

# CHEMISTRY

## Contact Information

### Chemistry

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### Angel A. Martí-Arbona

Chair  
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### Jeffrey D. Hartgerink

Vice Chair  
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The Department of Chemistry offers undergraduate chemistry majors leading to both the bachelor of science (BS) degree and the bachelor of arts (BA) degree. The BS program rigorously prepares students for advanced work in chemistry or a related discipline, and the degree requirements are consistent with the guidelines for certification by the American Chemical Society. This curriculum provides a broad and comprehensive introduction to core areas of chemistry while promoting depth of understanding in one or more specific fields. BS students complete a series of foundation courses in general chemistry, analytical chemistry, biological chemistry, inorganic chemistry, organic chemistry, and physical chemistry. Students then complete one or more areas of specialization, consisting of in-depth courses both in and out of the specialization. The BA program is a more flexible degree program that provides a comprehensive overview of all areas of chemistry, including laboratory experiences, but can be coupled more easily with other majors or professional career paths. Both degree programs offer students a solid background in the fundamental principles of chemistry, the properties and reactions of chemical compounds, and their uses.

Graduate studies emphasize individual research together with a fundamental understanding of chemistry beyond the students' specific interests. Faculty research interests include the synthesis and biosynthesis of organic natural products; supramolecular chemistry, molecular recognition and biological catalysis; bioinorganic and organometallic chemistry; main group element and transition metal chemistry; the design of nanophase solids; molecular photochemistry and photophysics; infrared kinetic spectroscopy, laser, and NMR spectroscopy; studies of electron transfer in crossed beams; theoretical and computational chemistry; the study of fullerene molecules, carbon nanotubes, and their derivatives; polymer synthesis and characterization; molecular electronics; molecular machines; and chemical-based nanotechnology.

## Bachelor's Programs

- Bachelor of Arts (BA) Degree with a Major in Chemistry (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/chemistry/chemistry-ba/>)
- Bachelor of Science (BS) Degree with a Major in Chemistry (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/chemistry/chemistry-bs/>)

## Coordinated Program

- Bachelor of Science (BS) Degree with a Major in Chemical Physics (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/chemical-physics/chemical-physics-bs/>)
- \* *This degree is jointly managed by the Department of Chemistry and the Department of Physics and Astronomy. For more information, see Chemical Physics. (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/chemical-physics/chemical-physics-bs/>)*

## Master's Program

- Master of Arts (MA) Degree in the field of Chemistry\*

## Doctoral Program

- Doctor of Philosophy (PhD) Degree in the field of Chemistry (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/chemistry/chemistry-phd/>)
- \* *Although students are not normally admitted to a Master of Arts (MA) degree program, graduate students may earn the MA as they work towards the PhD.*

## Chair

Angel A. Martí-Arbona

## Professors

Pulickel M. Ajayan  
Pedro J.J. Alvarez  
Zachary T. Ball  
Gang Bao  
Paul S. Engel  
Jason H. Hafner  
Naomi J. Halas  
Jeffrey D. Hartgerink  
John S. Hutchinson  
Oleg A. Igoshin  
Anatoly B. Kolomeisky  
László Kürti  
Christy F. Landes  
Stephan Link  
Jun Lou  
Frederick C. MacKintosh  
Angel A. Martí-Arbona  
Caroline A. Masiello  
Seiichi P. T. Matsuda  
Antónios G. Mikos  
Emilia Morosan  
K.C. Nicolaou  
Jose Nelson Onuchic  
Matteo Pasquali

George Phillips  
 Peter Rossky  
 Gustavo E. Scuseria  
 James M. Tour  
 R. Bruce Weisman  
 Kenton H. Whitmire  
 Peter G. Wolynes  
 Michael S. Wong  
 Boris I. Yakobson

## Associate Professors

Michael Diehl  
 Hans Renata  
 Han Xiao  
 Laurence Yeung  
 Eugene Zubarev

## Assistant Professors

Mingjie Dai  
 Xue Gao  
 Anna-Karin Gustavsson  
 Yimo Han  
 Raúl Hernández Sánchez  
 Matthew Jones  
 Kevin McHugh  
 Haotian Wang  
 Julian West  
 Samantha Yruegas

## Professors Emeriti

Andrew R. Barron  
 W. E. Billups  
 Philip R. Brooks  
 Cecilia Clementi  
 Vicki Colvin  
 Graham P. Glass  
 George McLendon  
 Ronald J. Parry  
 Lon J. Wilson

## Research Professor

Bruce R. Johnson

## Associate Research Professor

Carolyn A. Nichol

## Associate Teaching Professor

Kristi Kincaid

## Assistant Teaching Professors

Krista Kobylanskii  
 Kasey Leigh Yearty

## Lecturers

Michelle Gilbertson  
 Humayun Kabir  
 Caroline V. McNeil  
 Lesley O'Leary

Lesa Tran Lu

## Adjunct Faculty

Lawrence B. Alemany  
 Marco A. Ciufolini  
 Ayrat Dimiev  
 Scott Gilbertson  
 Ganesh Kailasam  
 Thomas Kent  
 Luz Maria Martinez Calderon  
 Henk Mooiweer  
 Frank Noe  
 Mark "Marty" Pagel  
 B. Montgomery Pettitt  
 Emilie Ringe  
 Hossein Robatjazi  
 Corina Rogge  
 Yongcheng Song  
 Marcelo Videia Vargas  
 Damian Young

*For Rice University degree-granting programs:*

To view the list of official course offerings, please see Rice's [Course Catalog](https://courses.rice.edu/admweb/!SWKSCAT.cat?p_action=cata) ([https://courses.rice.edu/admweb/!SWKSCAT.cat?p\\_action=cata](https://courses.rice.edu/admweb/!SWKSCAT.cat?p_action=cata))

To view the most recent semester's course schedule, please see Rice's [Course Schedule](https://courses.rice.edu/admweb/!SWKSCAT.cat) (<https://courses.rice.edu/admweb/!SWKSCAT.cat>)

## Chemistry (CHEM)

**CHEM 101 - INTRODUCTION TO SCIENTIFIC RESEARCH**

**Short Title:** INTRO SCIENTIFIC RESEARCH

**Department:** Chemistry

**Grade Mode:** Satisfactory/Unsatisfactory

**Course Type:** Research

**Credit Hours:** 5

**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

**Course Level:** Undergraduate Lower-Level

**Description:** This course is for rising junior and senior high school students. As visiting students, the students will conduct scientific research in the laboratories of Rice faculty in the areas of Nanotechnology, Chemistry, Materials, and Engineering. Two applications need to be submitted for enrollment into this course. First, the Research Experience in Chemistry application (download the Chemistry application here: <https://chemistry.rice.edu/community/chem-101-intro-scientific-research>) should be emailed, along with all the required documents as indicated in the application, to CHEM101@rice.edu. Upon confirmation of acceptance from the Chemistry department, students must then complete the visiting student application process for high school students. Instructions to do this can be found in the Application Checklist at [summer.rice.edu](https://summer.rice.edu). Instructor Permission Required. Repeatable for Credit.

