

and the application of these principles to the design of bioreactors, bioassays, drug delivery systems, and artificial organs. Normally graded Satisfactory (S) or No Credit (NC), but students may petition the instructor for a letter grade on the basis of assigned extra work or examination. Cross-listed with BIEN 264. Credit is awarded for only one of BIEN 159/CEE 159 or BIEN 264/CEE 264.

CEE 265. Special Topics in Microbial Fate and Transport in Aquatic Environments (1 or 2) Seminar, 1 hour; individual study, 0-3 hours. Prerequisite(s): graduate standing or consent of instructor. Explores the theoretical and applied research currently being conducted in the area of microbial pathogen transport in natural and engineered aquatic systems. Topics include the theory of colloid transport and filtration, quantification and analysis of microbial adhesion or deposition kinetics, and whole-cell and molecular-scale microbial analysis techniques. Students who give class presentations receive credit for 2 units; other students receive credit for 1 unit. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

CEE 266. Special Topics in Biological Conversion of Biomass (1 or 2) Seminar, 1 hour; individual study, 0-3 hours. Prerequisite(s): graduate standing. Consists of oral presentations and small group discussions of current and historic literature on biological conversion of biomass to fuels and chemicals. Students who make presentations receive credit for 2 units; other students receive credit for 1 unit. Graded Satisfactory (S) or No Credit (NC). Course is repeatable as topics change.

CEE 267. Special Topics in Bionanotechnology (2) Seminar, 2 hours. Prerequisite(s): graduate standing. Introduces recent advances in biomimetics, biomaterialization, and bio-inspired materials for nanostructures, as well as for energy storage and conversion applications. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable to a maximum of 18 units.

CEE 268. Special Topics in Environmental Chemistry (2) Seminar, 2 hours. Prerequisite(s): graduate standing. Addresses the key role that environmental chemical processes play in water quality, pollutant fate, and the development of strategies for the treatment and reuse of contaminated natural resources. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable to a maximum of 18 units.

CEE 286. Colloquium in Chemical and Environmental Engineering (1) Colloquium, 1 hour. Prerequisite(s): graduate standing. Lectures on a current research topic in chemical engineering, environmental engineering, and other related fields presented by faculty members and visiting scientists. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

CEE 290. Directed Studies (1-6) Individual study, 3-18 hours. Prerequisite(s): graduate standing; consent of instructor and graduate advisor. Individual study, directed by a faculty member, of selected topics in chemical and environmental engineering. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 9 units.

CEE 292. Concurrent Studies in Chemical and Environmental Engineering (1-4) Outside research, 3-12 hours. Prerequisite(s): consent of instructor. To be taken concurrently with a 100-series course but on an individual basis. Devoted to specific additional projects related to the 100-series course. Faculty

provide guidance and evaluation throughout the quarter. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 8 units.

CEE 297. Directed Research (1-6) Outside research, 3-18 hours. Prerequisite(s): graduate standing; consent of instructor. Research conducted under the supervision of a faculty member on selected problems in chemical and environmental engineering. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 9 units.

CEE 298-I. Individual Internship (1-12) Written work, 1-12 hours; internship, 2-24 hours. Prerequisite(s): graduate standing; consent of instructor. Individual apprenticeship in chemical and environmental engineering with an approved professional individual or organization, and a faculty member. A written report is required. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 16 units.

CEE 299. Research for the Thesis or Dissertation (1-12) Outside research, 3-36 hours. Prerequisite(s): graduate standing; consent of instructor. Research in chemical and environmental engineering for the M.S. thesis or Ph.D. dissertation. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

Professional Course

CEE 302. Teaching Practicum (1-4) Seminar, 1-4 hours. Prerequisite(s): appointment as a teaching assistant or associate in Chemical and Environmental Engineering. Topics include effective teaching methods such as those involved in leading discussion sections, preparing and grading examinations, and student-instructor relations in lower- and upper-division Chemical Engineering and Environmental Engineering courses. Required each quarter of teaching assistants and associates in Chemical and Environmental Engineering. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 12 units.

Chemistry

Subject abbreviation: CHEM
College of Natural and Agricultural Sciences

Eric L. Chronister, Ph.D., Chair
Leonard Mueller, Ph.D., Vice Chair
Department Office, 248 Chemical Sciences I
(951) 827-3522; chem.ucr.edu

Professors

Guy Bertrand, Ph.D.
David F. Bocian, Ph.D.
Eric L. Chronister, Ph.D.
Pingyun Feng, Ph.D.
Robert Haddon, Ph.D. (Chemistry/Chemical and Environmental Engineering)
Cynthia K. Larive, Ph.D.
Thomas H. Morton, Ph.D.
Michael Pirrung, Ph.D. *UC Presidential Chair in Chemistry*
Dallas L. Rabenstein, Ph.D.
Christopher A. Reed, Ph.D.
Gary W. Scott, Ph.D.
Christopher Y. Switzer, Ph.D.
Yinsheng Wang, Ph.D.
Francisco Zaera, Ph.D.
Jingsong Zhang, Ph.D.

Professors Emeriti

Walter J. Deal, Ph.D.
Everly B. Fleischer, Ph.D.

George K. Helmkamp, Ph.D.
François Mathey, Ph.D.
M. Mark Midland, Ph.D.
Robert C. Neuman, Jr., Ph.D.
William H. Okamura, Ph.D.
William H. Orttung, Ph.D.
Michael F. Rettig, Ph.D.
James N. Pitts, Jr., Ph.D.
Donald T. Sawyer, Ph.D.
Hartland H. Schmidt, Ph.D.
Charles L. Wilkins, Ph.D.
Richard M. Wing, Ph.D.

Associate Professors

Christopher J. Bardeen, Ph.D.
Ludwig Bartels, Ph.D.
Quan "Jason" Chen, Ph.D.
Michael J. Marsella, Ph.D.
Leonard J. Mueller, Ph.D.

Assistant Professors

Gregory J.O. Beran, Ph.D.
Chia-en Chang, Ph.D.
Richard Hooley, Ph.D.
Ryan Julian, Ph.D.
Catharine Larsen, Ph.D.
Yadong Yin, Ph.D.
Wenwan Zhong, Ph.D.

**

Cooperating Faculty

Roger Atkinson, Ph.D. (Environmental Sciences)
Sean Cutler, Ph.D. (Botany and Plant Sciences)
Richard Debus, Ph.D. (Biochemistry)
Russ Hille, Ph.D. (Biochemistry)
Jocelyn G. Millar, Ph.D. (Entomology)
Ashok Mulchandani, Ph.D. (Chemical Engineering)
Jerome S. Schultz, Ph.D. (Bioengineering)
Paul J. Ziemann, Ph.D. (Environmental Sciences)

Major

The Department of Chemistry offers a B.S. and B.A. degree in Chemistry and a B.S. in Chemistry with a Chemical Physics option or an Environmental Chemistry option.

The B.S. program is certified by the American Chemical Society and is designed for students interested in a professionally oriented major leading most often to a career or advanced study in chemistry.

The B.A. program is designed for students who wish to obtain a broad educational background with less intensive emphasis on chemistry. In this program, students have increased ease in meeting requirements for such areas as pre-medical, pre-dental, or prepharmaceutical science; education; and administration. Check www.careers.ucr.edu.

A **Chemical Physics** option is available for students who wish to prepare for admission to a graduate program in chemical physics.

The **Environmental Chemistry** option is available for students who wish to become familiar with environmental processes and problems related to air, water, and soil, and to apply their chemical knowledge working in environmental-related areas. This option also prepares students for admission to a graduate program emphasizing environmental chemistry.

Pre-Health Science Chemistry majors in either the B.S. or B.A. programs can prepare for admission to medical, pharmacy, or dental schools by care-

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fully planning their programs of study. Students planning to apply for post-graduate studies in the health sciences should make it a special point to consult with their Chemistry advisor early in their studies at UCR. Check www.mhcp.ucr.edu.

Teaching Credential

Teachers in the public schools in California must have a credential approved by the State Commission on Teacher Credentialing. The credential requires an undergraduate major, baccalaureate degree, and completion of a graduate credential program such as that offered by the Graduate School of Education at UCR (see Education in this catalog and www.education.ucr.edu).

UCR has an approved undergraduate program for Chemistry majors who plan to get a Multiple Subjects Credential and teach in the elementary (K-6) grades. A breadth of course work is necessary, in addition to the specified requirements for the major. Students are urged to start early, preferably as freshmen, selecting courses most helpful for this career. Details and counseling on the Bridge to Teaching Program, a preparation program for the multiple subjects credential, are available in the Office of Interdisciplinary Programs, 3111 Interdisciplinary Building South (INTS), (951) 827-1584; www.isnid.ucr.edu. Details and counseling on other programs are available in the Graduate School of Education and www.education.ucr.edu/programs.html.

UCR does not yet have a state-approved undergraduate program for chemistry majors who wish to teach at the secondary level. The Teaching Credential in Science, chemistry emphasis, is required for chemistry teachers, grades 7-12. Students who plan to get this credential must take the commission's subject-matter assessment examination and should make certain their academic program includes preparatory course work. The examination includes chemistry in depth and general science with introductory, college-level biology, chemistry, physics, and geoscience (geology, meteorology, oceanography, astronomy). Further information about courses, requirements, and examinations can be obtained in orientation meetings and the Graduate School of Education (1124 Sproul Hall).

