
Chemistry

FACULTY

**Year of initial appointment at Binghamton*

Bane, Susan L., *Associate Professor*, PhD, 1983, Vanderbilt University: Bioorganic and biophysical chemistry, ligand receptor mechanisms. (1985)*

Ben, Robert N., *Assistant Professor*, PhD, 1994, University of Ottawa: Synthetic organic chemistry, asymmetric synthesis. (1998)

Dix, James A., *Associate Professor and Director of Undergraduate Studies*, PhD, 1977, University of California at Los Angeles: Biophysics, membrane transport. (1981)

Doetschman, David C., *Professor*, PhD, 1969, University of Chicago: Photochemistry and electron paramagnetic resonance. (1975)

Eisch, John J., *Distinguished Professor*, PhD, 1956, Iowa State University: Synthetic and mechanistic studies of organometallic compounds and unusual heterocyclic nuclei. (1972)

Handy, Scott T., *Assistant Professor*, PhD, 1996, Indiana University: Synthetic organic chemistry, organometallic, bio-organic and medicinal chemistry. (1999)

Hull, C. Max, *Professor Emeritus*, PhD, 1935, Ohio State University: Organic chemistry. (1950)

Innes, K. Keith, *Distinguished Professor Emeritus*, PhD, 1951, University of Washington: Investigations of electronic spectra of molecules, nonlinear spectroscopy. (1969)

Jones, Wayne E., *Assistant Professor and Director of Graduate Admissions*, PhD, 1991, University of North Carolina, Chapel Hill: Inorganic photochemistry and photophysics: photo induced electron transfer; energy transfer; inorganic and organometallic odd electron species; photoactive polymers; multielectron transfer and storage systems. (1993)

Lees, Alistair J., *Professor and Department Chair*, PhD, 1979, University of Newcastle-upon-Tyne: Photochemistry and spectroscopy of transition-metal organometallic complexes. (1981)

Madan, Stanley K., *Professor Emeritus*, PhD, 1960, University of Illinois: Kinetics, preparation and characterization of metal complexes. (1960)

Musfeldt, Janice L., *Assistant Professor*, PhD, 1992, University of Florida: Physical chemistry; spectroscopic studies of low-dimensional electronic and magnetic solids; organic molecular conductors, conducting and light-emitting polymers, inorganic magnetic materials. (1995)

Myers, Clifford E., *Professor Emeritus*, PhD, 1956, Purdue University: High-temperature materials chemistry, thermodynamics, vaporization reactions. (1963)

Norcross, Bruce E., *Associate Professor*, PhD, 1960, Ohio State University: Organic chemistry reaction mechanisms. (1962)

Oliver, Scott R. J., *Assistant Professor*, PhD, 1997, University of Toronto: Inorganic materials chemistry, self-assembled monolayer and multilayer thin films, synthesis-structure-property relationships. (1999)

Sadik, Omowunmi A., *Assistant Professor*, PhD, 1994, Wollongong University: Analytical and environmental chemistry, biosensors. (1996)

Starzak, Michael E., *Professor*, PhD, 1968, Northwestern University: Biophysical chemistry of membranes. (1970)

Stevens, Eugene S., *Professor and Director of Graduate Studies*, PhD, 1965, University of Chicago: Biophysical chemistry of saccharides and polysaccharides. (1977)

Whittingham, M. Stanley, *Professor*, DPhil, 1968, Oxford University: Materials and inorganic chemistry, materials for energy storage and conversion. (1988)

Zhong, Chuan-Jian, *Assistant Professor*, PhD, 1988, Xiamen University: Analytical and materials chemistry, molecular assembly, analytical miniaturization, surface spectroscopy and electrochemistry. (1998)

Adjunct Faculty

Brinker, Udo H., *Adjunct Professor*, Dr. rer. nat., 1973, University of Cologne: Synthetic and mechanistic organic chemistry, highly strained compounds, reactive intermediates, carbenes. (1988)

Hartwick, Richard A., *Adjunct Associate Professor*, PhD, 1978, University of Rhode Island: Chemical separations: HPLC, capillary electrophoresis; biomedical applications. (1990)

Martin, Olivier R., *Adjunct Professor*, PhD, 1980, University of Geneva: Carbohydrate chemistry, structure-biological activity relationships of nucleoside antibiotics. (1983)

Poliks, Mark D., *Adjunct Assistant Professor*, PhD, 1987, University of Connecticut: High resolution solid state NMR spectroscopy. (1992)

UNDERGRADUATE PROGRAMS

The Department of Chemistry offers BA and BS degrees in chemistry, both of which are liberal arts degrees. The BS degree is generally

recognized as preparation for a career in chemistry at the bachelor's level and hence offers a greater concentration in the field, whereas the BA program provides a greater flexibility in designing a plan of study. Both degrees provide a background in chemistry for graduate and professional study. The department also offers degrees with emphasis in materials or emphasis in biophysical chemistry, as well as a minor in chemistry.

