CHE 5981	Graduate Seminar in Chemistry	
Directed Research (repeated for a total of 9 semester credit hours):		
CHE 6991	Directed Research	
CHE 6992	Directed Research	
CHE 6993	Directed Research	
CHE 6994	Directed Research	
CHE 6995	Directed Research	
CHE 6996	Directed Research	
Registration for CHE 5921 Research and Teaching Practice and Ethics is required for all students who are Teaching Assistants.		
B. A minimum of 9 semester credit hours of electives in chemistry, as approved by the M.S. Research Advisor and the Graduate Curriculum Committee.		9
C. Students must submit an acceptable final written report and pass an oral presentation, scheduled during the student's last semester of work, for completion of the degree program.		
<b>Total Credit Hours</b>		<b>30</b>

<sup>1</sup> Registration for CHE 5981 Graduate Seminar in Chemistry is required for each semester of residence, although no more than 3 semester credit hours may be applied to the master's degree. The laboratory work in chemistry should be taken as Directed Research.

## Doctor of Philosophy Degree in Chemistry

The Department of Chemistry offers opportunities for advanced study and research leading to the Doctor of Philosophy (Ph.D.) degree in Chemistry. The Ph.D. degree in Chemistry is awarded to candidates who have displayed an in-depth understanding of the subject matter and demonstrated the ability to make an original contribution to knowledge in their field of specialty.

Ph.D. students whose main research is in Biochemistry may select it as an area of emphasis (Doctor of Philosophy Degree in Chemistry with an emphasis in Biochemistry). The students selecting this option must take CHE 5313 Advanced Biochemistry as one of the Core curriculum courses.

The complete set of requirements for the Ph.D. in Chemistry is described in the Chemistry Ph.D. Program Handbook. The regulations for this degree comply with the general University regulations (refer to Student Policies, General Academic Regulations, and the Graduate Catalog, Doctoral Degree Regulations).

## Admission Requirements

In addition to satisfying the University-wide graduate admission requirements, applicants must have earned a Bachelor of Arts or a Bachelor of Science degree from an accredited university and a minimum grade point average of 3.0 (on a 4.0 scale) in upper-division and graduate work, preferably in Chemistry or Biochemistry. At least two letters of recommendation from persons familiar with the applicant's undergraduate (and graduate, where applicable) scholastic record, together with a meaningful statement of research interests and career goals (250–500 words) and a curriculum vitae, must be sent to Graduate Admissions at the same time application is made for admission to UTSA.

International applicants are required to prove proficiency in the English language by taking either the Test of English as a Foreign Language (TOEFL (<http://www.ets.org/toefl/>)), the International English Language Testing System (IELTS (<http://www.ielts.org/>)), or the Duolingo English Test (DET) (<https://englishtest.duolingo.com/applicants/>). See International Graduate Student Admission (<https://catalog.utsa.edu/policies/admission/graduate/internationalgraduatestudents/>) policies, for details.

## Degree Requirements

The Ph.D. degree in Chemistry requires a minimum of 75 semester credit hours beyond the baccalaureate degree. The curriculum consists of 18 semester credit hours of formal coursework, required teaching, research, and completion of the dissertation following advancement to candidacy. Enrollment in the Chemistry Research Colloquium and/or Graduate Seminar in Chemistry is required each semester of enrollment and may be taken for a maximum combined total of 12 semester credit hours. A minimum of 45 semester credit hours in doctoral research, including 10 semester credit hours of doctoral dissertation, must be completed. The student must have a grade point average of 3.0 or greater (on a 4.0 scale) in the core courses and elective courses combined. Each student must be a teaching assistant for a minimum of one academic year. Other requirements include (but are not limited to) the written dissertation and the final oral examination. The final oral examination consists of a

public presentation of the dissertation and a closed oral defense, which are evaluated by the student's Doctoral Studies Committee. Students matriculating with a master's degree may use up to 30 semester credit hours toward the degree, provided the courses are comparable to core and elective courses.