California Teach-Science/Mathematics Initiative (CaTEACH-SMI) California Teach-Science Mathematics Initiative (CaTEACH-SMI) has a goal of addressing the critical need of highly qualified K-12 science and mathematics teachers in California. With an economy increasingly reliant on science, technology, engineering, and mathematics (STEM) and the anticipated large scale retirement of qualified teachers, this is an essential time to explore and prepare for a career in teaching science or mathematics. CaTEACH-SMI at UCR offers undergraduate students paid/unpaid opportunities to explore STEM teaching as a career option. Through CaTEACH-SMI, students receive advising and mentoring to prepare for entrance into an intern teaching credential program while diligently

coordinating with academic advisors to ensure completion of STEM degree requirements. The CaTEACH-SMI Resource Center provides future STEM teachers with material and financial resources to promote planning and professional development towards a science/mathematics education career.

For more information about the CaTEACH-SMI program, please visit <http://smi.ucr.edu> or at the Resource Center at 1104 Pierce Hall, (951)827-4970.

Transfer Students

Students transferring to the Chemistry major must complete courses comparable to the following one-year sequences before they transfer:

1. General chemistry, equivalent to CHEM 001A, CHEM 001B, CHEM 001C, CHEM 01LA, CHEM 01LB, CHEM 01LC, each course completed with a grade of "C" or better
2. First-year calculus, equivalent to MATH 009A, MATH 009B, MATH 009C, each course completed with a grade of "C" or better

At least one of the following one-year sequences:

1. General physics (calculus-based) equivalent to PHYS 040A, PHYS 040B, PHYS 040C, each course completed with a grade of "C" or better (strongly recommended)
2. Second-year calculus, equivalent to MATH 010A, MATH 010B, MATH 046, each course completed with a grade of "C" or better
3. Organic chemistry (one-year lower-division), each course completed with a grade of "B" or better

Students must have a minimum grade point average of 2.70 in transferable college courses. UCR has articulation agreements with most of the California community colleges. These agreements list specific community college courses that have been designated as comparable to UCR courses (see the statewide articulation Web site at www.assist.org). Transfer students will usually find it advantageous to complete most or all sequences before starting at UCR. All prospective transfers should try to complete the sequences they begin rather than divide a sequence between two campuses.

University Requirements

See Undergraduate Studies section.

College Requirements

See College of Natural and Agricultural Sciences, Colleges and Programs section.

Some of the following requirements for the major may also fulfill some of the college's breadth requirements. Consult with a professional academic advisor at the CNAS Advising Center, 1223 Pierce Hall.

Major Requirements

The major requirements for the B.A. and the B.S. degree in Chemistry are as follows:

Bachelor of Arts

1. Lower-division requirements (51-53 units)
 - a) CHEM 001A, CHEM 001B, CHEM 001C, CHEM 01LA, CHEM 01LB, CHEM 01LC (or CHEM 01HA and CHEM 1HLA, CHEM 01HB and CHEM 1HLB, CHEM 01HC and CHEM 1HLC), CHEM 005
 - b) MATH 008B or MATH 009A, MATH 009B, MATH 009C, MATH 010A
 - c) PHYS 040A, PHYS 040B, PHYS 040C (or PHYS 002A, PHYS 002B, PHYS 002C, PHYS 02LA, PHYS 02LB, PHYS 02LC)
2. Upper-division requirements (38 units)
A minimum grade of "C-" for any upper-division course used to fulfill the requirements for the B.A. degree.
 - a) CHEM 110A, CHEM 110B, CHEM 112A, CHEM 112B, CHEM 112C, CHEM 113, CHEM 125, CHEM 150A, CHEM 191, and either CHEM 111 or CHEM 166
 - b) Ten (10) additional upper-division units in Chemistry if the year of organic chemistry is taken at a community college

Bachelor of Science

1. Lower-division requirements (64-66 units)
 - a) CHEM 001A, CHEM 001B, CHEM 001C, CHEM 01LA, CHEM 01LB, CHEM 01LC (or CHEM 01HA and CHEM 1HLA, CHEM 01HB and CHEM 1HLB, CHEM 01HC and CHEM 1HLC), CHEM 005
 - b) MATH 008B or MATH 009A, MATH 009B, MATH 009C, MATH 010A, MATH 010B, MATH 046
 - c) PHYS 040A, PHYS 040B, PHYS 040C, PHYS 040D
2. Upper-division requirements (50 units)
A minimum grade of "C-" for any upper-division course used to fulfill the requirements for the B.S. degree.
 - a) CHEM 110A, CHEM 110B, CHEM 111, CHEM 112A, CHEM 112B, CHEM 112C, CHEM 113, CHEM 125, CHEM 150A, CHEM 191
 - b) Two laboratory courses from CHEM 140, CHEM 166, BCH 102
 - c) One course from BCH 110A, CHEM 135/ENSC 135/ENTX 135, CHEM 136/ENSC 136/ENTX 136/SWSC 136, CHEM 150B

Chemical Physics Option

Students must consult with their Chemistry advisor before electing this option.

1. Lower-division requirements (64-66 units)
 - a) CHEM 001A, CHEM 001B, CHEM 001C, CHEM 01LA, CHEM 01LB, CHEM 01LC (or CHEM 01HA and CHEM 1HLA, CHEM 01HB and CHEM 1HLB, CHEM 01HC and CHEM 1HLC), CHEM 005

- b) MATH 008B or MATH 009A,
MATH 009B, MATH 009C, MATH 010A,
MATH 010B, MATH 046
- c) PHYS 040A, PHYS 040B, PHYS 040C,
PHYS 040D
2. Upper-division requirements (74 units)
A minimum grade of "C-" for any upper-division course used to fulfill the requirements for the Chemical Physics option.
- a) CHEM 110A, CHEM 110B, CHEM 111,
CHEM 112A, CHEM 112B, CHEM 112C,
CHEM 113, CHEM 140, CHEM 150A,
CHEM 150B, CHEM 191
- b) Twenty-four (24) units of upper-division course work in Mathematics or Physics (110 or above excluding 190 series)
- c) Nine (9) additional units in physical chemistry

Environmental Chemistry Option

Students must consult with their Chemistry advisor before electing this option.

1. Lower-division requirements (76-78 units)
- a) CHEM 001A, CHEM 001B, CHEM 001C,
CHEM 01LA, CHEM 01LB, CHEM 01LC
(or CHEM 01HA and CHEM 1HLA, CHEM 01HB and CHEM 1HLB, CHEM 01HC and CHEM 1HLC), CHEM 005
- b) MATH 008B or MATH 009A,
MATH 009B, MATH 009C, MATH 010A,
MATH 010B, MATH 046
- c) PHYS 040A, PHYS 040B, PHYS 040C,
PHYS 040D
- d) BIOL 005A, BIOL 05LA, BIOL 005B, BIOL 005C
2. Upper-division requirements (66-67 units)
A minimum grade of "C-" for any upper-division course used to fulfill the requirements for the Environmental Chemistry option.
- a) CHEM 110A, CHEM 110B, CHEM 111,
CHEM 112A, CHEM 112B, CHEM 112C,
CHEM 113, CHEM 125, CHEM 135/
ENSC 135/ENTX 135, CHEM 136/
ENSC 136/ENTX 136/SWSC 136,
CHEM 140, CHEM 150A, CHEM 166,
CHEM 191
- b) One course from ENSC 104/SWSC 104 or
GEO 137
- c) Two additional courses from CHEM 150B,
CHEM 197, CHEM 199, ENSC 100, ENSC 101,
ENSC 102, ENSC 104/SWSC 104,
ENSC 140/SWSC 140, ENSC 142,
ENSC 155, ENSC 163, ENTX 101, GEO 132,
GEO 137, GEO 157 (4 units total from
CHEM 197 and/or CHEM 199)

Undergraduate Research is strongly encouraged for students with the requisite ability. Students wishing to participate in this activity should consult Chemistry faculty, their Chemistry advisor, or check: or.ucr.edu/undergradresearch/

Sample Program

Student programs are planned on an individual basis with their advisors, and there is considerable flexibility in the sequence in which courses required for the major are taken. For example, PHYS 040A, PHYS 040B, PHYS 040C can be started equally well during either the freshman or sophomore year. The sample program is typical for a well-prepared entering freshman who seeks the B.S. degree.