The department requires a GPA of 2.0 or better in courses presented to satisfy either BA or BS major requirements. Among these courses, no more than two with a grade of P may be included.

BA Degree Program

The major in chemistry leading to the BA degree requires the following courses: CHEM 111*, 221, 231, 332, 341, 351, 496; MATH 221 and 222; PHYS 121 and 122 (or PHYS 131 and 132); 1-1/2 additional courses** from among CHEM 335, 422, 432, 445, 455, 465 and 497/498; two additional courses in chemistry; one additional course* within the Division of Science and Mathematics.

*CHEM 107-108 may be substituted for CHEM 111. If this substitution is made, the additional course in the Division of Science and Mathematics is not required.

**Subject to approval of the department, laboratory courses from other departments may be substituted.

No more than 12 credits of CHEM 397 and 497/498 may be used to satisfy the major, and no more than four of these credits may be CHEM 397.

These requirements afford students considerable flexibility in designing courses of study suited to their particular needs and interests. To take full advantage of that flexibility, it is important to plan carefully the sequence of courses in the first two years of study. The student is encouraged to seek early advice from a faculty member.

The following sample sequences are offered as a general guide.

Sequence with CHEM 111

	Fall	Spring
Freshman	CHEM 111 MATH 221	CHEM 231 MATH 222
Sophomore	CHEM 332 PHYS 121	CHEM 221 PHYS 122
Junior	CHEM 341 CHEM 351	CHEM elective CHEM elective
Senior	CHEM 496	CHEM elective

CHEM elective Science elective

Sequence with CHEM 107-108

	Fall	Spring
Freshman	CHEM 107 MATH 221	CHEM 108 MATH 222
Sophomore	CHEM 231 PHYS 121	CHEM 332 CHEM 221* PHYS 122
Junior	CHEM 341 CHEM 351	CHEM elective CHEM elective
Senior	CHEM 496 CHEM elective	CHEM elective

*Pre-health students may prefer to defer CHEM 221 to the junior year.

These sequences allow the student to explore the various upper-division chemistry course offerings in the junior and senior years.

It is possible to begin specialization within the major early, by choosing a group of electives concentrated on one particular area of chemistry, such as organic, analytical, inorganic or physical chemistry. Students may also design a program interdisciplinary in nature, by choosing complementary electives in other disciplines such as biology, geology or physics. Especially in the case of tailored programs, students should obtain advice from Chemistry Department faculty as early as possible in their careers.

For those students desiring a broad background in chemistry, the following general track of chemistry electives is suggested.

1. CHEM 335
2. CHEM 422
3. CHEM 442, 443, 444, 445 or 484
4. CHEM 451, 452 or 455.

BA PROGRAM WITH EMPHASIS IN MATERIALS

The major in chemistry with emphasis in materials leading to the BA degree requires the following courses: CHEM 111, 221, 231, 341, 351, 444, 496; MATH 221, 222; PHYS 121, 122 or 131, 132; one course from among CHEM 332, 451, 452, 455, 461; one additional course from 445, 497/498 or other materials laboratory course and 1/2 course from CHEM 335, 422, 432, 445, 465 and 497/498; and two materials course electives at any level.

BS Degree Program

The major in chemistry leading to the BS degree requires the following courses: CHEM 111, 221, 231, 332, 335, 341, 351, 422; MATH 221, 222, PHYS 121, 122 (or PHYS 131, 132); one course from among CHEM 442, 443, 444, 445, 484;

either CHEM 451 or 452; CHEM 455 (4 credits) and CHEM 496; and four courses in the Division of Science and Mathematics, or professionally related courses.

These courses provide the student with a broader and more intense course of study than the BA degree.

CHEM 107-108 may be substituted for CHEM 111 in any program.

The following sample sequences are offered as a general guide:

Sequence with CHEM 111

	<i>Fall</i>	<i>Spring</i>
Freshman	CHEM 111 MATH 221	CHEM 231 MATH 222
Sophomore	CHEM 332 CHEM 335 PHYS 131*	CHEM 221 Science elective PHYS 132*
Junior	CHEM 351 CHEM 341 CHEM 422	P CHEM II** INORG II*** Science elective
Senior	CHEM 455 CHEM 496	Science elective Science elective

Sequence with CHEM 107-108

	<i>Fall</i>	<i>Spring</i>
Freshman	CHEM 107 MATH 221	CHEM 108 MATH 222
Sophomore	CHEM 231 PHYS 131*	CHEM 332 CHEM 335 CHEM 221 PHYS 132*
Junior	CHEM 351 CHEM 341 CHEM 422	Phys. Chem. II** Inorganic II*** Science elective
Senior	CHEM 455 CHEM 496	Science elective Science elective Science elective

**Physics with calculus is strongly recommended but not required.*

***Phys. Chem. II may be CHEM 451 or CHEM 452.*

****Inorganic II may be CHEM 442, 443, 444, 445 or 484.*

BS PROGRAM WITH EMPHASIS IN MATERIALS

The major in chemistry with emphasis in materials leading to the BS degree requires the following courses: CHEM 111, 221, 231, 332, 335, 341, 351, 422, 444, 455, 496 and either 451 or 452; MATH 221 and 222; PHYS 121 and 122 (or PHYS 131 and 132); one course in the Division of Science and Mathematics, or professionally related course; and three materials

course electives that include an advanced laboratory or the completion of a research project and two others at any level.