### Program of Study

Code	Title	Credit Hours
A. Core curriculum. 9 semester credit hours selected from the following (for Biochemistry emphasis, CHE 5313 required, plus 6 semester credit hours selected from the following):		9
CHE 5263	Advanced Analytical Chemistry	
CHE 5313	Advanced Biochemistry	
CHE 5453	Advanced Inorganic Chemistry	
CHE 5643	Advanced Organic Chemistry	
CHE 5843	Advanced Physical Chemistry	
B. Colloquia and seminars (maximum 12 semester credit hours):		12
CHE 5981	Graduate Seminar in Chemistry	
CHE 7911	Chemistry Research Colloquium	
C. Doctoral research (minimum 45 semester credit hours required):		45
CHE 5921	Research and Teaching Practice and Ethics	
CHE 7913	Research Proposal Development	
CHE 7941	Scientific Presentations	
CHE 5931	Laboratory Rotations	
Directed Research (Select a minimum of 12 semester credit hours of the following):		
CHE 6991	Directed Research	
CHE 6992	Directed Research	
CHE 6993	Directed Research	
CHE 6994	Directed Research	
CHE 6995	Directed Research	
CHE 6996	Directed Research	
CHE 6997	Directed Research	
Doctoral Research (Select a minimum of 18 hours of the following):		
CHE 7921	Doctoral Research	
CHE 7922	Doctoral Research	
CHE 7923	Doctoral Research	
CHE 7926	Doctoral Research	
CHE 7927	Doctoral Research	
CHE 7928	Doctoral Research	
Doctoral Dissertation (Select a minimum of 10 hours of the following):		
CHE 7931	Doctoral Dissertation	
CHE 7932	Doctoral Dissertation	
CHE 7933	Doctoral Dissertation	
CHE 7936	Doctoral Dissertation	
CHE 7937	Doctoral Dissertation	
CHE 7938	Doctoral Dissertation	
D. A minimum of 9 semester credit hours of electives in chemistry, as approved by the Ph.D. Research Advisor and the Graduate Curriculum Committee.		9
<b>Total Credit Hours</b>		<b>75</b>

The entire program of study must be approved by the student's Doctoral Research Advisor, Doctoral Studies Committee, and Graduate Program Committee and must be submitted to the Dean of the Graduate School for final approval.

### Advancement to Candidacy

All students seeking a doctoral degree at UTSA must be admitted to candidacy. One of the requirements for admission to candidacy is passing the Qualifying Examination. The Qualifying Examination is divided into written and oral portions. A Dissertation Research Proposal (DRP) constitutes the written portion, and defense of the DRP constitutes the oral portion. The oral portion must be presented no later than one month following submission of the written portion. The student's performance on both the written and oral portions is evaluated by the student's Doctoral Studies Committee.

### Chemistry (CHE) Courses

#### CHE 5263. Advanced Analytical Chemistry. (3-0) 3 Credit Hours.

Prerequisite: CHE 3214 and CHE 4213, or equivalents. The physical and chemical principles of modern analytical chemistry with emphasis on error analysis, signals and noise, electrochemical techniques, analytical separations, and selected spectroscopic methods based on absorption and emission. This course has Differential Tuition. Course Fee: GS01 \$90.

#### CHE 5313. Advanced Biochemistry. (3-0) 3 Credit Hours.

Prerequisite: Undergraduate biochemistry. Advanced topics in modern biochemistry, including cell signaling, apoptosis, trafficking and processing of proteins, DNA array technology, and various aspects of bioinformatics. Ligand interactions and the thermodynamics and mechanisms underlying how these important macromolecules interact with each other. Spectroscopic determination of nucleic acid and protein structures, and reactions using techniques such as nuclear magnetic resonance spectroscopy, mass spectrometry and x-ray diffraction. This course has Differential Tuition. Course Fee: GS01 \$90.