Freshman Year	Fall	Winter	Spring
CHEM 001A, CHEM 001B, CHEM 001C, CHEM 01LA, CHEM 01LB, CHEM 01LC (or CHEM 01HA and CHEM 1HLA, CHEM 01HB and CHEM 1HLB, CHEM 01HC and CHEM 1HLC)	4,1	4,1	4,1
PHYS 040A, PHYS 040B MATH 008B or MATH 009A, MATH 009B, MATH 009C	4	4	4
ENGL 001A, ENGL 001B, ENGL 001C	4	4	4
Elective (optional)	4		
Total Units	17	18	18
Sophomore Year			
CHEM 112A, CHEM 112B, CHEM 112C	4	4	4
PHYS 040C, PHYS 040D MATH 010A, MATH 010B, MATH 046	4	4	4
CHEM 005	5		
Electives			8
Total Units	18	13	16
Junior Year			
CHEM 110A, CHEM 110B, CHEM 113	4	4	4
CHEM 150A, CHEM 150B Biological Science w/Lab, CHEM 125, CHEM 191	4	5	1
Electives	8	4	8
Total Units	16	17	17
Senior Year			
CHEM 111, CHEM 140		4	4
CHEM 166			4
Electives	12	8	4
Total Units	12	12	12

Minor

The minor in Chemistry consists of 28 upper-division units in chemistry.

- Of the specified upper-division units, a minimum of 16 units must be unique to the minor and may not be used to satisfy major requirements.
- At least one of the courses used to satisfy the 28 units must be in CHEM 125, CHEM 111, CHEM 140 or CHEM 166 (courses which include laboratory work).
- No more than 4 units of 190-199 courses may be used in fulfilling the upper-division units for a minor.

All of the upper-division courses in chemistry have a prerequisite of CHEM 001A, CHEM 001B, CHEM 001C, CHEM 01LA, CHEM 01LB, CHEM 01LC, or CHEM 01HA and CHEM 1HLA, CHEM 01HB and CHEM 1HLB, CHEM 01HC and CHEM 1HLC and most have CHEM 005 as a prerequisite.

Students with a minor in Chemistry should consult with their Chemistry advisor to construct a specific program consistent with their career goals.

See Minors under the College of Natural and Agricultural Sciences in the Colleges and Programs section of this catalog for additional information on minors.

Graduate Program

The Chemistry Department offers the M.S. and Ph.D. degrees in Chemistry.

Fields of specialization (subdisciplines) are analytical chemistry, inorganic chemistry, organic chemistry, and physical chemistry. Research is also carried out in bioanalytical, bioinorganic, bioorganic, and biophysical chemistry and in chemical physics, environmental/atmospheric, organometallic chemistry, and neuroscience. For additional information on the latter, please see Neuroscience Graduate Program in the Programs and Courses section of this catalog.

Admission All applicants must submit scores from the GRE General Test. A score from the Advanced Chemistry GRE is not required for admission. It is strongly recommended, however, that applicants submit this score in order to receive maximum consideration for fellowships. The department normally considers applications for teaching and research assistantships at the same time as fellowships; therefore, students are strongly encouraged to complete their applications for admission and support as early as possible. Normally applications for fellowships are awarded by February for students entering in the following fall quarter. Although most students begin in the fall quarter, students may begin their studies in the winter or spring quarter.

Orientation Examinations Admitted students must, at the beginning of their first quarter in residence, take orientation examinations. The examinations are normally given during two consecutive days starting up to one week prior to the first day of instruction. Although a notice of the times and places of these examinations is sent to each student admitted to regular graduate status in chemistry, it is the student's responsibility to be on the campus early enough to check the bulletin boards in Chemical Sciences for this information. Students take these examinations in the four subdisciplines: analytical, inorganic, organic, and physical chemistry. The purpose of these examinations is to assess the student's undergraduate preparation. The results permit the faculty to determine the course program that will most effectively aid the students' development in their chosen subdisciplines.

Master's Degree

The Department of Chemistry offers the M.S. degree in Chemistry.

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Requirements are:

1. Satisfactory performance in orientation examinations in analytical, inorganic, organic, and physical chemistry
2. General university requirements; and departmental requirements for either Plan I or Plan II.

Plan I (Thesis) Students must take at least 36 units of approved courses and graduate research of which five regular lecture courses in the CHEM 200-249 series (CHEM 110A or CHEM 110B, CHEM 113, CHEM 125, and CHEM 150A or CHEM 150B may apply under certain circumstances). A maximum of 12 units of seminar courses (CHEM 250-259) and a maximum of 12 units of graduate research; (but not those numbered CHEM 260-289) may apply towards the 36 units. Students must complete a thesis, and a final oral examination on the thesis may be required.

Plan II (Comprehensive Examination) Students must complete at least 36 units of approved courses of which at least 18 must be in regular lecture courses numbered CHEM 200-249 (CHEM 110A or CHEM 110B, CHEM 113, CHEM 125, and CHEM 150A or CHEM 150B may apply under certain circumstances) and up to 12 units of graduate seminar courses numbered CHEM 250-259. Those numbered CHEM 260-289 are specifically excluded.

Doctoral Degree

The Department of Chemistry offers the Ph.D. degree in Chemistry.

The requirements are orientation examinations in analytical, inorganic, organic, and physical chemistry; general university requirements; and departmental requirements.

Program of Study The departmental committee on graduate study determines a program of study on the basis of the students' performance on the orientation examinations and a consideration of their subdisciplines. For students with a normal B.S. level preparation, the typical course pattern for each subdiscipline is as follows:

1. Analytical (a minimum of three courses selected from CHEM 221A, CHEM 221B, CHEM 221C, CHEM 221D, CHEM 221E plus two other courses)
2. Inorganic (CHEM 231A, CHEM 231B, CHEM 231C plus two other courses)
3. Organic (CHEM 211A, CHEM 211B, CHEM 211C plus two other courses)
4. Physical (a minimum of three courses selected from CHEM 201A, CHEM 201B, CHEM 201C, CHEM 201D, CHEM 201E plus two other courses)

Second Year Research Evaluation Students seeking advancement to candidacy for the Ph.D. degree must undergo a Second-Year Research Evaluation (SYRE). The SYRE must take place by the end of the student's fourth academic quarter of residency and is administered by a four-member committee of the Chemistry faculty, one of whom is the student's dissertation advisor. The

Chair of the SYRE Committee will be someone other than the dissertation advisor. Typically, these same four faculty members would also serve on the oral qualifying examination committee, with the Chair of the SYRE Committee continuing on as Chair of the oral qualifying examination committee.

The SYRE consists of both a written and oral component and the student is assessed on both components. The written SYRE document should provide an introduction to the dissertation research, an outline of the goals and objectives, a description of the progress to date, and a delineation of the path forward. The SYRE document is limited to five single-spaced pages (12-point type), excluding references. The oral component of the SYRE will be a presentation of the written document. After presentation of the SYRE document, the student will be queried by committee to assess the student's general knowledge of the material. A student will receive a single grade of Pass, Qualified Pass, or Fail. A Pass signifies that the student has made satisfactory progress in research and is on track to pass the oral qualifying examination. A Qualified Pass signifies that a student's progress in research is reasonable, but that improvement is needed, and should be demonstrated at the time of the oral qualifying examination. A Fail signifies that a student has to date, not made satisfactory progress in research. A student who fails the SYRE would not be required to undergo a second evaluation; however, such students would be placed on notice that they are not on track to pass the oral qualifying examination unless major steps are taken to correct serious deficiencies in research performance.

Foreign Language Requirement A reading knowledge of German, French, or Russian is recommended but not required.

Oral Qualifying Examination This examination consists in part of defending an original proposition and is designed to test the extent of the candidates' development and their breadth of knowledge in chemistry and related fields.

Teaching Requirement Normally requires three quarters of service as a teaching assistant, or equivalent.

Normative Time to Degree 15 quarters

Lower-Division Courses

CHEM 001A. General Chemistry (4) F, W, Summer Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): a score of 3, 4, or 5 on the College Board Advanced Placement Chemistry Examination or a passing score on the California Chemistry Diagnostic Test or a grade of "C-" or better in MATH 005 or concurrent enrollment in MATH 008B or a grade of "C-" or better in MATH 008B or a grade of "C-" or better in an equivalent college-level mathematics or chemistry course; concurrent enrollment in CHEM 01LA or a grade of "C-" or better in CHEM 01LA. An introduction to the basic principles of chemistry. Credit is awarded for only one of CHEM 001A or CHEM 01HA.

CHEM 001B. General Chemistry (4) W, S, Summer Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): grades of "C-" or better in CHEM 001A and CHEM 01LA or grades of "C-" or better in CHEM 01HA and CHEM 1HLA; concurrent enrollment in CHEM 01LB

or a grade of "C-" or better in CHEM 01LB. An introduction to the basic principles of chemistry. Credit is awarded for only one of CHEM 001B or CHEM 01HB.

CHEM 001C. General Chemistry (4) F, S, Summer Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): grades of "C-" or better in CHEM 001B and CHEM 01LB or grades of "C-" or better in CHEM 01HB and CHEM 1HLB; concurrent enrollment in CHEM 01LC or a grade of "C-" or better in CHEM 01LC. An introduction to the basic principles of chemistry. Credit is awarded for only one of CHEM 001C or CHEM 01HC.

CHEM 001W. Preparation for General Chemistry (3) F Lecture, 2 hours; workshop, 3 hours. Prerequisite(s): completion of or concurrent enrollment in MATH 005 or MATH 008A. For students who are not prepared or qualified for admission to CHEM 001A. Instruction and practice in concept manipulation and problem solving to prepare students to master material in CHEM 001A. Concurrent enrollment in CHEM 001A is not allowed. Not open to students who have completed CHEM 001A with a grade of "C-" or better. Counts toward the 180-unit graduation requirement for the baccalaureate degree but does not satisfy any major or college breadth requirements. Graded Satisfactory (S) or No Credit (NC).