**CHEM 110 - FRESHMAN CHEMISTRY SEMINAR****Short Title:** FRESHMAN CHEMISTRY SEMINAR**Department:** Chemistry**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** This half-semester course introduces freshmen to chemical research at Rice and in Houston. All first-year non-transfer students are eligible to enroll in CHEM 110 regardless of AP credit.**CHEM 111 - AP/OTH CREDIT IN GENERAL CHEMISTRY I****Short Title:** AP/OTH CREDIT IN GEN CHEM I**Department:** Chemistry**Grade Mode:** Transfer Courses**Course Type:** Transfer**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Provides transfer credit based on student performance on approved examinations in chemistry, such as the Chemistry Advanced Placement exam or the International Baccalaureate higher-level chemistry exams. This credit counts toward the total credit hours required for graduation, and satisfies major requirements in lieu of CHEM 121, but does not count for distribution.**CHEM 112 - AP/OTH CREDIT IN GENERAL CHEMISTRY II****Short Title:** AP/OTH CREDIT IN GEN CHEM II**Department:** Chemistry**Grade Mode:** Transfer Courses**Course Type:** Transfer**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Provides transfer credit based on student performance on approved examinations in chemistry, such as the Chemistry Advanced Placement exam or the International Baccalaureate higher-level chemistry exams. This credit counts toward the total credit hours required for graduation, and satisfies major requirements in lieu of CHEM 122, but does not count for distribution.**CHEM 113 - AP/OTH CREDIT IN GENERAL CHEMISTRY LAB I****Short Title:** AP/OTH CREDIT-GEN CHEM LAB I**Department:** Chemistry**Grade Mode:** Transfer Courses**Course Type:** Transfer**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Provides transfer credit based on student performance on approved examinations in chemistry, such as the Chemistry Advanced Placement exam or the International Baccalaureate higher-level chemistry exams. This credit counts toward the total credit hours required for graduation, and satisfies major requirements in lieu of CHEM 123, but does not count for distribution.**CHEM 114 - AP/OTH CREDIT IN GENERAL CHEMISTRY LAB II****Short Title:** AP/OTH CREDIT-GEN CHEM LAB II**Department:** Chemistry**Grade Mode:** Transfer Courses**Course Type:** Transfer**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Provides transfer credit based on student performance on approved examinations in chemistry, such as the Chemistry Advanced Placement exam or the International Baccalaureate higher-level chemistry exams. This credit counts toward the total credit hours required for graduation, and satisfies major requirements in lieu of CHEM 124, but does not count for distribution.**CHEM 121 - GENERAL CHEMISTRY I****Short Title:** GENERAL CHEMISTRY I**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Introduction of chemical phenomena emphasizing problems and methods in Chemistry. Either CHEM 121 or CHEM 151 may be taken as a prerequisite for higher study in chemistry, but only one of these may be taken for credit. Students must also register for CHEM 123 General Chemistry Laboratory I. The course and the co-requisite lab are graded jointly.**CHEM 122 - GENERAL CHEMISTRY II****Short Title:** GENERAL CHEMISTRY II**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Prerequisite(s):** CHEM 111 or CHEM 121 or CHEM 151**Description:** A continuation of CHEM 121. Either CHEM 122 or CHEM 152 may be taken as prerequisites for higher study in chemistry, but only one may be taken for credit. Students must also register for CHEM 124 General Chemistry Laboratory II. The course and the co-requisite lab are graded jointly.

**CHEM 123 - GENERAL CHEMISTRY LABORATORY I****Short Title:** GENERAL CHEMISTRY LAB I**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Required laboratory component of CHEM 121. Students must also register for CHEM 121. Credit may only be received for either CHEM 123 or CHEM 153 but not both. The course and the co-requisite lab are graded jointly. Distribution Credit for CHEM 123 no longer eligible beginning Fall 2019.**CHEM 124 - GENERAL CHEMISTRY LABORATORY II****Short Title:** GENERAL CHEMISTRY LAB II**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Prerequisite(s):** CHEM 113 or CHEM 123 or CHEM 153**Description:** Required laboratory component of CHEM 122. Students must also register for CHEM 122. Credit may not be received for both CHEM 124 and CHEM 154. The course and the co-requisite lab are graded jointly. Distribution Credit for CHEM 124 no longer eligible beginning Fall 2019.**CHEM 125 - AFROCHEMISTRY: THE STUDY OF BLACK-LIFE MATTER****Short Title:** AFROCHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Students will apply chemical tools and analysis to understand Black life in the U.S. and students will implement African American sensibilities to analyze chemistry. Diverse historical and contemporary scientists, intellectuals, and chemical discoveries will inform personal reflections and proposals for addressing inequities in chemistry and chemical education. This course will be accessible to students from a variety of backgrounds including STEM and non-STEM disciplines. No prior knowledge of chemistry or African American studies is required for engagement in this course.**CHEM 176 - THE CHEMISTRY OF ART****Short Title:** THE CHEMISTRY OF ART**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Seminar**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** The chemistry of the materials and methods used to create, conserve and authenticate art objects will be presented. Topics will include sculpture, painting, photography, textiles, jewelry, furniture, etc. Taught in conjunction with the Conservation Department and Staff of the MFAH. Some classes will be held at the MFAH or HMNS.**CHEM 178 - THE CHEMISTRY OF COOKING****Short Title:** THE CHEMISTRY OF COOKING**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** This course examines the chemistry involved in the composition, transformation, and consumption of food. Topics include chemical properties and reactions of food, cooking tools, and techniques, sensory perception, and nutrition. Lectures and hands-on kitchen experiments are taught in conjunction with Rice Dining Service. Knowledge of high school chemistry is expected.**CHEM 201 - ADVANCED TOPICS IN GENERAL CHEMISTRY****Short Title:** ADV TOPICS IN GEN CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Prerequisite(s):** (CHEM 111 and CHEM 112) and (MATH 101 (may be taken concurrently) or MATH 102 (may be taken concurrently) or MATH 105 or MATH 106 or MATH 111 or MATH 112)**Description:** CHEM 201 is a one-semester lecture course intended for 1st-year undergraduate prospective Chemistry majors who have received credit for AP Chemistry (or equivalent). It is strongly encouraged for those who will take upper-level chemistry courses as a means to refresh and deepen their understanding of challenging core topics. Focus areas include: quantum descriptions of atoms and molecules, chemical thermodynamics, equilibria, and reaction kinetics. Completion of AP Calculus or concurrent enrollment in Math 101 or 102 is expected.