#### CHE 5453. Advanced Inorganic Chemistry. (3-0) 3 Credit Hours.

Prerequisite: CHE 4463 or equivalent. This course is intended to provide students with a firm foundation in modern inorganic chemistry and serve as a basis for advanced elective courses within the subdiscipline. Topics to be covered include symmetry and group theory, electronic structure and bonding in transition metal complexes, applications of group theory to vibrational and electronic spectroscopy, rudimentary topics in molecular magnetism, and inorganic reaction mechanisms. This course has Differential Tuition. Course Fee: GS01 \$90.

#### CHE 5643. Advanced Organic Chemistry. (3-0) 3 Credit Hours.

Prerequisite: 8 semester credit hours each of undergraduate organic chemistry and physical chemistry or graduate standing in chemistry. An advanced study of topics in organic chemistry such as stereochemistry, conformational analysis, nonbenzenoid, aromaticity, molecular orbital theory, and organic reaction mechanisms. Applications of these concepts to the structure and reactivity of biomolecules such as peptides and proteins, nucleic acids, and carbohydrates. This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 5653. Structure Determination Using Spectroscopic Methods. (3-0) 3 Credit Hours.**

Prerequisite: CHE 3643 or equivalent. An introduction to the techniques of multinuclear ( $^1\text{H}$ ,  $^{13}\text{C}$ ) NMR spectroscopy, infrared spectroscopy, and mass spectrometry as powerful tools for structure elucidation in organic chemistry. A brief introduction to the principles of NMR spectroscopy, infrared spectroscopy, and mass spectrometry will be followed by extensive analysis and discussion of NMR parameters such as chemical shift, coupling constants, splitting patterns, etc. The course will also describe the use of multi-pulse experiments (spin decoupling, NOE, APT, INEPT, DEPT etc.) and 2-dimensional techniques (COSY, NOESY, ROESY, etc.) along with mass spectrometry in the structure elucidation of natural products and organic small molecules. This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 5833. Computational Chemistry. (3-0) 3 Credit Hours.**

Prerequisite: CHE 3824 or equivalent. The application of molecular mechanical, molecular orbital, and density functional methods to problems of molecular structure, property, reactivity, and spectroscopy. (Formerly CHE 7843. Credit cannot be earned for both CHE 5833 and CHE 7843.) This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 5843. Advanced Physical Chemistry. (3-0) 3 Credit Hours.**

Prerequisite: CHE 3824 or equivalent. An advanced study of valence and spectra as grounded in valence bond theory, molecular orbital theory and the extended Hückel method. Topics include group theory as applied to molecular structure and spectra, electronic, vibrational and rotational spectroscopies, and chemical reactivity including Woodward-Hoffmann theory. This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 5921. Research and Teaching Practice and Ethics. (0-0) 1 Credit Hour.**

Prerequisite: Graduate standing in Chemistry and concurrent designation as a teaching assistant in the Chemistry program or consent of instructor. The course is designed to improve the instructional effectiveness of graduate students teaching at the college level. The course will cover, but is not limited to, board-work, clear speech, teacher-student interaction, professional responsibilities, course content and pace, grading policy, quiz writing, sensitivity training to student needs, information on technical support, and guest lecturers on special topics. Research ethics will be discussed based on case studies. The grade report for the course is either "CR" (satisfactory performance) or "NC" (unsatisfactory performance). (Formerly CHE 5923 and CHE 5922. Credit can only be earned for one of the following: CHE 5921, CHE 5922, or CHE 5923.) This course has Differential Tuition. Course Fee: GS01 \$30.

**CHE 5931. Laboratory Rotations. (0-0) 1 Credit Hour.**

Prerequisite: Graduate standing in Chemistry and status as a first-year doctoral student. This course constitutes a minimum of two one-month, but not more than three, rotations in the laboratories of the faculty in the Department of Chemistry. The purpose of this class is to expose new doctoral students to the science taking place in the Department of Chemistry and available opportunities for dissertation research. Students are expected to spend a minimum of 6 hours per week engaged in laboratory activities within their assigned research group and attend all group meetings that do not interfere with their classes and teaching responsibilities. The laboratory activities include, but are not limited to, research, shadowing of senior students, and discussions with the research supervisor. The grade report for the course is either "CR" (satisfactory performance) or "NC" (unsatisfactory performance) to be assigned by the GAR in consultation with the faculty members overseeing rotations. This course has Differential Tuition. Course Fee: GS01 \$30.