CHEM 003. Concepts of Chemistry (4) S Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): none. A survey of basic concepts of Chemistry. Designed for non-science majors and not as preparation for CHEM 001A or CHEM 01HA. Not open to students with credit for CHEM 001A or CHEM 01HA, but students who have completed CHEM 003 may take CHEM 001A or CHEM 01HA for full credit.

CHEM 005. Quantitative Analysis (5) F Lecture, 3 hours; laboratory, 8 hours. Prerequisite(s): CHEM 001C and CHEM 01LC with grades of "C-" or better or CHEM 01HC and CHEM 1HLC with grades of "C-" or better. Stoichiometric calculations and applications of principles of chemical equilibrium to analytical problems. Includes titrimetric and gravimetric laboratory procedures.

CHEM 01HA. Honors General Chemistry (4) F Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): completion of or concurrent enrollment in MATH 009A or MATH 09HA or equivalent or Advanced Placement (AP) chemistry credit or AP calculus credit or AP physics credit; a score of 640 or higher on the mathematics portion of the SAT Reasoning Test or a score of 28 or higher on the ACT Mathematics Test; high school chemistry; or consent of instructor; concurrent enrollment in CHEM 1HLA or a grade of "B" or better in CHEM 1HLA. Honors course corresponding to CHEM 001A. A limited enrollment course in which the principles of chemistry are covered in more depth than in CHEM 001A. Credit is awarded for only one of CHEM 001A or CHEM 01HA.

CHEM 01HB. Honors General Chemistry (4) W Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): grades of "B" or better in CHEM 001A and CHEM 01LA or grades of "B" or better in CHEM 01HA and CHEM 1HLA or consent of instructor; concurrent enrollment in CHEM 1HLB or a grade of "B" or better in CHEM 1HLB. Honors course corresponding to CHEM 001B. A limited enrollment course in which the principles of chemistry are covered in more depth than in CHEM 001B. Credit is awarded for only one of CHEM 001B or CHEM 01HB.

CHEM 01HC. Honors General Chemistry (4) S Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): grades of "B" or better in CHEM 001B and CHEM 01LB or grades of "B" or better in CHEM 01HB and CHEM 1HLB or consent of instructor; concurrent enrollment in CHEM 1HLC or a grade of "B" or better in CHEM 1HLC. Honors course corresponding to CHEM 001C.

A limited enrollment course in which the principles of chemistry are covered in more depth than in CHEM 001C. Credit is awarded for only one of CHEM 001C or CHEM 01HC.

CHEM 1HLA. Honors General Chemistry Laboratory (1) F, W, Summer Laboratory, 3 hours. Prerequisite(s): concurrent enrollment in CHEM 01HA or a grade of "B" or better in CHEM 01HA. Honors course corresponding to CHEM 01LA. An introduction to laboratory principles and techniques related to lecture topics in CHEM 01HA. Credit is awarded for only one of CHEM 01LA or CHEM 1HLA.

CHEM 1HLB. Honors General Chemistry Laboratory (1) W, S, Summer Laboratory, 3 hours. Prerequisite(s): grades of "B" or better in CHEM 001A and CHEM 01LA or grades of "B" or better in CHEM 01HA and CHEM 1HLA; concurrent enrollment in CHEM 01HB or a grade of "B" or better in CHEM 01HB. Honors course corresponding to CHEM 01LB. An introduction to laboratory principles and techniques related to lecture topics in CHEM 01HB. Credit is awarded for only one of CHEM 01LB or CHEM 1HLB.

CHEM 1HLC. Honors General Chemistry Laboratory (1) F, S, Summer Laboratory, 3 hours. Prerequisite(s): grades of "B" or better in CHEM 001B and CHEM 01LB or grades of "B" or better in CHEM 01HB and CHEM 1HLB; concurrent enrollment in CHEM 01HC or a grade of "B" or better in CHEM 01HC. Honors course corresponding to CHEM 01LC. An introduction to laboratory principles and techniques related to lecture topics in CHEM 01HC. Credit is awarded for only one of CHEM 01LC or CHEM 1HLC.

CHEM 01LA. General Chemistry Laboratory (1) F, W, Summer Laboratory, 3 hours. Prerequisite(s): concurrent enrollment in CHEM 001A or a grade of "C-" or better in CHEM 001A. An introduction to laboratory principles and techniques related to lecture topics in CHEM 001A. Credit is awarded for only one of CHEM 01LA or CHEM 1HLA.

CHEM 01LB. General Chemistry Laboratory (1) W, S, Summer Laboratory, 3 hours. Prerequisite(s): grades of "C-" or better in CHEM 001A and CHEM 01LA or grades of "C-" or better in CHEM 01HA and CHEM 1HLA; concurrent enrollment in CHEM 001B or a grade of "C-" or better in CHEM 001B. An introduction to laboratory principles and techniques related to lecture topics in CHEM 001B. Credit is awarded for only one of CHEM 01LB or CHEM 1HLB.

CHEM 01LC. General Chemistry Laboratory (1) F, S, Summer Laboratory, 3 hours. Prerequisite(s): grades of "C-" or better in CHEM 001B and CHEM 01LB or grades of "C-" or better in CHEM 01HB and CHEM 1HLB; concurrent enrollment in CHEM 001C or a grade of "C-" or better in CHEM 001C. An introduction to laboratory principles and techniques related to lecture topics in CHEM 001C. Credit is awarded for only one of CHEM 01LC or CHEM 1HLC.

CHEM 091. Freshman Seminar: What Chemists Do (1) Seminar, 1 hour. Explores the frontiers of chemistry (analytical, inorganic, organic, and physical) as well as the role of chemistry in allied areas such as agriculture, biology, environmental science, forensics, materials, medicine, and neuroscience. Graded Satisfactory (S) or No Credit (NC).

CHEM 097H. Freshman Honors Project: Introduction to Research (1-4) Outside research, 3-12 hours. Prerequisite(s): admission to the University Honors Program. Prior arrangement with a chemistry faculty member is required. An introduction to the methods of research in chemical sciences. The student conducts an investigation under the supervision of a faculty member. A written report is required at the end of the quarter. To satisfy the requirement for the

University Honors Program Freshman Project, the student must earn a minimum of 4 units during the first year. Satisfactory (S) or No Credit (NC) grading is not available. Course is repeatable.

Upper-Division Courses

CHEM 109. Survey of Physical Chemistry (4) F Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHEM 001C and CHEM 01LC with grades of "C-" or better or CHEM 01HC and CHEM 1HLC with grades of "C-" or better; MATH 009B with a grade of "C-" or better or MATH 09HB with a grade of "C-" or better. Introduces thermodynamics, chemical equilibrium, kinetics, quantum chemistry, atomic and molecular structure, and spectroscopy. Primarily for students with major interests in life and agricultural sciences; not recommended for Chemistry majors. Credit is not awarded for CHEM 109 if it has already been awarded for CHEM 110A or CHEM 110B.

CHEM 110A. Physical Chemistry: Chemical Thermodynamics (4) F Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHEM 001C and CHEM 01LC with grades of "C-" or better or CHEM 01HC and CHEM 1HLC with grades of "C-" or better; MATH 010A with a grade of "C-" or better (or if MATH 010A is taken concurrently, MATH 009C with a grade of "C-" or better or MATH 09HC with a grade of "C-" or better); PHYS 002C with a grade of "C-" or better or PHYS 040C with a grade of "C-" or better (PHYS 040C may be taken concurrently); or consent of instructor. An introduction to thermodynamics, with applications to chemical systems.

CHEM 110B. Physical Chemistry: Introduction to Statistical Mechanics and Kinetics (4) W Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHEM 110A with a grade of "C-" or better or consent of instructor; prior or concurrent enrollment in MATH 010B is recommended. Statistical mechanics, kinetic molecular theory, and chemical kinetics with applications to chemical systems.

CHEM 111. Physical Chemistry Laboratory (4) W Lecture, 2 hours; laboratory, 8 hours. Prerequisite(s): CHEM 110A and CHEM 110B with grades of "C-" or better (CHEM 110B may be taken concurrently), or consent of instructor. CHEM 113 recommended. Physical chemical measurements and laboratory experiments illustrating fundamental principles of physical chemistry. Modern electronic and optical measurement techniques.

CHEM 112A. Organic Chemistry (4) F, W, Summer Lecture, 3 hours; laboratory, 4 hours. Prerequisite(s): CHEM 001C and CHEM 01LC with grades of "C-" or better or CHEM 01HC and CHEM 1HLC with grades of "C-" or better. Covers modern organic chemistry including structure, nomenclature, reactivity, synthesis, and reaction mechanisms and the chemistry of carbohydrates, lipids, nucleic acids, amino acids, and proteins. Also includes laboratory techniques of purification, isolation, synthesis, reactions, and spectroscopic analysis.