BS PROGRAM WITH EMPHASIS IN BIOPHYSICAL CHEMISTRY

The major in chemistry with emphasis in biophysical chemistry leading to the BS degree requires the following courses: CHEM 111, 221, 231, 332, 335, 341, 351, 422, 461, 465, 496; MATH 221, 222; PHYS 121, 122 (or PHYS 131, 132); one course from among CHEM 442, 443, 444, 445, 484; three biophysical chemistry course electives; 1/2 course of chemistry laboratory elective; and one course in the Division of Science and Mathematics, or professionally related course.

Chemistry Minor

Requirements for the minor are:

1. CHEM 107 and 108
2. Four CHEM courses numbered 200 or above. At least two of these courses must be numbered 300 or above.

CHEM 111 may be substituted for CHEM 107-108. If this substitution is made, an additional chemistry course numbered 200 or above is required. Only courses that fulfill the chemistry major requirements can be used to fulfill the chemistry minor requirements. Keep in mind that at least four of the chemistry courses used for the chemistry minor requirement must be in addition to chemistry courses used to fulfill a student's major requirement. Among the courses for the chemistry minor, no more than one with a grade of P may be included.

American Chemical Society Certification

The Committee on Professional Training of the American Chemical Society sponsors a program to ensure minimum standards of competence for chemists at the bachelor's degree level. In addition to the BS requirement specified by course number above, ACS certification requires that at least 2 credits of CHEM 445 or at least 2 credits of Advanced Independent Study (CHEM 497 or 498) involving laboratory work in inorganic chemistry, and at least 2 additional credits of independent study (CHEM 397, 497, or 498) involving laboratory work, be used to satisfy the four-elective requirement for the BS degree. Two credits of independent study involve four to eight hours of laboratory work.

Honors Program

Graduation with honors in chemistry is granted for superior independent work. To qualify for

admission to the honors program, a student must have demonstrated academic accomplishment of high quality and must have prior enrollment in CHEM 497, Advanced Independent Study, and current enrollment in CHEM 498, Advanced Independent Research—Honors. The results of the honors project, presented in a thesis, are defended before an examining committee. Successful completion of the program earns the recognition Distinguished Independent Work in Chemistry. Detailed guidelines for the program are available from the department office, and should be consulted by majors in their junior year.

GRADUATE PROGRAMS

The Chemistry Department offers programs leading to the degrees of master of arts, master of science and doctor of philosophy. These programs train the student broadly in chemistry, and require original investigation in a specialized area. The PhD places major emphasis on training in depth, with the expectation of a significant contribution in the specialized area. Practical experience in teaching chemistry is also a recognized objective both in master's and in PhD programs.

An MAT program in chemistry is available in the School of Education and Human Development.

A University certificate in college teaching is awarded to students who satisfy certificate requirements as defined by the Chemistry Department.

Interdisciplinary Programs

In addition to the four traditional areas of chemistry—analytical, inorganic, organic and physical—the department also offers MS and PhD degrees with specializations in the three interdisciplinary areas of chemical physics, biophysical chemistry and materials chemistry.

Requirements

ADMISSION

All applicants should submit scores for the Graduate Record Examination Aptitude tests and the GRE advanced test in chemistry.

PLACEMENT EXAMINATIONS

On entering the graduate programs, students are expected to demonstrate a general competence equivalent to the baccalaureate degree with a major in chemistry, or to be prepared to make up deficiencies by taking appropriate courses. Proficiency is determined by placement examinations in the major subject areas of the

field. In the week preceding registration for each semester, a written comprehensive examination is given in each of the areas of organic, inorganic physical and analytical chemistry.

A student in the chemical physics program must demonstrate proficiency in two areas of chemistry, and either in classical physics (mechanics, electricity and magnetism) or in quantum physics. A student in the bBiophysical chemistry program must demonstrate proficiency in physical chemistry and in one of the other three traditional areas of chemistry; in addition, proficiency at the undergraduate level must be demonstrated in biochemistry. A student in the materials chemistry program must demonstrate proficiency in inorganic and physical chemistry and in solid state and materials sciences (the last topic can be replaced by taking both analytical and organic chemistry).