**CHE 5981. Graduate Seminar in Chemistry. (0-3) 1 Credit Hour.**

Prerequisite: Graduate standing in Chemistry or consent of the Graduate Advisor of Record. Current research and literature seminars are presented by faculty, visiting lecturers, and faculty candidates. Students in the Doctoral chemistry program must register every semester while in residence, but only 8 hours will apply toward the Doctoral degree. The grade report for the course is either "CR" (satisfactory performance) or "NC" (unsatisfactory performance). This course has Differential Tuition. Course Fee: GS01 \$30.

**CHE 6433. Organometallic Chemistry. (3-0) 3 Credit Hours.**

Prerequisite: CHE 4463 or equivalent. This course is intended to provide students with an introduction to the field of organometallic chemistry covering concepts in bonding, synthesis, and catalysis. Students will become familiar with common ligands and preparative methods in organometallic chemistry, theories of bonding and electronic structure, basic reaction mechanisms, and applications to catalysis in organic chemistry. (Formerly CHE 7433. Credit cannot be earned for both CHE 6433 and CHE 7433.) This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 6443. Green Chemistry and Catalysis. (3-0) 3 Credit Hours.**

Prerequisite: CHE 3464 or consent of instructor. Introduction to the 12 principles of green chemistry as well as the tools of green chemistry including the use of alternative feed stocks or starting materials, reagents, solvents, target molecules, and catalysts; demonstrates how to evaluate a reaction or process and determine "greener" alternatives; focuses on the application of innovative technology the development of "greener" routes to improve industrial processes and to produce important products. This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 6623. Advanced Organic Synthesis. (3-0) 3 Credit Hours.**

Prerequisite: CHE 3643 or equivalent. A study of modern methods of organic functional group transformation, simple carbon skeleton construction, asymmetric synthesis, introduction to the synthon concept and to retrosynthetic analytical methodology for designing rational synthetic approaches to complex organic molecules of biological interest. This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 6643. Chemistry of Heterocyclic Compounds. (3-0) 3 Credit Hours.**

Prerequisite: CHE 3643 or equivalent. The course gives a broad introduction to cyclic organic compounds that include heteroatoms, especially nitrogen, oxygen, and sulfur, in their ring structures. Emphasis is given to aromatic heterocyclic systems, such as pyridines, quinolines, isoquinolines, pyrroles, furans, thiophenes, indoles, pyrimidines, purines, and imidazoles. For each group, ring synthesis, chemical properties, and characteristic reactions will be discussed, as will the biological effects of representative structures. Aromaticity applied to heterocyclic compounds, general methods for ring synthesis, and different systems for nomenclature will be presented. This course requires a firm understanding of the principles of organic chemistry. This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 6673. Advanced Catalysis in Organic Synthesis. (3-0) 3 Credit Hours.**

Prerequisite: CHE 5643 or equivalent. This course will cover advanced topics in modern catalytic transformations useful in the synthesis of complex molecular structures. Topics will include an introduction to catalysis, organometallics overview, kinetics of catalysis, non-linear effects, kinetic resolutions, asymmetric hydrogenations, C-H activation, olefin metathesis, Pd-catalyzed allylic substitutions, transition metal mediated cross-couplings, biocatalysis and organocatalysis. (Formerly CHE 7633. Credit cannot be earned for both CHE 6673 and 7633.) This course has Differential Tuition. Course Fee: GS01 \$90.