CHEM 112B. Organic Chemistry (4) W, S, Summer Lecture, 3 hours; laboratory, 4 hours. Prerequisite(s): CHEM 112A with a grade of "C-" or better. Covers modern organic chemistry including structure, nomenclature, reactivity, synthesis, and reaction mechanisms and the chemistry of carbohydrates, lipids, nucleic acids, amino acids, and proteins. Also includes laboratory techniques of purification, isolation, synthesis, reactions, and spectroscopic analysis.

CHEM 112C. Organic Chemistry (4) F, S, Summer Lecture, 3 hours; laboratory, 4 hours. Prerequisite(s): CHEM 112B with a grade of "C-" or better. Covers

modern organic chemistry including structure, nomenclature, reactivity, synthesis, and reaction mechanisms and the chemistry of carbohydrates, lipids, nucleic acids, amino acids, and proteins. Also includes laboratory techniques of purification, isolation, synthesis, reactions, and spectroscopic analysis.

CHEM 113. Physical Chemistry: Introduction to Quantum Chemistry (4) S Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHEM 001C and CHEM 01LC with grades of "C-" or better or CHEM 01HC and CHEM 1HLC with grades of "C-" or better; MATH 009C with a grade of "C-" or better or MATH 09HC with a grade of "C-" or better. MATH 046 is recommended. Introduction to quantum mechanics with application to atomic and molecular structure and spectra.

CHEM 114. Advanced Physical Chemistry Laboratory (4) Lecture, 2 hours; laboratory, 8 hours. Prerequisite(s): CHEM 111 with a grade of "C-" or better or consent of instructor; completion of or concurrent enrollment in CHEM 113. Involves measurements and laboratory experiments illustrating applications of physical chemistry methods to problems in environmental, materials, and biological chemistry. Covers modern data acquisition, analysis, and computational techniques.

CHEM 122H. Honors Discussion for Organic Chemistry (1) F Discussion, 1 hour. Prerequisite(s): concurrent enrollment in CHEM 112A; admission to the University Honors Program or consent of instructor. Involves advanced, in-depth discussions of current literature relevant to the content of CHEM 112A. Students work in small teams to solve advanced problem sets. Satisfactory (S) or No Credit (NC) grading is not available.

CHEM 123H. Honors Discussion for Organic Chemistry (1) W Discussion, 1 hour. Prerequisite(s): concurrent enrollment in CHEM 112B; admission to the University Honors Program or consent of instructor. Involves advanced, in-depth discussions of current literature relevant to the content of CHEM 112B. Students work in small teams to solve advanced problem sets. Satisfactory (S) or No Credit (NC) grading is not available.

CHEM 124. Discussion for Organic Chemistry (1) S Discussion, 1 hour. Prerequisite(s): concurrent enrollment in CHEM 112C. Involves in-depth discussions of problems relevant to the content of CHEM 112C. Graded Satisfactory (S) or No Credit (NC). Credit is awarded for only one of CHEM 124 or CHEM 124H.

CHEM 124H. Honors Discussion for Organic Chemistry (1) S Discussion, 1 hour. Prerequisite(s): concurrent enrollment in CHEM 112C; admission to the University Honors Program or consent of instructor. Honors course corresponding to CHEM 124. Involves advanced, in-depth discussions of current literature relevant to the content of CHEM 112C. Students work in small teams to solve advanced problem sets. Satisfactory (S) or No Credit (NC) grading is not available. Credit is awarded for only one of CHEM 124 or CHEM 124H.

CHEM 125. Instrumental Methods (3 or 5) W Lecture, 3 hours; laboratory, 8 hours. Prerequisite(s): CHEM 005 with a grade of "C-" or better; PHYS 002C or PHYS 040C (PHYS 002C or PHYS 040C may be taken concurrently); or equivalents; or consent of instructor. Presents chromatographic separations, electrochemistry, and principles of spectroscopic techniques as an introduction to instrumental methods and their use in chemistry. Graduate students may register for either lecture only (3 units) or for lecture and laboratory (5 units).

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CHEM 135. Chemistry of the Clean and Polluted

Atmosphere (4) W Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHEM 112A, CHEM 112B, or consent of instructor; ENSC 102 recommended. Structure of the troposphere and stratosphere; formation of atmospheric ozone; tropospheric NO_x chemistry; methane oxidation cycle; phase distributions of chemicals; wet and dry deposition; chemistry of volatile organic compounds; formation of photochemical air pollution; modeling of air pollution and control strategies; stratospheric ozone depletion and global warming. Cross-listed with ENSC 135 and ENTX 135.

CHEM 136. Chemistry of Natural Waters (4) S Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHEM 005 with a grade of "C-" or better or ENSC 104 /SWSC 104 with a grade of "C-" or better or consent of instructor. Introduction to processes controlling the chemical composition of natural waters. Topics include chemical equilibria, acid-base and coordination chemistry, oxidation-reduction reactions, precipitation-dissolution, air-water exchange, and use of equilibrium and kinetic models for describing marine nutrient, trace metal, and sediment chemistry. Cross-listed with ENSC 136, ENTX 136, and SWSC 136.

CHEM 140. Environmental Chemistry Laboratory (4) S Lecture, 2 hours; laboratory, 8 hours. Prerequisite(s): CHEM 125 with a grade of "C-" or better, CHEM 110A (or CHEM 109) with a grade of "C-" or better; or consent of instructor. Theory and application of chemical techniques for the analysis of environmentally relevant chemical processes. Discusses gas phase, condensed phase, surface, and particulate chemistry. Topics include "acid rain," photochemical smog, ozone depletion, and chemical analysis monitoring.

CHEM 150A. Inorganic Chemistry (4) W Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHEM 112A, CHEM 112B, CHEM 112C all with grades of "C-" or better; CHEM 110A (or CHEM 109) with a grade of "C-" or better. A systematic introduction to the synthesis, reactions, structure, and bonding of important classes of inorganic compounds. Emphasis on non-transition metal chemistry.

CHEM 150B. Inorganic Chemistry (4) S Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHEM 150A with a grade of "C-" or better. A systematic introduction to synthesis, reactions, structure, and bonding of important classes of inorganic compounds. Emphasis on transition metal chemistry.

CHEM 166. Advanced Structural and Synthetic Methods (2 or 4) S Lecture, 2 hours; laboratory, 8 hours. Prerequisite(s): CHEM 005 with a grade of "C-" or better or BCH 102 with a grade of "C-" or better; CHEM 112C with a grade of "C-" or better; consent of instructor is required for students enrolling only in the lecture (2 units); CHEM 125 and CHEM 150A are recommended. Enrollment priority is given to students with a grade of "B-" or better in CHEM 112C. Covers methods for the characterization of organic and inorganic compounds and advanced methods of synthesis of organic and inorganic compounds such as vacuum, inert atmosphere, high-pressure, and photochemical techniques. Involves hands-on use of spectroscopic (nuclear magnetic resonance and optical spectroscopy and mass spectrometry) and computer-based methods for structural characterization. Non-Chemistry majors and graduate students may enroll for the lecture (2 units) or for the lecture and laboratory (4 units).

CHEM 190. Special Studies (1-5) To be taken with the consent of the chair of the department as a means of meeting special curricular problems.

CHEM 191. Seminar in Chemistry Careers (1) S

Seminar, 1 hour. Prerequisite(s): upper-division standing. Oral reports and discussions by students, faculty, and visiting speakers. Required of chemistry majors; normally taken in the spring of the junior year. Graded Satisfactory (S) or No Credit (NC).

CHEM 197. Research for Undergraduates (1-4) Outside research, 3-12 hours. Prerequisite(s): sophomore or junior standing; consent of instructor. An introduction to the methods of research in chemistry. Includes a research project completed under the supervision of a Chemistry faculty member. Students who submit a written research report receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable to a maximum of 6 units.

CHEM 198-I. Individual Internship (1-12) Internship, 2-24 hours; term paper or preparation for presentation, 1-12 hours. Prerequisite(s): upper-division standing in chemistry; consent of instructor. Industrial work experience coordinated and supervised by a chemistry faculty member and an off-campus sponsor. Requires a term paper or presentation. Course is repeatable to a maximum of 12 units.

CHEM 199. Senior Research (1-4) Outside research, 3-12 hours. Prerequisite(s): senior standing; consent of instructor. Research project completed under the supervision of a Chemistry faculty member. Students who submit a written research report receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Total credit for CHEM 199 and/or CHEM 199H may not exceed 9 units.

CHEM 199H. Senior Honors Research (1-5) Outside research, 3-15 hours. Prerequisite(s): senior standing; consent of instructor; a minimum GPA of 3.00 in chemistry courses and in all university course work. Research in chemistry conducted under the supervision of a Chemistry faculty member. Students who submit a written research report receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Total credit for CHEM 199 and/or CHEM 199H may not exceed 9 units.

Graduate Courses

CHEM 201A. Advanced Physical Chemistry: Quantum Mechanics (3) Lecture, 3 hours. Prerequisite(s): CHEM 113 with a grade of "C" or better. Covers concepts in quantum mechanics including wavepackets, uncertainty, single particles in multiple dimensions, and approximate methods for solving the Schroedinger equation.