Students who perform satisfactorily are admitted to graduate courses numbered 500 and above. Students showing deficiencies in specific areas are required to correct these deficiencies, normally by taking appropriate courses at lower levels or by passing subsequent examinations. Undergraduate deficiencies may be removed by audit (without credit), wherein all the requirements, including examinations, must be completed; the instructor provides a grade used by the departmental graduate committee in evaluating the student's progress. To remain in the program, students are ordinarily expected to pass at least two placement examinations, or otherwise remove deficiencies prior to the beginning of the second semester; all such examinations must be successfully completed by the beginning of the second calendar year of study.

Master of Arts Program

The master of arts program in chemistry satisfies the needs of students who desire a master's degree based primarily on coursework.

The departmental graduate committee recommends for the degree of master of arts in chemistry students who complete the following requirements:

1. Completion of an acceptable research project (at least four credits of CHEM 597).
2. Participation for one semester in the graduate seminar (CHEM 592).
3. Two semesters of Frontiers in Chemistry (CHEM 593).
4. Completion of six graduate courses, at least four of which are in chemistry, the balance to be related courses approved by the departmental graduate committee.
5. Public presentation of a seminar on the subject of the research project.
6. A total of at least 32 graduate credit hours obtained under the above requirements.

Master of Science Program

A candidate for the degree of master of science in chemistry is expected to demonstrate a general knowledge in the field and the ability to do original work in a specialized area of the field of chemistry, leading to an acceptable thesis. The program is guided by an adviser and the departmental graduate committee until certification and approval of a research subject and adviser. The research problem is started as early as possible in the student's graduate education, consistent with the attainment of an acceptable general proficiency as determined by the satisfactory completion of appropriate courses and examinations.

The departmental graduate committee recommends for the degree of master of science in chemistry students who complete the following requirements:

1. An acceptable research project and thesis (CHEM 599).
2. Participation for one semester in the graduate seminar (CHEM 592).
3. Two semesters of Frontiers in Chemistry (CHEM 593).
4. Four graduate courses, at least three of which ordinarily are in chemistry, the balance in related courses approved by the departmental graduate committee. A student in the chemical physics program must complete two courses in chemistry and two courses in physics that are approved by the graduate committee. A student in the biophysical chemistry program must complete at least two courses in chemistry and the remainder from the fields of physics, mathematics, computers or biology, approved by the graduate committee. A student in the materials chemistry program must complete at least two courses in chemistry, including CHEM 544, and at least two courses from the fields of biology, computer science, geology, physics or engineering approved by the graduate committee.
5. Passing an oral examination on the subject of the research thesis.
6. A total of at least 30 graduate credit hours obtained under the above requirements.

The examining committee for each candidate consists of three to five members appointed from the faculty by the departmental graduate committee and may include one or two faculty members from other departments.

Doctor of Philosophy Program

The PhD is awarded for original investigation leading to a significant advance of knowledge in a specialized area. Courses and seminars provide necessary background in the knowledge, basic

principles, methods and theories of chemistry. Under the guidance of the departmental graduate committee, students complete those courses that best serve their particular needs. In the course of their training, they are expected to demonstrate by appropriate examinations a breadth of knowledge in chemistry; a perspective of the relation of chemistry to other fields of knowledge—particularly the fields of mathematics, physics and biology; and competence in depth in a specialized area of chemistry. At the earliest date consistent with their general progress, students select a research topic and begin research (see below under "Research and Dissertation").

COURSES

A student is normally expected to take six to eight courses, two of which may be from the fields of physics, mathematics and biology. A student in the chemical physics program must present at least three courses in chemistry and PHYS 524, 525 and either PHYS 511 or 514. A student in the biophysical chemistry program must present at least three courses in chemistry, and the remainder from the fields of physics, mathematics, computer sciences or biology, approved by the graduate committee. A student in the materials chemistry program must complete at least three courses in chemistry, including CHEM 544, and at least two courses from the fields of biology, computer science, geology, physics or engineering approved by the graduate committee, for a total of six to eight. Most of the basic graduate courses in a student's program should be taken during the first year of residence.

COMPREHENSIVE EXAMINATIONS

Proficiency in a specialized area (organic, inorganic, analytical, physical, biophysical or materials chemistry) is established by cumulative examinations. Four of these in each specialty are scheduled at stated times in each semester. Students normally begin the cumulative examinations as soon as possible after passing all of the placement examinations, and ordinarily take them in uninterrupted sequence until they pass three out of eight such cumulative examinations in the selected area of specialization. Failure to pass three out of eight such examinations is considered sufficient reason for dismissal from the PhD program. Following the satisfactory completion of the cumulative examinations, students are required to stand an oral examination in the area of specialization.