**CHE 6693. Medicinal Chemistry. (3-0) 3 Credit Hours.**

Prerequisite: CHE 3643 or equivalent or consent of instructor. The course aims to provide students with an in-depth understanding of how medicinal chemistry impacts the overall drug discovery process, with an underlying emphasis on the role organic chemistry concepts and theory play. The course will highlight and teach how concepts within medicinal chemistry interplay with other disciplines, such as computational chemistry, pharmacology, drug metabolism, and toxicology. Students will learn how medicinal chemistry plays a role in each level of the drug discovery process and how structural changes in a molecule impact multiple factors besides activity at a given pharmacological target. Students will also learn contemporary drug discovery research platforms such as PROTACs (Proteolysis Targeting Chimeras), covalent drug discovery approaches, and fragment-based drug discovery approaches. (Formerly titled Pharmaceutical Chemistry.) This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 6823. Chemical Kinetics and Dynamics. (3-0) 3 Credit Hours.**

Prerequisite: CHE 5843. An advanced study of topics in chemical kinetics and dynamics. The course will discuss mechanisms and rates of chemical reactions from a fundamental point of view. It further discusses the nature of collision and develops concepts of cross-section and rate constant. Theories of elementary bimolecular and decay processes, as well as different rate laws, the method of steady state approximation, and its application to various types of reactions are critically examined. This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 6883. Mass Spectrometry. (3-0) 3 Credit Hours.**

Prerequisite: Consent of instructor. The basic principles of interpreting mass spectra and how they are produced. The effect the method of ion production has on the observed mass spectra, and the theory and operation of various types of mass spectrometers will be covered. The basic theory of ion-molecule reactions and other advanced topics will be presented. This course has Differential Tuition. Course Fee: GS01 \$90; IUC1 \$15; L001 \$30.

**CHE 6961. Comprehensive Examination. (0-0) 1 Credit Hour.**

Prerequisite: Approval of the appropriate Graduate Program Committee. Independent study course for the purpose of taking the Comprehensive Examination. May be repeated as many times as approved by the Graduate Program Committee. Enrollment is required each term in which the Comprehensive Examination is taken if no other courses are being taken that term. The grade report for the course is either "CR" (satisfactory performance on the Comprehensive Examination) or "NC" (unsatisfactory performance on the Comprehensive Examination). This course has Differential Tuition. Course Fee: GS01 \$30.

**CHE 6973. Special Problems. (3-0) 3 Credit Hours.**

Prerequisite: Consent of instructor. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Problems courses may be repeated for credit when the topics vary, but not more than 6 hours, regardless of discipline, will apply to the Master's degree. This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 6983. Master's Thesis. (0-0) 3 Credit Hours.**

Prerequisite: Permission of the Graduate Advisor of Record and thesis director. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 6991. Directed Research. (0-0) 1 Credit Hour.**

Prerequisite: Graduate standing and permission in writing (form available) from the instructor and the student's Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. Normally a written report is required. May be repeated for credit, but not more than 9 hours or 19 hours, regardless of discipline, will apply to the Master's degree or Doctoral degree, respectively. This course has Differential Tuition. Course Fee: GS01 \$30.

**CHE 6992. Directed Research. (0-0) 2 Credit Hours.**

Prerequisite: Graduate standing and permission in writing (form available) from the instructor and the student's Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. Normally a written report is required. May be repeated for credit, but not more than 9 hours or 19 hours, regardless of discipline, will apply to the Master's degree or Doctoral degree, respectively. This course has Differential Tuition. Course Fee: GS01 \$60.

**CHE 6993. Directed Research. (0-0) 3 Credit Hours.**

Prerequisite: Graduate standing and permission in writing (form available) from the instructor and the student's Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. Normally a written report is required. May be repeated for credit, but not more than 9 hours or 19 hours, regardless of discipline, will apply to the Master's degree or Doctoral degree, respectively. This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 6994. Directed Research. (0-0) 4 Credit Hours.**

Prerequisite: Graduate standing and permission in writing (form available) from the instructor and the student's Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. Normally a written report is required. May be repeated for credit, but not more than 9 hours or 19 hours, regardless of discipline, will apply to the Master's degree or Doctoral degree, respectively. This course has Differential Tuition. Course Fee: GS01 \$120.

**CHE 6995. Directed Research. (0-0) 5 Credit Hours.**

Prerequisite: Graduate standing and permission in writing (form available) from the instructor and the student's Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. Normally a written report is required. May be repeated for credit, but not more than 9 hours or 19 hours, regardless of discipline, will apply to the Master's degree or Doctoral degree, respectively. This course has Differential Tuition. Course Fee: GS01 \$150.