**CHEM 205 - ADVANCED TOPICS IN GENERAL CHEMISTRY LABORATORY****Short Title:** ADV TOPICS IN GEN CHEM LAB**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Corequisite:** CHEM 201**Description:** Required laboratory component for CHEM 201. Students must also register for CHEM 201.**CHEM 210 - WILD TOPICS IN CHEMISTRY AND NANOTECHNOLOGY****Short Title:** WILD TOPICS CHEM AND NANOTECH**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** A variety of topics related to chemistry and nanotechnology will be discussed. Some topics are classical while others are current. Topics may include nanocars, molecular electronics, how to form a start-up company. Grades will be based upon attendance and quizzes. Cross-list: CEVE 210, MSNE 210. Repeatable for Credit.**CHEM 211 - ORGANIC CHEMISTRY I****Short Title:** ORGANIC CHEMISTRY I**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Prerequisite(s):** CHEM 112 or CHEM 122 or CHEM 152**Corequisite:** CHEM 213**Description:** Organic chemistry of aliphatic and aromatic compounds with emphasis on structure, functional groups, bonding, stereochemistry, and reaction mechanisms. CHEM 211 may be taken as a prerequisite for higher study in chemistry. CHEM 211 and CHEM 213 are co-requisites and must be taken together in the same semester.**CHEM 213 - ORGANIC CHEMISTRY DISCUSSION I****Short Title:** ORGANIC CHEM DISCUSSION I**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 0**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Corequisite:** CHEM 211**Description:** CHEM 211 and CHEM 213 are co-requisites and must be taken together in the same semester.**CHEM 215 - ORGANIC CHEMISTRY LAB****Short Title:** ORGANIC CHEMISTRY LAB**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hours:** 2**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Prerequisite(s):** CHEM 211 or CHEM 319**Description:** Synthesis, purification, and characterization of organic compounds. Experiments related to topics covered in CHEM 211, 212. Includes identification of unknown organic compounds. One lab per week.**CHEM 217 - ORGANIC LABORATORY FOR CHEMICAL ENGINEERS****Short Title:** ORGANIC LAB CHEM ENGINEERS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Prerequisite(s):** CHEM 211**Description:** Organic laboratory designed for chemical engineering majors. Emphasis placed on the synthesis and the characterization of organic compounds. This laboratory does not satisfy requirements for science majors or premedical students. This course meets 7 times during the semester.**CHEM 219 - ORGANIC CHEMISTRY I HONORS****Short Title:** ORGANIC CHEMISTRY I HONORS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** CHEM 219 focuses on the understanding of organic reaction mechanisms as well as on the prediction of reactivity by carefully analyzing the participating molecular orbitals, stereochemistry and relevant molecular conformations of the substrates as well as the specific reaction conditions.**CHEM 220 - UNDERGRADUATE CHEMISTRY SEMINAR****Short Title:** UNDERGRADUATE CHEMISTRY SEM**Department:** Chemistry**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** An introduction to modern chemical research through seminars and/or directed reading.



**CHEM 238 - SPECIAL TOPICS****Short Title:** SPECIAL TOPICS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Internship/Practicum, Laboratory, Lecture, Seminar, Independent Study**Credit Hours:** 1-4**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Topics and credit hours vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.**CHEM 280 - UNDERGRADUATE TEACHING PRACTICUM****Short Title:** UG TEACHING PRACTICUM**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Internship/Practicum**Credit Hours:** 1-3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** In this course, undergraduates who have previously excelled in CHEM courses will develop teaching skills while supporting faculty as teaching assistants (TAs) in a particular CHEM course for the benefit of the students taking that particular course. This course is open only to undergraduates with special permission of the course instructor and can be repeated for credit. Instructor Permission Required. Repeatable for Credit.**CHEM 301 - PHYSICAL CHEMISTRY I****Short Title:** PHYSICAL CHEMISTRY I**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (CHEM 112 or CHEM 122 or CHEM 152) and (MATH 212 or MATH 222)**Description:** An introduction to fundamental principles in quantum chemistry, chemical bonding and molecular spectroscopy. Mutually Exclusive: Cannot register for CHEM 301 if student has credit for CHEM 312.**CHEM 302 - PHYSICAL CHEMISTRY II****Short Title:** PHYSICAL CHEMISTRY II**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (CHEM 112 or CHEM 122 or CHEM 152) and MATH 212**Description:** An introduction to the principles of thermodynamics, statistical thermodynamics, kinetic theory of gases, chemical kinetics and the statistical mechanics. Mutually Exclusive: Cannot register for CHEM 302 if student has credit for CHEM 311.**CHEM 313 - ORGANIC CHEMISTRY II****Short Title:** ORGANIC CHEMISTRY II**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 211 or CHEM 319 or CHEM 219**Description:** Continuation of CHEM 211 with an emphasis on aromatic compounds, reactivity and biologically relevant molecules. Either CHEM 313 or CHEM 320 may be taken as a prerequisite for higher study in chemistry, but only one of these may be taken for credit. CHEM 313 and CHEM 314 are co-requisites and must be taken together the same semester.**CHEM 314 - ORGANIC CHEMISTRY DISCUSSION II****Short Title:** ORGANIC CHEM DISCUSSION II**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 0**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** CHEM 313 and CHEM 314 are co-requisites and must be taken together in the same semester. Repeatable for Credit.**CHEM 320 - ORGANIC CHEMISTRY II HONORS****Short Title:** ORGANIC CHEMISTRY II HONORS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to students with a major in Chemistry or Chemical Physics. Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 211 or CHEM 219 or CHEM 319**Description:** A continuation of CHEM 211 that is in greater depth than CHEM 212. Primarily for chemistry majors and science or engineering students with a strong interest in chemistry research. Either CHEM 212 or CHEM 320 completes the two-semester organic chemistry sequence and may be taken as a prerequisite for higher study in chemistry. Majors other than CHEM should request instructor permission to enroll. Mutually Exclusive: Cannot register for CHEM 320 if student has credit for CHEM 212.