CHEM 201B. Advanced Physical Chemistry: Quantum Mechanics and Spectroscopy (3) Lecture, 3 hours. Prerequisite(s): CHEM 113 with a grade of "C" or better. Covers concepts in quantum mechanics with particular applications to spectroscopy.

CHEM 201C. Advanced Physical Chemistry: Elementary Statistical Mechanics (3) Lecture, 3 hours. Prerequisite(s): CHEM 110A and CHEM 110B with grades of "C" or better. Covers concepts in elementary statistical mechanics including ensembles, interpretations of thermodynamic functions, and quantum statistics.

CHEM 201D. Advanced Physical Chemistry: Thermodynamics (3) Lecture, 3 hours. Prerequisite(s): CHEM 110A and CHEM 110B with grades of "C" or better. Covers concepts in thermodynamics including fundamental equations, potentials, Maxwell relations, and stability criteria.

CHEM 201E. Advanced Physical Chemistry: Kinetics (3) Lecture, 3 hours. Prerequisite(s): CHEM 110A and CHEM 110B with grades of "C" or better. Covers concepts in kinetics including reaction mechanisms and the molecular interpretation of reaction dynamics.

CHEM 202. Advanced Instrument Design (2) Lecture, 1 hour; laboratory, 3 hours. Prerequisite(s): graduate standing in Chemistry or consent of instructor; consent of instructor of CHEM 202 or both concurrent enrollment in and consent of instructor of CHEM 297 or both concurrent enrollment in and consent of instructor of CHEM 299. Focuses on the technical aspects of design and manufacture of instrumentation for physical chemistry and related fields. Introduces design and simulation software and provides hands-on experience in the realization of advanced instrumentation development projects. Students who complete a project and take the final examination receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade.

CHEM 203. Nanoscience and Nanotechnology (3) Lecture, 3 hours. Prerequisite(s): graduate standing in Chemistry, Physics, Engineering, or a related subject or consent of instructor. Gives a condensed, interdisciplinary overview of selected fields of nanoscience and emerging nanotechnological applications. Special focus is on applications relevant for the campus research community that are not based on electronic applications of silicon.

CHEM 206A. Introduction to Computational Quantum Chemistry (3) Lecture, 3 hours. Prerequisite(s): CHEM 113 or equivalent, graduate standing; or consent of instructor. Introduces computational techniques in quantum chemistry. Includes Hartree-Fock theory, Density Functional Theory, and electron correlation methods. Emphasizes practical applications in a research setting.

CHEM 206B. Modeling Chemical and Biochemical Molecules (3) Lecture, 3 hours. Prerequisite(s): graduate standing in Chemistry or a related field or consent of instructor. Introduces students to the principles, concepts, and techniques for modeling chemical and biological systems. Covers the various methods and techniques for molecular simulations, energy calculations, obtaining initial data, accessing data reliably, visualization and analysis of molecules, and screening and designing chemicals for proteins.

CHEM 207. Chemical Group Theory (3) Lecture, 3 hours. Prerequisite(s): consent of instructor. The principles of group theory and molecular symmetry. Applications in several areas of chemistry.

CHEM 208. Interdisciplinary Overview of Current Issues in Semiconductor Processing (3) Lecture, 3 hours. Prerequisite(s): graduate standing in Chemistry, Physics, Engineering, or a related subject or consent of instructor. An interdisciplinary overview of present-day semiconductor processing. Introduces topics such as properties of semiconductors, cleanroom environment, epitaxy, ion implantation, etching, lithography, device architecture, testing, and fault detection. May offer field trips. Cross-listed with PHYS 202.

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CHEM 209 (E-Z). Advanced Topics in Physical Chemistry (2-3) Lecture, 2 hours (2 units) or 3 hours (3 units). Prerequisite(s): consent of instructor. Additional prerequisites are required for some segments of this course; see department. Selected advanced topics from modern physical chemistry.

CHEM 210. Advanced Organic Reactions (3) Lecture, 3 hours. Prerequisite(s): CHEM 112C. Covers modern organic reactions and reagents and their mechanistic pathways, with emphasis on recent developments.

CHEM 211A. Advanced Organic Chemistry (3) Lecture, 3 hours. Prerequisite(s): CHEM 112C, CHEM 113. Covers structure and bonding in organic compounds, with emphasis on more advanced aspects of the field.

CHEM 211B. Advanced Organic Chemistry (3) Lecture, 3 hours. Prerequisite(s): CHEM 112C, CHEM 113. Covers the kinetics and mechanism of organic reactions, with emphasis on more advanced aspects of the field.

CHEM 211C. Advanced Organic Chemistry (3) Lecture, 3 hours. Prerequisite(s): CHEM 112C, CHEM 113. Covers synthetic organic chemistry, with emphasis on more advanced aspects of the field.

CHEM 215A. Organic Synthesis (3) Lecture, 3 hours. Prerequisite(s): CHEM 211A, CHEM 211B, CHEM 211C. An advanced treatment of synthetic organic chemistry. CHEM 215A is not a prerequisite to CHEM 215B.

CHEM 215B. Organic Synthesis (3) Lecture, 3 hours. Prerequisite(s): CHEM 211A, CHEM 211B, CHEM 211C. An advanced treatment of synthetic organic chemistry. CHEM 215A is not a prerequisite to CHEM 215B.

CHEM 216A. Physical Organic Chemistry (3) Lecture, 3 hours. Prerequisite(s): CHEM 211A, CHEM 211B, CHEM 211C. An advanced treatment of physical organic chemistry.

CHEM 216B. Physical Organic Chemistry (3) Lecture, 3 hours. Prerequisite(s): CHEM 211A, CHEM 211B, CHEM 211C. An advanced treatment of physical organic chemistry.

CHEM 217. Polymers: Synthesis and Characterization (3) Lecture, 3 hours; extra reading, 3 hours. Prerequisite(s): graduate standing in Biochemistry and Molecular Biology, Biology, Chemical and Environmental Engineering, Chemistry, Electrical Engineering, Mechanical Engineering, or Physics or consent of instructor. Introduces fundamentals of polymer synthesis, types of polymers, stereo architectures, and applications. Explores modern methods of synthesis, emphasizing catalytic methods. Describes industrial synthetic methods.

Examines polymer physics and characterization, emphasizing physical methods.

CHEM 221A. Advanced Analytical Chemistry: Separation Science (3) Lecture, 3 hours. Prerequisite(s): CHEM 125. Provides an overview of modern analytical separations including theory, instrumentation, and applications.

CHEM 221B. Advanced Analytical Chemistry: Optical Spectroscopy (3) Lecture, 3 hours. Prerequisite(s): CHEM 125. Provides an overview of modern analytical optical spectroscopic techniques including theory, instrumentation, and applications.

CHEM 221C. Advanced Analytical Chemistry: Electrochemistry (3) Lecture, 3 hours. Prerequisite(s): CHEM 125. Provides an overview of modern electrochemistry including basic theory, applications, and instrumentation of potentiometry and amperometry.

CHEM 221D. Advanced Analytical Chemistry: Mass Spectroscopy (3) Lecture, 3 hours. Prerequisite(s): CHEM 125. Provides an overview of modern mass spectroscopy including basic theory, instrumentation, and applications. Focus is on biological applications.

CHEM 221E. Advanced Analytical Chemistry: Introduction to Bioanalytical Chemistry (3) Lecture, 3 hours. Prerequisite(s): CHEM 125. Covers important aspects of modern chemical measurements, with particular emphasis on bioanalysis. Discusses analytical challenges associated with drug discovery and development, including analysis of combinatorial libraries,

high-throughput screening, metabonomics, genomics, and proteomics, as well as new developments in analytical methods and instrumentation.

CHEM 223. Nature of the Chemical Bond (3) Lecture, 3 hours. Prerequisite(s): graduate standing in Chemistry or a related field or consent of instructor. Explores all aspects of chemical bonding including molecular orbital theory, valence bond theory, and noncovalent bonding, with coverage of key concepts from all subdivisions of chemistry.

CHEM 229 (E-Z). Advanced Topics in Analytical Chemistry (2-3) lecture, 2 hours (2 units) or 3 hours (3 units). Prerequisite(s): consent of instructor. Selected advanced topics from modern analytical chemistry. The contents of these courses will vary. Course may be repeated with different topic (and different letter).

CHEM 231A. Structure and Bonding in Inorganic Chemistry (3) Lecture, 3 hours. Prerequisite(s): CHEM 150A, CHEM 150B. Covers advanced synthesis, structure, and bonding in inorganic, coordination, and organometallic chemistry.

CHEM 231B. Reactivity and Mechanism in Inorganic and Organometallic Chemistry (3) Lecture, 3 hours. Prerequisite(s): CHEM 231A. Covers advanced synthesis, reactivity, and mechanism in inorganic, coordination, and organometallic chemistry.

CHEM 231C. Solid State and Materials in Inorganic Chemistry (3) Lecture, 3 hours. Prerequisite(s): CHEM 231A. Covers the advanced synthesis, structure, bonding, and properties of inorganic materials.