**CHE 6996. Directed Research. (0-0) 6 Credit Hours.**

Prerequisite: Graduate standing and permission in writing (form available) from the instructor and the student's Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. Normally a written report is required. May be repeated for credit, but not more than 9 hours or 19 hours, regardless of discipline, will apply to the Master's degree or Doctoral degree, respectively. This course has Differential Tuition. Course Fee: GS01 \$180.

**CHE 6997. Directed Research. (0-0) 7 Credit Hours.**

Prerequisite: Graduate standing and permission in writing (form available) from the instructor and the student's Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. Normally a written report is required. May be repeated for credit, but not more than 9 hours or 19 hours, regardless of discipline, will apply to the Master's degree or Doctoral degree, respectively. This course has Differential Tuition. Course Fee: GS01 \$210.

**CHE 7911. Chemistry Research Colloquium. (0-0) 1 Credit Hour.**

Prerequisite: Graduate standing in Chemistry. Discussions of current journal articles, reviews, and recent advances in specialized areas of chemistry (including current research progress of students). May be repeated for credit as topics vary. The grade report for this course is either "CR" (satisfactory participation in the colloquium) or "NC" (unsatisfactory participation in the colloquium). This course has Differential Tuition. Course Fee: GS01 \$30.

**CHE 7913. Research Proposal Development. (3-0) 3 Credit Hours.**

Prerequisite: Graduate standing in Chemistry or consent of instructor. The course is intended to provide students with a hands-on experience in the development of a research grant proposal. Topics will include development of specific aims, literature review, biosketch, and other grant components. Technical aspects, such as scientific database and literature searches, the use of chemical drawing and reference management software, as well as general principles of effective grant writing and proposal review will also be covered. The course will culminate in the development and oral presentation of a NIH/NSF-style research proposal. This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 7921. Doctoral Research. (0-0) 1 Credit Hour.**

Prerequisite: Graduate standing in Chemistry. Doctoral research and preparation. May be repeated for credit, but not more than 26 hours will apply to the Doctoral degree. Enrollment in either CHE 7921-8 or CHE 7931-8, depending on progress, is required each term in which the dissertation is in progress. This course has Differential Tuition. Course Fee: GS01 \$30.

**CHE 7922. Doctoral Research. (0-0) 2 Credit Hours.**

Prerequisite: Graduate standing in Chemistry. Doctoral research and preparation. May be repeated for credit, but not more than 26 hours will apply to the Doctoral degree. Enrollment in either CHE 7921-8 or CHE 7931-8, depending on progress, is required each term in which the dissertation is in progress. This course has Differential Tuition. Course Fee: GS01 \$60.

**CHE 7923. Doctoral Research. (0-0) 3 Credit Hours.**

Prerequisite: Graduate standing in Chemistry. Doctoral research and preparation. May be repeated for credit, but not more than 26 hours will apply to the Doctoral degree. Enrollment in either CHE 7921-8 or CHE 7931-8, depending on progress, is required each term in which the dissertation is in progress. This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 7926. Doctoral Research. (0-0) 6 Credit Hours.**

Prerequisite: Graduate standing in Chemistry. Doctoral research and preparation. May be repeated for credit, but not more than 26 hours will apply to the Doctoral degree. Enrollment in either CHE 7921-8 or CHE 7931-8, depending on progress, is required each term in which the dissertation is in progress. This course has Differential Tuition. Course Fee: GS01 \$180.

**CHE 7927. Doctoral Research. (0-0) 7 Credit Hours.**

Prerequisite: Graduate standing in Chemistry. Doctoral research and preparation. May be repeated for credit, but not more than 26 hours will apply to the Doctoral degree. Enrollment in either CHE 7921-8 or CHE 7931-8, depending on progress, is required each term in which the dissertation is in progress. This course has Differential Tuition. Course Fee: GS01 \$210.

