CHEMISTRY

Contact Information

Chemistry
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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 degree 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 degree 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. The department also jointly manages the Chemical Physics (https://ga.rice.edu/programs-study/departments-programs/natural-sciences/chemical-physics/) program.

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. The department also administers the Master of Science in Applied Chemical Sciences (MSACS) (https://ga.rice.edu/programs-study/departments-programs/natural-sciences/applied-chemical-sciences/) degree program

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/)*.*

Master's Programs

- Master of Arts (MA) Degree in the field of Chemistry*
- Master of Science in Applied Chemical Sciences (MSACS) Degree (https://ga.rice.edu/programs-study/departments-programs/natural-sciences/applied-chemical-sciences/applied-chemical-sciences-msacs/)

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.*

Department Chair

Angel A. Martí-Arbona

Professors

Pulickel M. Ajayan
Pedro J.J. Alvarez
Zachary T. Ball
Gang Bao
Jason H. Hafner
Naomi J. Halas
Jeffrey D. Hartgerink
Randall Hulet
John S. Hutchinson
Oleg A. Igoshin
Anatoly B. Kolomeisky
László Kürti
Jun Lou
Frederick C. MacKintosh
Angel A. Martí-Arbona
Lane Martin

Caroline A. Masiello
Seiichi P. T. Matsuda
Antonios G. Mikos
Emilia Morosan
Andriy Nevidomskyy
K.C. Nicolaou
Peter Norlander
Jose Nelson Onuchic
Matteo Pasquali
George Phillips
Hans Renata
Peter Rossky
David Sarlah
Gustavo E. Scuseria
James M. Tour
R. Bruce Weisman
Kenton H. Whitmire
Pernilla Wittung-Stafshede
Peter G. Wolynes
Michael S. Wong
Han Xiao
Boris I. Yakobson

Associate Professors

Michael Diehl
Matthew Jones
Kevin McHugh
Lea Nienhaus
Haotian Wang
Laurence Yeung
Eugene Zubarev

Assistant Professors

Kushal Bagchi
Mingjie Dai
Anna-Karin Gustavsson
Yimo Han
Raúl Hernández Sánchez
Stavroula Kampouri
Yuan Ma
Amanda B. Marciel
Quanbing Mou
James Shee
Julian West
Samantha Yruegas

Professors Emeriti

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

Associate Research Professor

Carolyn A. Nichol

Associate Teaching Professors

Krista Kobylianskii

Assistant Teaching Professors

Kasey Leigh Yearty

Lecturers

Caroline V. McNeil
Rosalynn Nankya
Lesley O'Leary
Lesa Tran Lu

Adjunct Faculty

Marco A. Ciufolini
Ayrat Dimiev
Henry Everitt
Bruce Johnson
Thomas Kent
Christy Landes
Stephan Link
Luz Maria Martinez Calderon
Henk Mooiweer
Frank Noe
B. Montgomery Pettitt
Carmen Reznik
Emilie Ringe
Hossein Robatjazi
Corina Rogge
Yongcheng Song
Marcelo Videa 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).
To view the most recent semester's course schedule, please see Rice's Course Schedule (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. 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.

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 176 - THE CHEMISTRY OF ART
Short Title: THE CHEMISTRY OF ART
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: 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 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 313 (may be taken concurrently) or CHEM 320 (may be taken concurrently)
Description: Synthesis, purification, and characterization of organic compounds, including identification of unknown organic molecules using spectroscopy. This course does not fulfill the organic chemistry lab requirement for the chemistry major. Enrollment in CHEM 215 requires either prior completion of CHEM 313 or 320, or concurrent enrollment in one of these courses.

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) and (MATH 211 or MATH 220) and (PHYS 101 or PHYS 111 or PHYS 125)
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) and (MATH 211 or MATH 220) and (PHYS 101 or PHYS 111 or PHYS 125)
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
Corequisite: CHEM 314
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
Corequisite: CHEM 313
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
Description: A continuation of CHEM 211 that is in greater depth than CHEM 313. Primarily for chemistry majors and science or engineering students with a strong interest in chemistry research. Either CHEM 313 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 219 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 340 - BIOCHEMISTRY AND CHEMICAL BIOLOGY
Short Title: BIOCHEMISTRY AND CHEM 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 313 or CHEM 320
Description: Biochemistry and Chemical Biology explores the chemical and molecular mechanisms that underlie biological processes from a molecular perspective. The course covers the chemistry, structure and function of biomolecules, enzymatic catalysis, metabolic pathways, and the regulation of biochemical processes. Students will gain an understanding of how chemical principles apply to biological systems and receive a foundation for further studies in chemical biology.