**CHEM 330 - ANALYTICAL CHEMISTRY****Short Title:** ANALYTICAL CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 211 or CHEM 319**Description:** A treatment of modern analytical chemistry with an emphasis on instrumentation. Applications of analytical chemistry as applied to areas of medicine, forensics, and material. Taught in the Fall.**CHEM 360 - INORGANIC CHEMISTRY****Short Title:** INORGANIC CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Corequisite:** CHEM 362**Description:** Survey of the periodic table; atomic and molecular structure; bonding in covalent, ionic, and electron deficient systems; thermochemical principles and experimental techniques for analysis, structure determination, and synthesis.**CHEM 362 - INORGANIC CHEMISTRY DISCUSSION****Short Title:** INORGANIC CHEMISTRY DISCUSSION**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 0**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Corequisite:** CHEM 360**Description:** . Repeatable for Credit.**CHEM 365 - ORGANIC CHEMISTRY LAB****Short Title:** ORGANIC CHEMISTRY LAB**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hours:** 2**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 211 or CHEM 219**Description:** Experiments illustrating techniques in synthetic organic chemistry and instrumental methods of analysis. Normally taken in conjunction with CHEM 212 or CHEM 320. NOTE: only one of CHEM 232 and CHEM 365 may be taken for credit.**CHEM 366 - INORGANIC CHEMISTRY LAB****Short Title:** INORGANIC CHEMISTRY LAB**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 2**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Various porphyrin and metalloporphyrin compounds are synthesized, purified and characterized by modern research techniques such as infrared spectroscopy, mass spectrometry, proton magnetic resonance spectroscopy, and magnetic measurements. Data analysis to determine molecular structure is by student group tutorials. NOTE: only one of CHEM 231 and CHEM 366 may be taken for credit. Mutually Exclusive: Cannot register for CHEM 366 if student has credit for CHEM 231.**CHEM 367 - MATERIALS CHEMISTRY LAB****Short Title:** MATERIALS CHEMISTRY LAB**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hours:** 2**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Provides a hands-on experience for undergraduate student interested in the synthesis and structural characterization of nanostructured materials. Synthetic methods will include wet chemistry techniques and lithographic preparation of nanostructures. The course will provide understanding of and exposure to modern analysis and characterization techniques, including spectroscopy, X-ray methods, and microscopy.**CHEM 368 - CHEMICAL MEASUREMENT LAB****Short Title:** CHEMICAL MEASUREMENT LAB**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hours:** 2**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Introduction to Experimental Physical Chemistry. NOTE: only one of CHEM 381 and CHEM 368 may be taken for credit. Mutually Exclusive: Cannot register for CHEM 368 if student has credit for CHEM 381.**CHEM 376 - ADVANCED INORGANIC SYNTHESIS****Short Title:** ADVANCED INORGANIC SYNTHESIS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hours:** 2**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Advanced techniques in inorganic and organometallic synthesis will be covered including air sensitive manipulations using Schlenk line, vacuum lines and dry box. Graduate students may register with an approved Special Registration form.

**CHEM 391 - RESEARCH FOR UNDERGRADUATES****Short Title:** RESEARCH FOR UNDERGRADUATES**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Research**Credit Hours:** 1-5**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Independent chemical research at Rice or in other Texas Medical Center groups. Students spend at least 3 hours per week in the laboratory for each semester hour of credit, in addition to other requirements. If taken for 3 or more hours, counts toward the CHEM 391 requirement for the BS degree in chemistry. Instructor permission required. Students are expected to complete CHEM 391 before the end of their junior year; permission is not normally granted for students in their final year of undergraduate study. Prior to enrollment, students must secure a position in a laboratory. Application materials found on the department website must be submitted by August 1st for Fall term and December 1st for the Spring term. Instructor Permission Required.**CHEM 398 - ADVANCED MODULE: DEVELOPMENT OF EXPERIMENTS FOR UNDERGRADUATE CHEMISTRY LABS****Short Title:** ADV MOD DEV EXP UG CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** An advanced laboratory module open to exceptional majors to develop laboratory experiments under the supervision of a chemistry faculty member. Each student will design an experiment to be included in an undergraduate teaching lab. Required is a written document, which should include an experimental protocol, background information and possible pre- and post-lab questions. Instructor Permission Required.**CHEM 401 - ADVANCED ORGANIC CHEMISTRY****Short Title:** ADVANCED ORGANIC CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 212 or CHEM 320**Description:** The principles of structure and bonding are used to explain and predict reactivity in organic chemistry. Extensive practice with reaction mechanism and curved-arrow formalism. Topics include conformational analysis, acidity/basicity, functional group preparation, stereoselective synthesis, and organo-element chemistry. Graduate/Undergraduate Equivalency: CHEM 501. Mutually Exclusive: Cannot register for CHEM 401 if student has credit for CHEM 501.**CHEM 415 - CHEMICAL KINETICS AND DYNAMICS****Short Title:** CHEMICAL KINETICS & DYNAMICS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 212 and (PHYS 102 or PHYS 112)**Description:** Description and analysis of the rates of unimolecular, bimolecular and composite chemical reactions in gas and solution phases. Both macroscopic kinetics and microscopic reaction dynamics are covered. Graduate/Undergraduate Equivalency: CHEM 515. Mutually Exclusive: Cannot register for CHEM 415 if student has credit for CHEM 515.**CHEM 420 - CLASSICAL AND STATISTICAL THERMODYNAMICS****Short Title:** CLASSICAL & STAT THERMODYNAMIC**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 212 and (PHYS 102 or PHYS 112) and CHEM 310 or (CHEM 311 and CHEM 312) or (CHEM 301 and CHEM 302)**Description:** A review of the principles of classical thermodynamics and an introduction to the theories and methods of statistical thermodynamics with applications to problems in chemistry. Graduate/Undergraduate Equivalency: CHEM 520. Mutually Exclusive: Cannot register for CHEM 420 if student has credit for CHEM 520.**CHEM 430 - QUANTUM CHEMISTRY****Short Title:** QUANTUM CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (CHEM 310 or CHEM 312 or CHEM 301) and MATH 212 and (PHYS 102 or PHYS 112)**Description:** The purpose of this course is to provide the student with a working knowledge of the basic concepts and mathematical formalism of quantum mechanics. Topics include the mathematics of quantum mechanics, one-dimensional problems, central field problems, the harmonic oscillator, angular momentum, perturbation theory, spin, and introduction to methods of modern electronic structure theory, with applications in atomic and molecular structures, spectroscopy, and chemical bonding. Graduate/Undergraduate Equivalency: CHEM 530. Mutually Exclusive: Cannot register for CHEM 430 if student has credit for CHEM 530.