**CHE 7928. Doctoral Research. (0-0) 8 Credit Hours.**

Prerequisite: Graduate standing in Chemistry. Doctoral research and preparation. May be repeated for credit, but not more than 26 hours will apply to the Doctoral degree. Enrollment in either CHE 7921-8 or CHE 7931-8, depending on progress, is required each term in which the dissertation is in progress. This course has Differential Tuition. Course Fee: GS01 \$240.

**CHE 7931. Doctoral Dissertation. (0-0) 1 Credit Hour.**

Prerequisite: Permission of the Graduate Advisor of Record and dissertation director. Preparation and writing of the Doctoral dissertation. May be repeated for credit, but not more than 12 hours will apply to the Doctoral degree. Enrollment in either CHE 7921-8 or CHE 7931-8, depending on progress, is required each term in which the dissertation is in progress. This course has Differential Tuition. Course Fee: GS01 \$30.

**CHE 7932. Doctoral Dissertation. (0-0) 2 Credit Hours.**

Prerequisite: Permission of the Graduate Advisor of Record and dissertation director. Preparation and writing of the Doctoral dissertation. May be repeated for credit, but not more than 12 hours will apply to the Doctoral degree. Enrollment in either CHE 7921-8 or CHE 7931-8, depending on progress, is required each term in which the dissertation is in progress. This course has Differential Tuition. Course Fee: GS01 \$60.

**CHE 7933. Doctoral Dissertation. (0-0) 3 Credit Hours.**

Prerequisite: Permission of the Graduate Advisor of Record and dissertation director. Preparation and writing of the Doctoral dissertation. May be repeated for credit, but not more than 12 hours will apply to the Doctoral degree. Enrollment in either CHE 7921-8 or CHE 7931-8, depending on progress, is required each term in which the dissertation is in progress. This course has Differential Tuition. Course Fee: GS01 \$90.

**CHE 7934. Doctoral Dissertation. (0-0) 4 Credit Hours.**

Prerequisites: Permission of the Graduate Advisor of Record and dissertation director. Preparation and writing of the Doctoral dissertation. May be repeated for credit, but not more than 12 hours will apply to the Doctoral degree. Enrollment in either CHE 7921-8 or CHE 7931-8, depending on progress, is required each term in which the dissertation is in progress. Differential Tuition: \$200. Course Fees: GS01 \$120.

**CHE 7936. Doctoral Dissertation. (0-0) 6 Credit Hours.**

Prerequisite: Permission of the Graduate Advisor of Record and dissertation director. Preparation and writing of the Doctoral dissertation. May be repeated for credit, but not more than 12 hours will apply to the Doctoral degree. Enrollment in either CHE 7921-8 or CHE 7931-8, depending on progress, is required each term in which the dissertation is in progress. This course has Differential Tuition. Course Fee: GS01 \$180.

**CHE 7937. Doctoral Dissertation. (0-0) 7 Credit Hours.**

Prerequisite: Permission of the Graduate Advisor of Record and dissertation director. Preparation and writing of the Doctoral dissertation. May be repeated for credit, but not more than 12 hours will apply to the Doctoral degree. Enrollment in either CHE 7921-8 or CHE 7931-8, depending on progress, is required each term in which the dissertation is in progress. This course has Differential Tuition. Course Fee: GS01 \$210.

**CHE 7938. Doctoral Dissertation. (0-0) 8 Credit Hours.**

Prerequisite: Permission of the Graduate Advisor of Record and dissertation director. Preparation and writing of the Doctoral dissertation. May be repeated for credit, but not more than 12 hours will apply to the Doctoral degree. Enrollment in either CHE 7921-8 or CHE 7931-8, depending on progress, is required each term in which the dissertation is in progress. This course has Differential Tuition. Course Fee: GS01 \$240.

**CHE 7941. Scientific Presentations. (1-0) 1 Credit Hour.**

Prerequisite: CHE 6973 and good standing in Chemistry. The course is intended to improve the skills of oral presentation of advanced research topics and graduate students' current research and to provide guidance and preparation for seminars and conferences. May be repeated for credit. This course has Differential Tuition. Course Fee: GS01 \$30.