CHEM 239 (E-Z). Advanced Topics in Inorganic Chemistry (2-3) lecture, 2 hours (2 units) or 3 hours (3 units). Prerequisite(s): graduate standing. Prerequisites are required for some segments of this course; see department. Covers selected advanced topics in modern inorganic chemistry. The contents of the segments vary.

CHEM 241. Bioorganic Chemistry (3) Lecture, 3 hours. Prerequisite(s): BCH 100 or BCH 110A; BCH 184 or CHEM 110B; CHEM 112A, CHEM 112B, CHEM 112C; graduate standing or consent of instructor. Biochemical reactions discussed from a chemical standpoint, including reactions associated with bioenergetics, biosynthesis, and enzyme catalysis. Emphasis on reaction mechanisms. Cross-listed with BCH 241.

CHEM 242. Combinatorial Chemistry and Chemical Genomics (3) Lecture, 3 hours. Prerequisite(s): BIOL 102, CHEM 112C, or equivalents; a passing grade on the Chemistry Department organic orientation examination. Explores topics in chemical genomics. Part I of the course involves combinatorial principles, library methods, solid-phase and split-pool synthesis, deconvolution, library design and informatics, and parallel synthesis. Part II involves screening and selection systems, forward and reverse chemical genetic approaches, phenocopies and epistasis, preparation and use of molecular arrays, and target identification. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

CHEM 244. Airborne Toxic Chemicals (3) Lecture, 3 hours. Prerequisite(s): CHEM 109 or CHEM 110A; and CHEM 110B, CHEM 135/ENSC 135/ENTX 135; or consent of instructor. Atmospheric chemistry of airborne chemicals. Intermedia partitioning. Structure of the atmosphere. Gas-particle distributions of chemicals, and wet and dry deposition of gases and particles. Atmospheric reactions of organic compounds, with emphasis on toxics. Theoretical and experimental methods for determination of atmospheric lifetimes and products of chemicals. Cross-listed with ENTX 244.

CHEM 245. Chemistry and Physics of Aerosols (3) Lecture, 3 hours. Prerequisite(s): CHEM 109, CHEM 110B; or consent of instructor. Fundamentals of chemical and physical processes controlling behavior and properties of airborne particles. Topics include particle mechanics; electrical, optical, and thermodynamic properties; nucleation; surface and aqueous-phase chemistry; gas particle partitioning; sampling; size and chemical analysis; atmospheric aerosols; and environmental effects. Cross-listed with ENTX 245 and SWSC 245.

CHEM 246. Fate and Transport of Chemicals in the Environment (4) Lecture, 4 hours. Prerequisite(s): CHEM 109 or CHEM 110B; CHEM 112A, CHEM 112B, CHEM 112C; or consent of instructor. Covers the identification of toxicants and their sources in the environment; equilibrium partitioning of chemicals in the environment (between air, water, soil, sediment, and biota) using physico-chemical properties; and the transport and chemical transformations of chemical compounds in air, water, and soil media. Includes case studies of fate and transport of selected toxic chemicals. Cross-listed with ENSC 200 and ENTX 200.

CHEM 250. Graduate Seminar in Chemistry (1) Seminar, 1.5 hours. Prerequisite(s): graduate standing. Oral reports by graduate students, faculty, and visiting scholars on current research topics in chemistry. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

CHEM 251. Graduate Seminar in Analytical Chemistry (2) Seminar, 2 hours. Prerequisite(s): graduate student status. Oral reports and discussion by students, faculty, and visiting scholars on current research topics in analytical chemistry. The course is offered each quarter. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

CHEM 252. Graduate Seminar in Inorganic Chemistry (2) Seminar, 2 hours. Prerequisite(s): graduate student status. Oral reports and discussion by students, faculty, and visiting scholars on current research topics in inorganic chemistry. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

CHEM 253. Graduate Seminar in Organic Chemistry (2) Seminar, 2 hours. Prerequisite(s): graduate student status. Oral reports and discussion by students, faculty, and visiting scholars on current research topics in organic chemistry. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

CHEM 254. Graduate Seminar in Physical Chemistry (2) Seminar, 2 hours. Prerequisite(s): graduate student status. Oral reports and discussion by students, faculty, and visiting scholars on current research topics in physical chemistry. The course is offered each quarter. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

CHEM 256. Chemistry of Nanostructured Materials (2) Seminar, 2 hours. Prerequisite(s): graduate standing in Chemistry or consent of instructor. Explores the chemistry of nanostructured materials. Introduces nanotechnology, solid state chemistry and physics of nanomaterials, nanoscale characterization tools, lithography, micro- and nanofabrication, physical and chemical methods to nanomaterials, surface modification, sol-gel chemistry, self assembly at various length scales, and bio-inspired materials. Emphasis is on development of novel functional nanostructured

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materials through chemical synthesis, surface modification, and self-assembly. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Yin**

CHEM 258. Seminar in Surface Science (1) Seminar, 1 hour. Prerequisite(s): graduate standing in Physics or Chemistry or consent of instructor. Oral presentations by participating visiting scholars, postdoctoral researchers, students, and UCR faculty on current research topics in surface science. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. Cross-listed with PHYS 258. **Zaera**

CHEM 259. Bioanalytical Chemistry (2) Seminar, 2 hours. Prerequisite(s): graduate standing in Chemistry or consent of instructor. Explores bioanalytical separation and detection techniques. Topics include liquid chromatography, capillary electrophoresis, field flow fractionation, flow cytometry, multidimensional or multiplexed chromatography, microfluidics, mass spectrometry, biological sample preparation, and biosensors. Emphasis is on development of new bioanalytical techniques for detection of pathogens and study of pathogen-host interactions. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Zhong**

CHEM 261. Scanning Probe Microscopy in Surface Science (2) Seminar, 2 hours. Prerequisite(s): graduate standing; consent of instructor. Focuses on theory and applications of scanning probe microscopy in surface science, including the use of scanning tunneling microscopy to image surfaces on the atomic and molecular length scale, and scanning probe techniques to investigate and control elementary steps of surface reactions. Reviews surface crystallography, electronic, and phononic band structure. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Bartels**

CHEM 262. Ultrafast Dynamics in Condensed Matter (2) Seminar, 2 hours. Prerequisite(s): consent of instructor. The extremely fast relaxation and dephasing of nuclear (vibrational) and electronic excitations in condensed matter are probed by the use of coherent spectroscopy using (sub-picosecond) light pulses. Decay mechanisms are studied by making spectroscopic measurements at cryogenic temperatures (approximately 1K) and at various high pressures (greater than 100 Kbar). Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. May be repeated for credit. **Chronister**

CHEM 264. Novel Synthesis in Inorganic Chemistry (2) Seminar, 2 hours. Prerequisite(s): graduate standing or consent of instructor. Discusses strategies for the synthesis of novel structures in bioinorganic coordination, organometallic, and materials chemistry. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade based on seminar participation. Course is repeatable. **Reed**

CHEM 265. Raman Spectroscopy of Biological Systems (2) Seminar, 2 hours. Prerequisite(s): graduate standing or consent of instructor. Applications of Raman spectroscopy to the characterization of the structure and function of biological membranes and membrane proteins. Emphasis will be placed on resonance enhanced Raman scattering, including the theoretical origins of resonance enhancement. Students who present a seminar or submit a term paper receive

a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Bocian**

CHEM 266. Molecular Recognition and Catalysis (2) Seminar, 2 hours. Prerequisite(s): graduate standing in Chemistry or consent of instructor. Explores topics in biological and organic chemistry relevant to the study of molecular recognition. Emphasizes the study of non-covalent forces in self-association and the properties of macromolecular constructs. Also involves the study of the synthetic organic and inorganic chemistry used to create these constructs. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Hoolley**

CHEM 267. Organic Electronic Materials (2) Seminar, 2 hours. Prerequisite(s): graduate standing or consent of instructor. A study of design, synthesis, purification, manufacture, and application of carbon-based electronic materials. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. Cross-listed with CEE 254. **Haddon**

CHEM 269. New Trends in Main Group Chemistry (2) Seminar, 2 hours. Prerequisite(s): senior or graduate standing in Chemistry or consent of instructor. Training in modern main group chemistry, covering boron, silicon, phosphorous, and related elements. Organic and inorganic chemists benefit from this course. Introduces students to the peculiar properties of these elements, thus enabling them to use this knowledge in their own field of expertise. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Bertrand**

CHEM 270. Theoretical Quantum Chemistry: Methods and Applications (2) Seminar, 2 hours. Prerequisite(s): graduate standing in Chemistry or consent of instructor. Explores topics in computational quantum chemistry relevant to both wave function and density functional theories. Emphasizes new computational algorithms and physical approximations that can be used to accelerate calculations and the applications of these methods to solve chemical problems. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Beran**

CHEM 271. Design, Synthesis, and Applications of Highly Conjugated Organic Systems (2) Seminar, 2 hours. Prerequisite(s): graduate standing or consent of instructor. Focuses on the design and synthesis of highly conjugated organic molecules and polymers for application in molecule-based devices such as sensors, light emitting diodes, and conductors. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Marsella**