**CHEM 442 - MEDICINAL CHEMISTRY I****Short Title:** MEDICINAL CHEMISTRY I**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** A course intended to provide the student with an overview of the elements of drug discovery, design and development. Targets for drug discovery will be discussed, as well as considerations of drug optimization with respect to the biological target and drug metabolism. Graduate/Undergraduate Equivalency: CHEM 542.**CHEM 452 - CHEMICAL BIOLOGY****Short Title:** CHEMICAL BIOLOGY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 212 or CHEM 320**Description:** This course examines a variety of biological problems from a chemical and structural perspective. The structural and functional properties of amino acids, nucleotides, and sugars will be presented, with special emphasis on their catalytic and chemical properties required for chemical transformations within the cells. This is followed by a discussion of how to harness the power of chemistry to specifically modulate and manipulate these molecules as well as their higher-order structures, such as proteins, nucleic acids, and membranes. Topics include macromolecular structure-function relationships, nucleic acid structure and recognition, protein synthesis and folding, synthetic chemical biology, probes of cellular function, developing hybrid chemical/biologic drugs, as well as modern approaches for target discovery and validation. Graduate/Undergraduate Equivalency: CHEM 552.**CHEM 462 - ORGANIC CHEMISTRY OF ENZYME-CATALYZED REACTIONS****Short Title:** ENZYME MECHANISMS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** This class will discuss the organic chemistry that is involved in the production of primary and secondary metabolites. The reactivity patterns and the underlying logic for different enzyme families will be provided, along with the roles of cofactor, from the perspective of mechanistic organic chemistry. Graduate/Undergraduate Equivalency: CHEM 562. Mutually Exclusive: Cannot register for CHEM 462 if student has credit for CHEM 562.**CHEM 475 - PHYSICAL METHODS IN INORGANIC CHEMISTRY****Short Title:** PHYS METH INORGANIC CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 360**Description:** A survey course of research techniques used in modern inorganic chemistry. Topics covered will include X-ray diffraction, mass spectrometry, magnetism, and various spectroscopies (IR, Raman, UV-Vis, NMR, EPR, XPS, and Mossbauer). Graduate/Undergraduate Equivalency: CHEM 575. Mutually Exclusive: Cannot register for CHEM 475 if student has credit for CHEM 575.**CHEM 477 - SPECIAL TOPICS****Short Title:** SPECIAL TOPICS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Internship/Practicum, Lecture, Seminar, Laboratory**Credit Hours:** 1-4**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Topics and credit hours vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.**CHEM 491 - RESEARCH FOR UNDERGRADUATES****Short Title:** RESEARCH FOR UNDERGRADUATES**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Research**Credit Hours:** 1-5**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 391**Description:** Independent chemical research at Rice or in other Teams Medical Center groups. Ordinarily taken by students who have taken CHEM 391. Students spend at least 3 hours per week in the laboratory for each semester hour of credit, in addition to other requirements. Instructor permission required. Prior to enrollment, students must secure a position in a laboratory. Application materials, found on the department website, must be submitted by August 1st for Fall term, December 1st for Spring term, or April 1st for Summer term. Instructor Permission Required. Repeatable for Credit.

**CHEM 492 - UNDERGRADUATE HONORS RESEARCH****Short Title:** UNDERGRADUATES HONORS RESEARCH**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Research**Credit Hours:** 5**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 391

**Description:** The 1st half of the Honors Research Program. CHEM 492 and CHEM 493 function as a pair and must be taken in the same academic year. Registration for CHEM 492 requires a commitment to register for CHEM 493. Requirements include at least 15 hours of laboratory research per week and written and/or oral progress reports. The sequence will culminate in the completion of a thesis (research report) in the spring term. Instructor permission required; for approved students only. Applications must be submitted to the course instructor February 1 - August 1. Students are encouraged to apply early. Students who complete the Chemistry Honors Research Program are given primary consideration for "Distinction in Research and Creative Work," a university award for select undergraduates, chosen by the department and granted at commencement, which appears on the transcript and diploma. Ordinarily offered Fall term. Instructor Permission Required.

**CHEM 493 - UNDERGRADUATE HONORS RESEARCH****Short Title:** UNDERGRADUATE HONORS RESEARCH**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Research**Credit Hours:** 5**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 492

**Description:** The 2nd half of the Honors Research Program. CHEM 492 and CHEM 493 function as a pair and must be taken in the same academic year. Requirements include at least 15 hours of laboratory research per week and a thesis (research report). Students who complete the Chemistry Honors Research Program are given primary consideration for "Distinction in Research and Creative Work," a university award for select undergraduates, chosen by the department and granted at commencement, which appears on the transcript and diploma. Ordinarily offered in Spring. Instructor Permission Required.

**CHEM 495 - TRANSITION METAL CHEMISTRY****Short Title:** TRANSITION METAL CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 211 and CHEM 360

**Description:** Structure, bonding and reactivity of coordination and organometallic compounds; ligand field theory; electronic spectroscopy; magnetism; reaction mechanisms; catalysis. Graduate/Undergraduate Equivalency: CHEM 595. Mutually Exclusive: Cannot register for CHEM 495 if student has credit for CHEM 595.

**CHEM 496 - ADVANCED INORGANIC CHEMISTRY****Short Title:** ADVANCED INORGANIC CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 360

**Description:** Advanced Inorganic Chemistry. In-depth survey course of the periodic table with particular focus on main group inorganic and transition metal structure, synthesis, and reactivity. Graduate/Undergraduate Equivalency: CHEM 596.

**CHEM 501 - ADVANCED ORGANIC CHEMISTRY****Short Title:** ADVANCED ORGANIC CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** The principles of structure and bonding are used to explain and predict reactivity in organic chemistry. Extensive practice with reaction mechanism and curved-arrow formalism. Topics include conformational analysis, acidity/basicity, functional group preparation, stereoselective synthesis, and organo-element chemistry. Graduate/Undergraduate Equivalency: CHEM 401. Mutually Exclusive: Cannot register for CHEM 501 if student has credit for CHEM 401.

**CHEM 504 - PUBLISHING YOUR FIRST SCIENTIFIC RESEARCH PAPER****Short Title:** PUBLISHING YOUR FIRST PAPER**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** Completing the last 10% of your first research paper is one of the biggest hurdles for many PhD students. You have collected most of your data. You have a rough figure outline. You might even have a first draft of your manuscript. But getting from data to manuscript to accepted paper requires new skills. This course is designed for students with publication-quality data, and will address: How to frame the motivation, knowledge gap, and conclusion statement? How to edit for a particular journal target? How to arrange the results to support the strongest hypothesis? How to select appropriate reviewers? How to write (and rewrite) an abstract? How to write a cover letter? And finally, how to respond to reviewers and GET YOUR PAPER PUBLISHED? Students with publication-ready data will work through all of these issues together within this course, led by an experienced journal editor. Instructor Permission Required. Cross-list: CHBE 504, ELEC 504.