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 - ADVANCED ORGANIC CHEMISTRY LAB
Short Title: ADVANCED 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 313 (may be taken concurrently) or CHEM 320 (may be taken concurrently)
Description: Experiments illustrating techniques in synthetic organic chemistry, purification, and characterization of organic compounds using instrumental methods of analysis. Assignments include an emphasis on scientific writing. This course must be taken as the first advanced laboratory for the chemistry major. Enrollment in CHEM 365 requires either prior completion of CHEM 313 or 320, or concurrent enrollment in one of these courses.

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
Prerequisite(s): CHEM 365
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
Prerequisite(s): CHEM 365
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
Prerequisite(s): CHEM 365
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 369 - CHEMICAL BIOLOGY LAB
Short Title: CHEMICAL BIOLOGY 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 365
Description: A hands-on, design-forward introduction to experimental chemical biology for students new to the field. Organized around two modern modules—(1) glucose sensing with DNA aptamers and (2) CRISPR/Cas12a-based viral nucleic-acid detection—the course builds core laboratory competencies and emphasizes experimental design: students formulate hypotheses, select assay parameters and justify controls to meet performance targets (specificity, sensitivity, dynamic range). Work proceeds through approximately 12 scaffolded experiments that incorporate guided choice points, iteration, and quantitative decision-making. Emphasis is placed on safety, reproducibility, and interpreting assay performance (specificity, sensitivity, dynamic range). Instruments include a microplate reader, PAGE system, DNA spin-purification columns, a NanoDrop, and micropipettes. Open to undergraduate students only. No prior experience in chemical biology is required; recommended background includes general chemistry with laboratory and organic chemistry laboratory (or permission of the instructor). Two credit hours.

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: 3
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 313 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
Prerequisite(s): (CHEM 313 or CHEM 320) and BIOS 301
Description: A course intended to provide the student with an overview of the elements of drug discover, 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 I
Short Title: CHEMICAL BIOLOGY 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 212 or CHEM 313 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 454 - CHEMICAL BIOLOGY II
Short Title: CHEMICAL BIOLOGY II
Department: Chemistry
Grade Mode: Standard Letter
Course Type: Lecture
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 313 or CHEM 320) and (BIOS 301 or CHEM 340)
Description: This course introduces how chemistry contributes to fundamental biochemistry science, disease therapy, and diagnostics. This is followed by exploring the integration of chemical methodologies to advance understanding of biochemistry fundamental knowledge and contribute to biomedical applications. Graduate/Undergraduate Equivalency: CHEM 554. Mutually Exclusive: Cannot register for CHEM 454 if student has credit for CHEM 554.

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: Seminar, Internship/Practicum, Laboratory, Lecture, Lecture/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 483 - 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 Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.
Course Level: Undergraduate Upper-Level
Prerequisite(s): CHEM 320 or CHEM 313
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 484: 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. Graduate/Undergraduate Equivalency: CHEM 583. Recommended Prerequisite(s): CHEM 360 Mutually Exclusive: Cannot register for CHEM 483 if student has credit for CHEM 583.

CHEM 484 - ORAGANOMETALLIC CHEMISTY II
Short Title: ORGANOMETALLIC CHEMISTRY II
Department: Chemistry
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 1.5
Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.
Course Level: Undergraduate Upper-Level
Corequisite: CHEM 483
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 483: Organometallic Chemistry I. Each course is a half-semester course. Expected to be taught 2nd half of the term. Graduate/Undergraduate Equivalency: CHEM 584. Mutually Exclusive: Cannot register for CHEM 484 if student has credit for CHEM 584.