For those students pursuing research in an interdisciplinary area, an alternative examination option is available under the guidance of an interdisciplinary examining committee. For students in the chemical physics program, a comprehensive examination in physics is also required. This covers the material in the undergraduate courses of Analytical Mechanics (PHYS 341), Electromagnetic Theory (PHYS 331-

COURSE OFFERINGS/ UNDERGRADUATE

NOTE: Unless otherwise noted, all undergraduate courses carry 4 credits and are offered every year.

CHEM 100. BASIC CHEMISTRY *spring*

For students intending to major in sciences or nursing who have not had an adequate course in chemistry prior to college or no chemistry in high school. A one-semester overview of the basic concepts of chemistry including modern atomic theory, chemical bonding, chemical equations, chemical calculations and behavior of gases. Develops skills in problem solving. Lecture and lab. Course does not fulfill all-college requirements in science and math. Prerequisite: consent of instructor.

CHEM 101. INTRODUCTION TO CHEMISTRY I *fall*

For students who want some knowledge of chemistry for itself, or who require background in chemistry for professional pursuits in such areas as nursing, psychology, social sciences and management. Structure and reactivity of matter, chemical bonding, acids and bases, electrochemistry, nuclear chemistry, chemical equilibrium, chemical kinetics, solution chemistry. Lecture and lab. Does not satisfy major requirements.

CHEM 102. INTRODUCTION TO CHEMISTRY II *spring*

Continuation of CHEM 101. Organic chemistry, biochemistry, physiological chemistry, chemistry and the environment. Lecture and lab. Prerequisite: CHEM 101.

CHEM 107. INTRODUCTORY CHEMISTRY I *fall*

First of two courses for students who want a one-year, two-semester introductory general chemistry course as basis for further work in a science. Scientific measurement, atomic structure, periodic relationships, theories of bonding, states of matter, solution properties. Lecture and lab. Prerequisite: high school chemistry. Not open to students who have credit for CHEM 111.

CHEM 108. INTRODUCTORY CHEMISTRY II *spring*

Continuation of CHEM 107. Thermochemistry and thermodynamics; equilibrium; chemical kinetics; electrochemistry; nuclear chemistry; descriptive inorganic, organic and biochemistry. Lecture and lab. Prerequisite: CHEM 107 or equivalent. Not open to students who have credit for CHEM 111.

CHEM 111. CHEMICAL PRINCIPLES *fall*

A one-semester introductory course in modern chemistry for potential science and engineering majors. Covers molecular structure and bonding, solids, organic chemistry and polymers, acid/base and redox chemistry, thermodynamics, electrochemistry and kinetics in both lecture and laboratory. Fulfills all requirements met by CHEM 107-108. Lecture and lab. Prerequisite: high school chemistry. Not open to students who have credit for CHEM 107 or CHEM 108.

CHEM 180. FRESHMAN CHEMISTRY SEMINAR

fall, 1 credit

Introduction to and discussion of current topics in chemistry. Lectures by faculty and outside speakers; introduction to the research capabilities of the department. Prerequisite: strong high school chemistry background or a score of 4 or 5 on the chemistry AP exam. P/F only.

CHEM 221. INTRODUCTION TO ANALYTICAL CHEMISTRY THEORY AND PRACTICE *spring*

Principles and techniques of chemical analysis, including methods of separation, quantitative measurements, evaluation of analytical data. Topics of lectures, with laboratory examples, include titration and extraction methods (using conditional constants for multiple solution equilibria), and instrumental methods based on electrometric, spectrometric and chromatographic approaches for determining macro to trace concentrations. Prerequisite: CHEM 108 or 111.

CHEM 231. ORGANIC CHEMISTRY I *every semester*

Introduction to organic chemistry. Structure, stereochemistry, mechanisms and reactions of carbon compounds. Prerequisite: CHEM 108 or 111.

CHEM 332. ORGANIC CHEMISTRY II *every semester*

Further study of organic compounds; biological aspects of organic chemistry. Prerequisite: CHEM 231.

CHEM 335. ORGANIC CHEMISTRY LABORATORY

every semester, 2 credits

Introduction to separation, purification and analysis of organic compounds; simple and multistep syntheses, reaction kinetics. Lecture and lab. Prerequisite: CHEM 231.

CHEM 341. INORGANIC CHEMISTRY *fall*

Relations among structure, energy and reactivity of inorganic systems; transition and nontransition elements. Descriptive chemistry of common elements; chemistry of solid state. Prerequisite: CHEM 108 or 111.

CHEM 351. INTRODUCTION TO PHYSICAL CHEMISTRY

fall

Elementary concepts of quantum mechanics, thermodynamics and chemical kinetics, with applications to molecular structure and spectra, energy relationships between substances, and reactivity. Prerequisites: CHEM 108 or 111, and MATH 122; prerequisite or corequisite: PHYS 121.

CHEM 391. PRACTICUM IN COLLEGE TEACHING

every semester, variable credit

Independent study by assisting in a course. Various assignments directed by instructor including laboratory instruction. May be repeated for total of no more than 8 credits. Credit may not be earned in conjunction with course in which student is currently enrolled. Does not satisfy major or all-college requirements. Prerequisite: consent of instructor and departmental approval. P/F only.