**CHEM 505 - PROPOSAL WRITING AND REVIEW IN CHEMISTRY****Short Title:** PROPOSAL WRITING IN CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This course teaches how to prepare scientific proposals including developing an idea, writing, and peer review including creating a mock panel review.**CHEM 511 - SPECTRAL METHODS IN ORGANIC CHEMISTRY****Short Title:** SPECTRAL METHODS ORGANIC CHEM**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** CHEM 212 or CHEM 320**Description:** Enrollment is open to all students. Undergraduate enrollment requires instructor permission via special registration form. Elucidation of organic structures by physical techniques. Interpretation of infrared, ultraviolet, nuclear magnetic resonance, and mass spectral.**CHEM 515 - CHEMICAL KINETICS AND DYNAMICS****Short Title:** CHEMICAL KINETICS & DYNAMICS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Description and analysis of the rates of unimolecular, bimolecular, and composite chemical reactions in gas and solution phases. Both macroscopic kinetics and microscopic reaction dynamics are covered. Graduate/Undergraduate Equivalency: CHEM 415. Mutually Exclusive: Cannot register for CHEM 515 if student has credit for CHEM 415.**CHEM 520 - CLASSICAL AND STATISTICAL THERMODYNAMICS****Short Title:** CLASSICAL & STAT THERMODYNAMIC**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** CHEM 310 or (CHEM 311 or CHEM 312) and MATH 212 and (PHYS 102 or PHYS 112)**Description:** A review of the principles of classical thermodynamics and an introduction to the theories and methods of statistical thermodynamics with applications to problems in chemistry. Graduate/Undergraduate Equivalency: CHEM 420. Mutually Exclusive: Cannot register for CHEM 520 if student has credit for CHEM 420.**CHEM 523 - ADVANCED ANALYSIS METHODS FOR MOLECULAR DYNAMICS FROM STATISTICAL MECHANICS TO MACHINE LEARNING****Short Title:** MOLECULAR DYNAMICS METHODS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1.5**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Enrollment is open to all students. Undergraduate enrollment requires instructor permission via special registration form. Modern methods to extract physical and chemical information from molecular dynamics simulation will be presented, including the determination of reaction coordinates, free energies calculations, and estimation of experimentally measurable observables. The theoretical background and different applications will be discussed. The students will apply the methods on practical examples.**CHEM 525 - FUNDAMENTAL PHOTOLUMINESCENCE SPECTROSCOPY****Short Title:** FUND PHOTOLUM SPECT**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1.5**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Enrollment is open to all students. Undergraduate enrollment requires instructor permission via special registration form. This course aims to cover basic topics in photoluminescence spectroscopy such as instrumentation, different photoluminescent species, solvent relaxation, photoluminescence quenching, energy transfer and anisotropy. Novel applications of photoluminescence spectroscopy such as sensing, multiphoton excitation and the fluorescence of proteins will also be discussed. Undergraduates may register for this course by a Special Registration form.**CHEM 530 - QUANTUM CHEMISTRY****Short Title:** QUANTUM CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** The purpose of this course is to provide the student with a working knowledge of the basic concepts and mathematical formalism of quantum mechanics. Topics include the mathematics of quantum mechanics, one-dimensional problems, central field problems, the harmonic oscillator, angular momentum, perturbation theory, spin, and introduction to methods of modern electronic structure theory, with applications in atomic and molecular structures, spectroscopy, and chemical bonding. Graduate/Undergraduate Equivalency: CHEM 430. Mutually Exclusive: Cannot register for CHEM 530 if student has credit for CHEM 430.

**CHEM 531 - ADVANCED QUANTUM CHEMISTRY****Short Title:** ADV QUANTUM CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Enrollment is open to all students. Undergraduate enrollment requires instructor permission via special registration form. A hands-on approach to the methods of computational quantum chemistry and their application.**CHEM 533 - NANOSCIENCE AND NANOTECHNOLOGY I****Short Title:** NANOSCIENCE & NANOTECHNOLOGY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Enrollment is open to all students. Undergraduate enrollment requires instructor permission via special registration form. An introduction to the basic principles of nanoscience and nanotechnology. Size dependent physical properties of nanoscopic solids will be described using solid state physics and molecular orbital theory as a foundation. Wet chemical techniques that produce nanoscale materials (e.g. carbon nanotubes, semiconductor and metallic nanocrystals, dendrimers...) will be introduced in the second half of the semester. Expected to be taught Spring 2019. Cross-list: CEVE 533, MSNE 534.**CHEM 537 - BIOPHYSICAL CHEMISTRY****Short Title:** BIOPHYSICAL CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This course will cover selected modern experimental and theoretical approaches to biophysical problems. Specifically, protein folding, single molecules and cytoskeleton dynamics will be discussed from theoretical and experimental points of view.**CHEM 541 - MOLECULES THAT CHANGED THE WORLD****Short Title:** MOLECULES CHANGED THE WORLD**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1.5**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** CHEM 212 or CHEM 320**Description:** Enrollment is open to all students. Undergraduate enrollment requires instructor permission via special registration form. This course will expand on our learned knowledge of some of the Nature's most intriguing molecules and the ability of Man to discover, synthesize, modify and use them to our advantage in what areas were not formerly envisioned. Undergraduates may register for the course by filling out a special registration form. These forms can be brought to DBH 243 for processing.**CHEM 542 - MEDICINAL CHEMISTRY I****Short Title:** MEDICINAL CHEMISTRY I**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** A course intended to provide the student with an overview of the elements of drug discovery, design and development. Targets for drug discovery will be discussed, as well as considerations of drug optimization with respect to the biological target and drug metabolism. A summary of the FDA and patent processes will also be included. Graduate/Undergraduate Equivalency: CHEM 442.**CHEM 545 - PHYSICAL ORGANIC CHEMISTRY****Short Title:** PHYSICAL ORGANIC CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Study of organic reaction mechanisms. Includes Huckel M.O. theory, kinetics, isotope effects, linear free energy relationships, thermochemical group additivity, substituent and solvent effects, acidity, and free radical chemistry. Recommended Prerequisite(s): CHEM 311. Repeatable for Credit.**CHEM 547 - SUPRAMOLECULAR CHEMISTRY****Short Title:** SUPRAMOLECULAR CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Enrollment is open to all students. Undergraduate enrollment requires instructor permission via special registration form. An examination of noncovalent interactions and their impact in biology, chemistry, and engineering. Topics will include self-assembly, molecular recognition, protein folding and structure, nucleic acid structure, polymer organization, crystallization and applications of the above for the design and synthesis of nanostructured materials.**CHEM 548 - PEPTIDE CHEMISTRY DESIGN, SYNTHESIS AND STRUCTURE****Short Title:** PEPTIDE CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1.5**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Undergraduates may register for this course by Special Registration form. The course examines solid phase peptide synthesis and strategies to prepare both simple and complex peptide primary architectures. This is followed by looking at analytical methods to assess peptide purity and structure. The course will then consider the design and characterization of peptide sequences that will result in specific 3D structures.

**CHEM 551 - BIOMOLECULAR CONCEPTS****Short Title:** BIOMOLECULAR CONCEPTS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** CHEM 310 or CHEM 311

**Description:** Enrollment is open to all students. Undergraduate enrollment requires instructor permission via special registration form. This course will explore quantitative concepts and tools from chemistry and physics relevant to molecular biology. An executive survey of molecular biology and the basic experimental approaches to biomolecular structure will be followed by a discussion of the structural basics of proteins and nucleic acids. The motion and energy landscapes of proteins will be discussed. Protein folding and evolution and the dynamic basis of gene regulation will be explored. Mutually Exclusive: Cannot register for CHEM 551 if student has credit for CHEM 451.

**CHEM 552 - CHEMICAL BIOLOGY****Short Title:** CHEMICAL BIOLOGY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** This course examines a variety of biological problems from a chemical and structural perspective. The structural and functional properties of amino acids, nucleotides, and sugars will be presented, with special emphasis on their catalytic and chemical properties required for chemical transformations within the cells. This is followed by a discussion of how to harness the power of chemistry to specifically modulate and manipulate these molecules as well as their higher-order structures, such as proteins, nucleic acids, and membranes. Topics include macromolecular structure-function relationships, nucleic acid structure and recognition, protein synthesis and folding, synthetic chemical biology, probes of cellular function, developing hybrid chemical/biologic drugs, as well as modern approaches for target discovery and validation. Graduate/Undergraduate Equivalency: CHEM 452.