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 Texas 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 or 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 measureable 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 532 - QUANTUM THEORY OF ELECTRON CORRELATION IN MOLECULES
Short Title: THEORY OF ELECTRON CORRELATION
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: This is a rigorous graduate-level course in theoretical quantum chemistry, focusing on both traditional and relatively modern ab initio electronic structure models. Students will learn the fundamentals of many-particle quantum mechanics alongside concepts relevant to molecular electronic structure theory. The course will cover theoretical models of interacting electrons spanning Hartree-Fock theory, many-body perturbation theory, coupled cluster theory, and stochastic methods. Recommended Prerequisite(s): CHEM 430 or CHEM 530

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 536 - PHYSICAL CHEMISTRY OF SOFT MATERIALS
Short Title: PHYSICAL CHEM OF SOFT MATERIAL
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 aim of the course is to generate interest in the chemical physics of soft and organic materials, while also creating quantitative knowledge and understanding of the course content. While a wide range of topics will be covered, specialized topics that will be covered that could be of broad interest to researchers in material science and biophysics in Rice include 1) The behavior of nanoparticles in solutions, 2) The physics and chemistry of synthetic and natural macromolecules, 3) The crystallization of small-molecules including but not limited to pharmaceutical systems and 4) the self-assembly of biomolecules. The objective of the course is to simultaneously give a broad overview of the field of soft matter while also covering specialized topics that will be of interest to the broadest possible range of researchers at Rice.

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 discover, 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 I
Short Title: CHEMICAL BIOLOGY 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: 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 - CHEMICAL BIOLOGY II
Short Title: CHEMICAL BIOLOGY 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
Description: This course introduces how chemistry contributes to fundamental biochemistry science, disease therapy, and diagnostics. This is followed by exploring the integration of chemical methodologies to advance understanding of biochemistry fundamental knowledge and contribute to biomedical applications. Graduate/Undergraduate Equivalency: CHEM 454. Mutually Exclusive: Cannot register for CHEM 554 if student has credit for CHEM 454.

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 AND MICROSCOPY FROM THE BULK TO THE SINGLE MOLECULE LIMIT
Short Title: SPEC/MICR BULK TO NANO
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 theoretical background and operating principles of optical, electron and X-ray spectroscopy, spectromicroscopy, and scanning probe microscopy from the ensemble to the molecular level.

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 561 - CHEMISTRY OF NUCLEIC ACIDS
Short Title: CHEMISTRY OF NUCLEIC ACIDS
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: This course provides an in-depth exploration of nucleic acids, covering their chemical properties, biological functions, and applications in research and medicine. Topics include DNA/RNA structure, mechanisms of replication and transcription, gene regulation, nucleic acid modifications, and cutting-edge techniques in nucleic acid research such as CRISPR, mRNA engineering, and super-resolution imaging. The course will also examine the roles of nucleic acids in disease and therapeutic strategies.

CHEM 562 - 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 Graduate level students.
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 565 - POLYMER CHEMISTRY
Short Title: POLYMER 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 covers advanced topics in polymer chemistry, including synthesis, characterization, and properties of polymers, as well as their applications in various fields.

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. This course includes lab demos of SEM and TEM. Cross-list: MSNE 580.

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. Graduate/Undergraduate Equivalency: CHEM 483. Recommended Prerequisite(s): CHEM 320 or CHEM 313 or CHEM 360 Mutually Exclusive: Cannot register for CHEM 583 if student has credit for CHEM 483.

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. Graduate/Undergraduate Equivalency: CHEM 484. Mutually Exclusive: Cannot register for CHEM 584 if student has credit for CHEM 484.

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 and introduction to MATLAB as an example of computational toll 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: NANOCHEMISTRY Section 4: CARBON NANOCHEMISTRY. 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 SPECTROSCPY
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.

Description 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

Home School Description and Code

- Natural Sciences: NS

Home Department (or Program) Descriptions and Codes

- Chemistry: CHEM
- Chemical Physics: CPHY

Undergraduate Degree Descriptions and Codes

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

Undergraduate Major Descriptions and Codes

- Major in Chemistry (BA and BS degrees): CHEM
- Major in Chemical Physics (BS degree): CPHY

Graduate Degree Descriptions and Codes

- Master of Arts degree: MA
- Master of Science in Applied Chemical Sciences degree: MSACS
- Doctor of Philosophy degree: PhD

Graduate Degree Program Description and Code

- Degree Program in Applied Chemical Sciences: ACSC
- Degree Program in Chemistry: CHEM

CIP Code and Description [1]

- **ACSC** Major/Program: CIP Code/Title: *41.0301 - Chemical Technology/Technician*
- **CHEM** Major/Program: CIP Code/Title: *40.0501 - Chemistry, General*
- **CPHY** Major/Program: CIP Code/Title: *40.0508 - Chemical Physics*

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