CHEM 397. INDEPENDENT WORK

every semester, variable credit

Individual research under supervision of faculty member. Not limited to chemistry majors. May be repeated for credit. Chemistry majors repeating courses are strongly encouraged to choose different faculty supervisors. No more than four credits of CHEM 397 may be used to satisfy major requirement for chemistry. Prerequisites: consent of instructor and approval of department chair or designee. Written report of work required. Consult detailed guidelines before advance registration.

CHEM 411. TECHNIQUES FOR STUDYING SOLIDS

every other year

Introduction to the techniques used to make physical measurements on and to analyze inorganic solids. Examples include electron and optical microscopy, x-ray analysis, TGA/DTA, NMR and EPR, magnetic susceptibil-

ity, and electron and ion transport measurements. Prerequisite: junior standing.

CHEM 422. INSTRUMENTAL METHODS OF ANALYSIS

fall

Instrumentation, theory, and practice of electrometric, spectrometric, chromatographic, radiochemical and other physicochemical methods of measurement and analysis. Lecture and lab. Prerequisites: CHEM 221 and PHYS 122.

CHEM 431. PHYSICAL ORGANIC CHEMISTRY

Effect of structure on reactivity of organic compounds. Introduction to organic reaction mechanisms, molecular orbital theory. Prerequisites: CHEM 351 and 332.

CHEM 432. CHEMICAL SYNTHESIS

variable credit

Rationale and methods of synthesis, purification and characterization of organic and inorganic compounds. Lecture and lab. Prerequisite: CHEM 335.

CHEM 434. BIOORGANIC CHEMISTRY

Application of the theories and methodologies of organic chemistry to the study of biological systems. Topics include chemical synthesis of proteins and nucleic acids, biomimetic systems, mechanistic enzymology and drug design. Prerequisite: CHEM 332.

CHEM 442. INTRODUCTION TO PHYSICAL INORGANIC CHEMISTRY

Descriptive chemistry of transition metal complexes. Inorganic reaction mechanisms; use of symmetry and group theory in chemical systems; applications of modern spectroscopic techniques to inorganic systems. Prerequisites: CHEM 341 and 351.

CHEM 443. MOLECULAR PHOTOCHEMISTRY

Introduction to modern molecular photochemistry of organic, inorganic, and organometallic systems. Excited states, photophysical processes, energy transfer, electron transfer, substitutional photochemistry, chemiluminescence. Prerequisite: CHEM 351.

CHEM 444. CHEMISTRY OF SOLIDS

spring

Introduction to modern solid state and materials chemistry. Synthesis of solids, intercalation chemistry, crystal chemistry, structural analysis, catalysis, transport properties, superconductivity, electrochemistry, diffusion and other topical areas. Prerequisite: one or more years of chemistry and/or physics.

CHEM 445. INORGANIC/MATERIALS CHEMISTRY LABORATORY

spring, variable credit

Preparation and characterization of inorganic compounds: structure, reaction kinetics, spectroscopic properties, photochemistry. Lecture and lab. Prerequisites: CHEM 221 and 341.

CHEM 451. QUANTUM CHEMISTRY, SPECTROSCOPY, AND KINETICS

every other spring

Principles of quantum mechanics applied to problems of molecular structure and spectra. Introduction to kinetics. Prerequisites: CHEM 351 and PHYS 122.

CHEM 452. THERMODYNAMICS AND STATISTICAL MECHANICS

every other spring

Equilibrium and nonequilibrium properties of matter. Chemical thermodynamics and statistical mechanics. Prerequisites: CHEM 351 and PHYS 122.

CHEM 455. EXPERIMENTAL PHYSICAL CHEMISTRY

fall, variable credit

Physical methods and instrumentation in chemical investigation. Design of experiments and writing scientific reports. Prerequisite: CHEM 351.

CHEM 461. BIOPHYSICAL CHEMISTRY

fall

Physical chemistry of biological macromolecules. Molecular weight, size and shape of macromolecules, intra- and intermolecular forces, fine structure as revealed by spectroscopic and X-ray methods, denaturation and conformational changes, acid-base properties. Prerequisites: CHEM 351, MATH 122, and PHYS 122.

CHEM 465. BIOPHYSICAL CHEMISTRY LABORATORY

spring, 2 credits

Laboratory examination of physical techniques in biochemistry. Experiments illustrate principles of molecular weight determination and study of macromolecular interaction. Prerequisite: CHEM 461.

CHEM 481. TOPICS IN MATERIALS CHEMISTRY

Advanced treatment of selected areas of materials chemistry. May be repeated for credit. Recent topics include: X-ray powder diffraction and reactivity of solids (inorganic phase equilibria). Prerequisite: consent of instructor.