**CHEM 553 - STRATEGIC APPLICATIONS OF NAMED REACTIONS IN ORGANIC SYNTHESIS****Short Title:** NAMED REACTIONS IN SYNTHESIS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** In this course we will cover the mechanism and strategic applications of approximately 150 widely used named reactions in organic synthesis. The students will learn how to navigate the vast chemical literature effectively using sophisticated search engines like SciFinder and Reaxys and will get the opportunity to prepare and give 10-minute presentations on 5 recent named rxns. Recommended Prerequisite(s): CHEM 211 and CHEM 212. Repeatable for Credit.

**CHEM 554 - DRUG DISCOVERY AT THE INTERFACE OF CHEMISTRY AND BIOLOGY****Short Title:** DRUG DISCOVERY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1.5**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** Drug discovery requires a close integration of chemistry and biology. This course explores the design and development of new medicine from a chemical biological perspective. Topics includes fundamental methods for biomolecule synthesis and engineering and application to hybrid chemical/biologic drugs, as well as modern approaches for target discovery and validation.

**CHEM 557 - NANOCARBONS****Short Title:** NANOCARBONS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1.5**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** Enrollment is open to all students. Undergraduate enrollment requires instructor permission via special registration form. This course will survey the chemistry, physics, and selected applications of carbon nanostructures. Fullerenes, carbon nanotubes, and graphene will be the main focus. Students are expected to have a solid background in physical chemistry. Undergraduate students may register for this course by Special Registration form.

**CHEM 558 - NANOCRYSTALS****Short Title:** NANOCRYSTALS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** This course will provide a detailed investigation into the chemical and physical principles of inorganic nanocrystals. Topics will include nucleation and growth, crystal faceting, surface ligand chemistry, size-dependent properties and scaling relationships, interparticle forces, and nanoparticle self-assembly. Proficiency in physical chemistry and inorganic materials is strongly encouraged.

**CHEM 559 - SPECTROSCOPY AT THE SINGLE MOLECULE/PARTICLE LIMIT****Short Title:** SPEC SINGLE MOLECULE/PARTICLE**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** Enrollment is open to all students. Undergraduate enrollment requires instructor permission via special registration form. This course will cover principles of electronic spectroscopy of molecules and nanoparticles with emphasis on single molecule/particle spectroscopy methods and analysis techniques.



**CHEM 560 - ADVANCED OPTICAL MICROSCOPY****Short Title:** ADV OPTICAL MICROSCOPY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** Enrollment is open to all students. Undergraduate enrollment requires instructor permission via special registration form. This course covers a broad array of optical techniques for single-molecule detection, spectroscopy, and imaging for detection of (A) motional dynamics, (B) super-resolution structures beyond the diffraction limit, and (C) nanoscale interactions and orientations in biological samples. This course integrates rigorous quantitative analysis approaches and theoretical considerations across the disciplines of chemistry, biology, and physics.

**CHEM 562 - ORGANIC CHEMISTRY OF ENZYME-CATALYZED REACTIONS****Short Title:** ENZYME MECHANISMS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Course Level:** Graduate

**Description:** This class will discuss the organic chemistry that is involved in the production of primary and secondary metabolites. The reactivity patterns and the underlying logic for different enzyme families will be provided, along with the roles of cofactor, from the perspective of mechanistic organic chemistry. Graduate/Undergraduate Equivalency: CHEM 462. Mutually Exclusive: Cannot register for CHEM 562 if student has credit for CHEM 462.

**CHEM 570 - NANOTECHNOLOGY FOR TEACHERS, TEACHING CHEMICAL CONCEPTS VIA INQUIRY I****Short Title:** TEACHING CHEMICAL CONCEPTS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** Using the Concept Development Approach, this course will teach teachers how to engage students in inquiry science and provide teachers with in depth conceptual knowledge about chemical fundamentals. The course will include hands-on activities and discussions about chemical concepts that include atomic molecular theory, atomic structure, quantum energy levels, thermodynamics, equilibrium, and bonding. Nanotechnology research with environmental applications will be highlighted throughout the course. Instructor Permission Required.

**CHEM 571 - TEACHING CHEMICAL CONCEPTS VIA INQUIRY II, NANOTECHNOLOGY FOR TEACHERS****Short Title:** CHEMICAL CONCEPTS - INQUIRY II**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** Using the Concept Development Approach, this course will teach teachers how to engage students in inquiry science and provide teachers with in depth conceptual knowledge about chemical fundamentals. The course will include hands-on activities and discussions about chemical concepts that include gas laws, kinetic molecular theory, acid base equilibrium, and phase equilibrium. Nanotechnology research with biological applications will be highlighted throughout the course. Instructor Permission Required. Recommended Prerequisite(s): CHEM 570.

**CHEM 575 - PHYSICAL METHODS IN INORGANIC CHEMISTRY****Short Title:** PHYS METH INORGANIC CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** A survey course of research techniques used in modern inorganic chemistry. Topics covered will include X-ray diffraction, matrix isolation, mass spectrometry, magnetism, electrochemistry, and various spectroscopies (IR, Raman, UV-Vis, NMR, EPR, XPS, EXAFS, and Mossbauer). Graduate/Undergraduate Equivalency: CHEM 475. Mutually Exclusive: Cannot register for CHEM 575 if student has credit for CHEM 475.

**CHEM 580 - MICROSCOPY METHODS IN MATERIALS SCIENCE****Short Title:** MICROSCOPY METHODS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** This course covers theory and applications of electron microscopy techniques with an emphasis on transmission and scanning transmission electron microscopy (TEM, STEM). Topics include modern instrumentation and hardware, electron diffraction, imaging modes, tomography, and spectroscopy (energy dispersive x-ray spectroscopy (EDS), electron-energy loss spectroscopy (EELS), cathodoluminescence (CL)). Previous experience with electron microscopes recommended. Can be taken alone or concurrently with lab course MSNE 582. Cross-list: MSNE 580.

**CHEM 582 - ELECTRON MICROSCOPY CENTER LAB****Short Title:** ELECTRON MICROSCOPY CENTER LAB**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Corequisite:** CHEM 580

**Description:** Hands-on laboratory using the instruments in the electron microscopy center. The students will gain the knowledge necessary to operate the instruments and analyze data independently. MSNE 582 must be taken concurrently with MSNE 580; CHEM 582 must be taken concurrently with CHEM 580. Cross-list: MSNE 582.