CHEM 272. Gaseous Ion Chemistry (2) Seminar, 2 hours. Prerequisite(s): graduate standing in Chemistry or consent of instructor. Surveys all aspects of ion chemistry in the gas phase. Topics include mass spectrometry, ion mobility, electrospray ionization, matrix-assisted laser desorption ionization, ion-molecule reactions, ion-ion reactions, quantum calculations, instrumentation, and photodissociation spectroscopy. Emphasis is on bioanalytical applications for the study of protein structure, folding, and assembly. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Julian**

CHEM 273. Bioanalytical Nuclear Magnetic Resonance Spectroscopy (2) Seminar, 2 hours. Prerequisite(s): consent of instructor. Development of Pulse Fourier transform NMR techniques and their application to the characterization of peptides, proteins and intact cells. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. May be repeated for credit. **Rabenstein**

CHEM 274. Chemical Biology (2) Seminar, 2 hours. Prerequisite(s): senior or graduate standing in Chemistry or consent of instructor. Involves formal presentations by graduate students on topics in the current literature and their research. Presentation responsibilities rotate among enrolled students and postdoctoral fellows. Also entails team work on problem sets and oral presentation of solutions. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Pirrung**

CHEM 275. Bioorganic Chemistry of Nucleic Acids (2) Seminar, 2 hours. Prerequisite(s): consent of instructor. The design, synthesis, and evaluation of nucleotides with novel hydrogen-bonding capabilities as well as oligonucleotides capable of regulating gene expression. Discussion of ribonucleic acid catalysis, including possible catalytic functions that have not yet been determined. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Switzer**

CHEM 277. Surface Chemistry (2) Seminar, 2 hours. Prerequisite(s): consent of instructor. Discussions for new advances in surface science, concentrating mainly on the use of molecular level. Letter grades will be assigned to students who present a paper; others will be graded Satisfactory (S) or No Credit (NC). May be repeated for credit. **Zaera**

CHEM 278. Nuclear Magnetic Resonance: Theory, Techniques, and Applications (2) Seminar, 2 hours. Prerequisite(s): graduate standing or consent of instructor. Focuses on the development of solid-state and liquid-state nuclear magnetic resonance (NMR) as a probe of molecular structure, function, and dynamics with applications that range from chemistry to physics and biology. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade based on seminar participation. Course is repeatable. **Mueller**

CHEM 279. Molecular Spectroscopy (2) Seminar, 2 hours. Prerequisite(s): consent of instructor. Properties of excited states of molecules. Molecular photophysics and photochemistry. Theory of radiationless transitions. Kinetics and mechanism of excited state decay. Laser spectroscopy. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. May be repeated for credit. **Scott**

CHEM 280. Chemistry and Biochemistry of Gaseous Molecules (2) Lecture, 1 hour; discussion, 1 hour. Prerequisite(s): consent of instructor. Reactions and properties of organic compounds and ions in the absence of bulk media. Preparative mass spectrometry and ion-molecule reactions. Molecular mechanisms in the sense of smell. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. May be repeated for credit. **Morton**

CHEM 281. Interface between Heteroatom and Transition Metal Chemistry (2) Seminar, 2 hours. Prerequisite(s): graduate standing in Chemistry or consent of instructor. Discusses heteroatom chemistry

as a source of new ligands for transition metal chemistry and applications in catalysis and material science. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Mathey**

CHEM 282. Elementary Processes in Atmospheric Chemistry (2) Seminar, 2 hours. Prerequisite(s): graduate standing or consent of instructor. Applies state-of-the-art laser techniques to investigate elementary processes in atmospheric chemistry. Emphasis is quantitative understandings of atmospheric free-radical intermediates, their photochemistry, and their reaction mechanisms. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Zhang**

CHEM 283. Development of Inorganic Solid State Materials (2) Seminar, 2 hours. Prerequisite(s): graduate standing; consent of instructor. Focuses on the development of advanced materials such as optical, electronic, and porous materials. Topics include synthetic methods, characterization techniques, property measurements, and device applications. Special emphasis is placed on the design of synthetic strategies for the discovery of new functional materials with novel properties. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade based on seminar participation. Course is repeatable. **Feng**

CHEM 284. Biological Mass Spectrometry (2) Seminar, 2 hours. Prerequisite(s): graduate standing or consent of instructor. A study of the synthesis, purification, and mass spectrometric characterization of biomolecules, nucleic acids in particular. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Wang**

CHEM 285. Bio-inspired Materials and Chemical Sensors (2) Seminar, 2 hours. Prerequisite(s): graduate standing or consent of instructor. A study of biomaterials and their application in analytical chemistry. Focus is on the design and synthesis of new materials, electrochemical detection, and the Surface Plasmon Resonance (SPR) technique. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Cheng**

CHEM 286. Time-Resolved Spectroscopy and Microscopy and Dynamics in Complex Systems (2) F, W, S Seminar, 2 hours. Prerequisite(s): senior or graduate standing in Chemistry or consent of instructor. A comprehensive survey of modern time-resolved spectroscopy and microscopy techniques. Emphasizes applications to outstanding problems in materials science and biology. Specific problems include the measurement of energy transport in organic semiconductors and DNA dynamics in biological media. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Bardeen**

CHEM 287. Modeling Molecular Recognition (2) Seminar, 2 hours. Prerequisite(s): graduate standing in Chemistry or consent of instructor. Focuses on molecular recognition and systems-level simulations, addressing theory and applications. Includes statistical mechanics (as applied to the prediction of equilibrium and nonequilibrium properties of chemical and biological systems), drug design and discovery, and cheminformatics. Utilizes numerical analysis, molecu-

lar dynamics and Brownian dynamics simulations, docking and scoring programs, and chemical database tools. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Chang**

CHEM 288. Bioanalytical Applications of Nuclear Magnetic Resonance (NMR) and Mass Spectrometry (MS) (2) Seminar, 2 hours. Prerequisite(s): consent of instructor. Focuses on the study of ligand-protein interactions, metabonomics, with special emphasis on the application of hyphenated NMR and MS experiments. Also discusses new NMR pulse sequences and microcoil probes. Students who present a seminar or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. **Larive**

CHEM 289. Special Topics in Neuroscience (2) Seminar, 2 hours. Prerequisite(s): graduate standing or consent of instructor. An interdisciplinary seminar consisting of student presentations and discussion of selected topics in neuroscience. Content and instructor(s) vary each time course is offered. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. Cross-listed with BCH 289, BIOL 289, ENTM 289, NRSC 289, and PSYC 289. **Hatton in charge**

CHEM 297. Directed Research (1-6) Prerequisite(s): consent of a staff member. Research in analytical, inorganic, organic, or physical chemistry under the direction of a member of the staff. A written report is required of the research study. Graded Satisfactory (S) or No Credit (NC).

CHEM 299. Research for Thesis or Dissertation (1-12) Prerequisite(s): consent of a staff member. Research in analytical, inorganic, organic, or physical chemistry under the direction of a member of the staff. This research is to be included as part of the dissertation. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

Professional Courses

CHEM 301. Oral Presentations in Chemistry (1)

Lecture, 1 hour. The technique of oral presentation, emphasizing the problems that arise in chemistry laboratory and classroom situations. Designed primarily for new graduate students in the Chemistry Department. Graded Satisfactory (S) or No Credit (NC).

CHEM 302. Teaching Practicum (1-2) lecture/laboratory, 4-8 hours. Prerequisite(s): Limited to Chemistry Department teaching assistants and Associates-In Chemistry. Supervised teaching in undergraduate courses in Chemistry. Graded Satisfactory (S) or No Credit (NC). May be repeated for credit. Units are not applicable to degree unit requirements.

The Chicano Bilingual-Bicultural Studies Minor

College of Humanities, Arts, and Social Sciences

Adalberto Aguirre, Jr., Ph.D., Chair
Office, 1225 Watkins Hall
(951) 827-5507; chicanobbbstudies.ucr.edu

Committee in Charge

Philip Gericke, Ph.D. (Spanish and Portuguese)
Alfredo M. Mirandé, Ph.D. (Ethnic Studies)
Yolanda Venegas, Ed.D.
Stephen E. Cullenberg, Ph.D.
Dean, College of Humanities, Arts, and Social Sciences, ex officio

The Chicano Bilingual-Bicultural Studies minor provides the student with a basic understanding of the Spanish language and of the Mexican American bicultural contacts in which that language is used in the southwestern United States.

- Lower-division requirements (8 units)
 - Four (4) units from ETST 002, ETST 004/HIST 004
 - Four (4) units from one of the following:
 - SPN 006
 - Any upper-division course taught in Spanish language
- Upper-division requirements (16 units)
 - One course in the general area of Education and Bilingualism from ETST 146/EDUC 146, ETST 163/SOC 163, ETST 165/SOC 165, ETST 166
 - One course from the general area of Societal Perspectives on the Chicano Experience ETST 142
 - One course from ETST 123, ETST 124, ETST 126, ETST 128/SOC 128
 - One course in Chicano Art or Literature from ETST 108P, ETST 114, ETST 153/LNST 153, ETST 191N

See Minors under the College of Humanities, Arts, and Social Sciences in the Colleges and Programs section of this catalog for additional information on minors.