CHEM 482. TOPICS IN ANALYTICAL CHEMISTRY

Advanced treatment of selected areas of analytical chemistry. May be repeated for credit. Prerequisite: consent of instructor.

CHEM 483. TOPICS IN ORGANIC CHEMISTRY

Advanced treatment of selected areas of organic chemistry. May be repeated for credit. Recent topics include: polymer chemistry, stereochemistry, conformation, analysis, organometallic chemistry, theoretical organic chemistry, natural products, spectroscopy, synthetic organic chemistry, heterocyclic chemistry, and synthesis by organometallics. Prerequisite: consent of instructor.

CHEM 484. TOPICS IN INORGANIC CHEMISTRY

Advanced treatment of selected areas of inorganic chemistry. May be repeated for credit. Recent topics include: coordination chemistry, reactivity of solids (inorganic phase equilibria), bioinorganic chemistry, chemical group theory, spectroscopic methods, X-ray powder diffraction and main group chemistry. Prerequisite: consent of instructor.

CHEM 485. TOPICS IN PHYSICAL CHEMISTRY

Advanced treatment of selected areas of physical chemistry. May be repeated for credit. Recent topics include: chemical kinetics, spectroscopy, molecular modeling, magnetic resonance, surface chemistry, mathematical chemistry, polymer chemistry and photochemistry. Prerequisite: consent of instructor.

CHEM 486. TOPICS IN BIOPHYSICAL CHEMISTRY

Advanced treatment of selected areas of biophysical chemistry. May be repeated for credit. Recent topics include: quantum biochemistry, chemical physics-biopolymers and chemistry of membranes. Prerequisites: CHEM 231 and 351.

CHEM 488. SPECIAL TOPICS IN CHEMISTRY

2 credits

Advanced treatment of selected areas of chemistry. May be repeated for credit. Prerequisite: consent of instructor.

CHEM 496. SENIOR SEMINAR

every semester, 2 credits

Presentation and discussion of current chemical literature. Includes use of library resources and computer databases of chemical literature. Students present a seminar and a poster on an assigned topic. Prerequisite: senior standing.

CHEM 497. ADVANCED INDEPENDENT STUDY

every semester, variable credit

Individual research under direct supervision of faculty member. Requires more extensive preparation than CHEM 397. Before advance registration, student must make formal application and receive approval of instructor and department. May be repeated for credit. No more than 12 credits total of CHEM 397 and CHEM 497 may be used to satisfy major requirement for chemistry. Prerequisite: completion of any three of CHEM 221, 231, 341 and 351, with the fourth as a corequisite, and demonstrated potential for independent study. Written report of work required. Consult detailed guidelines before advance registration.

CHEM 498. ADVANCED INDEPENDENT RESEARCH—HONORS

every semester, variable credit

See CHEM 497 for description. To receive the honor "Distinguished Independent Work in Chemistry," candidate must write and defend a thesis based on the research.

COURSE OFFERINGS/ GRADUATE

CHEM 511. TECHNIQUES FOR STUDYING SOLIDS

Introduction to the techniques used to make physical measurements on and to analyze inorganic solids. Examples include electron and optical microscopy, x-ray analysis, TGA/DTA, NMR and EPR, magnetic susceptibility, and electron and ion transport measurements.

CHEM 521. ADVANCED ANALYTICAL CHEMISTRY

Theoretical foundations of analytical chemistry from an advanced standpoint, including separation and determination methods applicable to inorganic and organic species, critical evaluation of methods and data. Review of current research in analytical chemistry.

CHEM 531. ADVANCED ORGANIC CHEMISTRY I

Physical organic chemistry: structural theories. Effect of structure on reactivity. Kinetics and thermodynamics of organic reactions. Determinations of organic reaction mechanisms.

CHEM 532. ADVANCED ORGANIC CHEMISTRY II

Organic synthesis: concepts of retrosynthetic analysis. Synthetic methods: C-C bond-forming reactions, functional group interconversion, oxidation, reduction. Applications.

CHEM 534. BIOORGANIC CHEMISTRY

Application of the theories and methodologies of organic chemistry to the study of biological systems. Topics include chemical synthesis of proteins and nucleic acids, biomimetic systems, mechanistic enzymology and drug design.

CHEM 542. PHYSICAL INORGANIC CHEMISTRY

Modern spectroscopic techniques and inorganic systems; molecular symmetry and group theory in chemical applications; reaction mechanisms.

CHEM 543. MOLECULAR PHOTOCHEMISTRY

Introduction to modern molecular photochemistry of organic, inorganic, and organometallic systems. Excited states, photophysical processes, energy transfer, electron transfer, substitutional photochemistry, chemiluminescence.

CHEM 544. CHEMISTRY OF SOLIDS

Introduction to modern solid state and materials chemistry. Synthesis of solids, intercalation chemistry, crystal chemistry, structural analysis, catalysis, transport properties, superconductivity, electrochemistry, diffusion and other topical areas.