**CHEM 583 - ORGANOMETALLIC CHEMISTRY I****Short Title:** ORGANOMETALLIC CHEMISTRY I**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1.5**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** Organometallic Chemistry I. An introduction to organometallic chemistry, focusing on transition metal structure, bonding, and reactivity. This course is the first half of a two-course sequence, together with CHEM 584: Organometallic Chemistry II. Each course is a half-semester course. Expected to be taught 1st half of the term. Undergraduates with appropriate preparation may register by filling out a special registration form. Recommended Prerequisite(s): CHEM 320 or CHEM 212 or CHEM 360

**CHEM 584 - ORGANOMETALLIC CHEMISTRY II****Short Title:** ORGANOMETALLIC CHEMISTRY II**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1.5**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Corequisite:** CHEM 583

**Description:** Organometallic Chemistry II. An introduction to organometallic chemistry, focusing on transition metal structure, bonding, and reactivity. This course is the first half of a two-course sequence, together with CHEM 583: Organometallic Chemistry I. Each course is a half-semester course. Expected to be taught 2nd half of the term. Undergraduates with appropriate preparation may register by filling out a special registration form.

**CHEM 586 - CHEMICAL TOOLS FOR BIOLOGY****Short Title:** CHEMICAL TOOLS FOR BIOLOGY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1.5**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** Enrollment is open to all students. Undergraduate enrollment requires instructor permission via special registration form. Selected topics in modern chemical biology. The development and application of chemical methods to probe, perturb, and understand biological systems. Topics include protein and DNA chemistry, classical and modern approaches to inhibitor development, and chemical reaction design in living cells. Expected to be taught Fall 2018.

**CHEM 590 - PROFESSIONAL MASTERS SEMINAR IN APPLIED CHEMISTRY****Short Title:** PROF. MS. SEMINAR IN APP. CHEM**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** This course is designed for students in the Applied Chemistry Professional Master's program. The course will consist of two parts. In the first part, speakers from industrial, education and government entities will be invited to give talks on the topics of their activities. In the second part, students will be required to present on various topics related to Applied Chemistry.

**CHEM 591 - RESEARCH LABORATORY EXPERIENCE****Short Title:** RESEARCH LAB EXPERIENCE**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Research**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** This course is designed for students in the Professional Masters' Program in Applied Chemistry. The student will be assigned to a project and mentor in a current research laboratory in the Chemistry Department.

**CHEM 592 - STATISTICAL DATA ANALYSIS****Short Title:** STATISTICAL DATA ANALYSIS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** This course provides an overview of the statistical tools and methods needed for the analysis of large scientific datasets including an overview of fundamental statistical concepts, statistical tests, and estimation methods. This course will also provide an introduction to MATLAB as an example of computational tool for the analysis and visualization of large datasets.

**CHEM 595 - TRANSITION METAL CHEMISTRY****Short Title:** TRANSITION METAL CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** Structure, bonding and reactivity of coordination and organometallic compounds; ligand field theory; electronic spectroscopy; magnetism; reaction mechanisms; catalysis. Graduate/Undergraduate Equivalency: CHEM 495. Mutually Exclusive: Cannot register for CHEM 595 if student has credit for CHEM 495. Repeatable for Credit.

**CHEM 596 - ADVANCED INORGANIC CHEMISTRY****Short Title:** ADVANCED INORGANIC CHEMISTRY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** Advanced Inorganic Chemistry. In-depth survey course of the periodic table with particular focus on main group inorganic and transition metal structure, synthesis, and reactivity. Graduate/Undergraduate Equivalency: CHEM 496.

**CHEM 600 - GRADUATE SEMINAR****Short Title:** GRADUATE SEMINAR**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** Section 1: PHYSICAL CHEMISTRY-NANO Section 2: ORGANIC AND BIOLOGICAL CHEMISTRY Section 3: NANO CHEMISTRY Section 4: CARBON NANO CHEMISTRY. This seminar series is open to all chemistry graduate students or graduate students whose home department is chemistry. Students from other departments may audit the course with instructor permission. Repeatable for Credit.

**CHEM 630 - MOLECULAR SPECTROSCOPY****Short Title:** MOLECU SPECTROSCOPY**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** CHEM 430 or CHEM 530

**Description:** The spectra of simple molecules, including microwave, infrared, visible, ultraviolet, and Raman spectra; resonance spectroscopy; surface-enhanced spectroscopy.

**CHEM 650 - CHEMICAL PHYSICS OF CONDENSED AND BIOLOGICAL MATTER****Short Title:** CHEM PHYS CONDENSED&BIO MATTER**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** The principles underlying the structure and dynamics of condensed phase and biological matter. Both experimental phenomenology and theoretical approaches will be used. Starting with a review of intermolecular forces, the course will describe the structure and thermodynamics of clusters, crystalline solids, metals, liquids, glasses and biomolecules. A unified picture of reactions and classical and quantum phase transitions in condensed matter will be presented. The energy landscape theory of the dynamics of glasses and protein folding will also be covered. Expected to be taught Fall 2018. Mutually Exclusive: Cannot register for CHEM 650 if student has credit for CHEM 450.

**CHEM 656 - CLASSICS IN TOTAL SYNTHESIS****Short Title:** CLASSICS IN SYNTHESIS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** CHEM 401 or CHEM 501

**Description:** Selected total synthesis will be discussed. Special emphasis will be placed on retro-synthetic analysis, synthetic strategies and technologies, asymmetric synthesis and catalysis.

**CHEM 677 - SPECIAL TOPICS****Short Title:** SPECIAL TOPICS**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Internship/Practicum, Laboratory, Independent Study, Lecture, Seminar, Lecture/Laboratory**Credit Hours:** 1-4**Restrictions:** Enrollment is limited to Graduate or Visiting Graduate level students.**Course Level:** Graduate

**Description:** Topics and credit hours vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.

**CHEM 700 - TEACHING PRACTICUM****Short Title:** TEACHING PRACTICUM**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Internship/Practicum**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

**Description:** Open to graduate students in chemistry and only in exceptional circumstances to undergraduates. Repeatable for Credit.

**CHEM 800 - GRADUATE RESEARCH****Short Title:** GRADUATE RESEARCH**Department:** Chemistry**Grade Mode:** Standard Letter**Course Type:** Research**Credit Hours:** 1-15**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Repeatable for Credit.

## Department and Code Legend

*Note: Internally, the university uses the following descriptions, codes, and abbreviations for this academic program. The following is a quick reference:*

### Course Catalog/Schedule

- Course offerings/subject code: CHEM

### Department Description and Code

- Chemistry: CHEM

### Undergraduate Degree Descriptions and Codes

- Bachelor of Arts degree: BA
- Bachelor of Science degree: BS

### Undergraduate Major Descriptions and Codes

- Major in Chemistry: CHEM
- Major in Chemical Physics: CPHY

### Graduate Degree Descriptions and Codes

- Master of Arts degree: MA
- Doctor of Philosophy degree: PhD

### Graduate Degree Program Description and Code

- Degree Program in Chemistry: CHEM

### CIP Code and Description <sup>1</sup>

- **CHEM** Major/Program: CIP Code/Title: 40.0501 - Chemistry, General
- **CPHY** Major/Program: CIP Code/Title: 40.0508 - Chemical Physics

<sup>1</sup> Classification of Instructional Programs (CIP) 2020 Codes and Descriptions from the National Center for Education Statistics: <https://nces.ed.gov/ipeds/cipcode/>