CHEM 551. ADVANCED PHYSICAL CHEMISTRY I

Quantum chemistry, spectroscopy and structural dynamics.

CHEM 552. ADVANCED PHYSICAL CHEMISTRY II

Thermodynamics and statistical mechanics.

CHEM 561. BIOPHYSICAL CHEMISTRY

Physical chemistry of biological macromolecules.

CHEM 581. SPECIAL TOPICS IN MATERIALS CHEMISTRY

Advanced treatment of selected areas of materials and solid state chemistry. Areas will vary from year to year. Present topics include: reactivity of solids, inorganic and materials laboratory, x-ray powder diffraction. May be repeated for credit.

CHEM 582. SPECIAL TOPICS IN ANALYTICAL CHEMISTRY

Advanced treatment of selected areas of analytical chemistry, such as electroanalytical chemistry; separation methods; trace methods, environmental analysis, clinical chemistry. May be repeated for credit.

CHEM 583. SPECIAL TOPICS IN ORGANIC CHEMISTRY

Advanced treatment of selected areas of organic chemistry. Including: advanced physical organic chemistry, reactive intermediates, spectroscopic identification of organic compounds, organometallic chemistry, organic polymers, natural products chemistry. May be repeated for credit.

CHEM 584. SPECIAL TOPICS IN INORGANIC CHEMISTRY

Advanced course dealing with subjects not ordinarily covered by regularly scheduled courses; discussions of newly developing areas of inorganic research. May be repeated for credit.

CHEM 585. SPECIAL TOPICS IN PHYSICAL CHEMISTRY

Advanced treatment of selected areas of physical chemistry. Topics vary from year to year. May be repeated for credit.

CHEM 586. SPECIAL TOPICS IN BIOPHYSICAL CHEMISTRY

Advanced treatment of selected areas of biophysical chemistry. Topics vary from year to year. May be repeated for credit.

CHEM 588. SPECIAL TOPICS IN CHEMISTRY 2 credits

Advanced treatment of selected areas of chemistry. May be repeated for credit.

CHEM 591. THE TEACHING OF COLLEGE CHEMISTRY*1-2 credits*

Guided experience in teaching chemistry. Normally may not be counted toward residency requirement. S/U grading only.

CHEM 592. GRADUATE SEMINAR*2 credits*

Seminar discussion of current research topics. Attendance required of all degree candidates. Credit granted in those semesters student presents seminar report. May be repeated for credit.

CHEM 593. FRONTIERS IN CHEMISTRY*1 credit*

Seminars on current topics in chemistry. Students attend presentations, participate in discussion, and write reports. Visiting speakers included. May be repeated for credit to be counted toward fulfilling residency requirement; may not substitute for specified course requirements (including seminars). Two credits required of all graduate students. Prerequisite: graduate standing in chemistry. S/U grading only.

CHEM 597. INDEPENDENT STUDY*1-4 credits*

Directed study in a field of chemistry, under guidance and with approval of instructor and department. May be counted toward residency requirement, but does not ordinarily fulfill specified course requirements. S/U grading unless departmental approval has been obtained in advance for regular letter grading.

CHEM 598. PRE-THESIS RESEARCH*2-6 credits*

Independent research toward preparation of master's thesis. Limited to six credits, to be counted toward fulfilling residency requirement, but may not be used to satisfy specific course requirements. Prerequisite: must be accepted as candidate for the master's program, with entrance exams and majority of course work complete. S/U grading only.

CHEM 599. THESIS RESEARCH*1-12 credits*

Credit determined in advance by consultation with adviser. Does not count toward residency requirement. S/U grading only.

SPECIAL TOPICS SEMINARS*1 credit***CHEM 691. MATERIALS SEMINAR****CHEM 692. ANALYTICAL SEMINAR****CHEM 693. ORGANIC SEMINAR****CHEM 696. BIOPHYSICAL SEMINAR**

Students attend, make presentations of, participate in discussions of current topics in chemistry. Visiting speakers included. One meeting per week. May be repeated for credit to be counted toward residency requirement, but may not be used to satisfy specific course requirements (including seminars) for MA, MS, or PhD degrees. Prerequisite: graduate standing in chemistry. S/U grading only.

CHEM 697. INDEPENDENT WORK IN CHEMISTRY FOR DOCTORAL STUDENTS*1-4 credits*

Open to doctoral students who have not yet been admitted to candidacy. May not be used to satisfy specific course requirements (including seminars) for MA, MS or PhD degrees, but may be used to fulfill residency requirements. S/U grading only.

CHEM 698. PREDISSERTATION RESEARCH*1-9 credits/semester*

Independent reading and/or research in preparation for comprehensive examinations for admission to PhD candidacy, and/or preparation of dissertation prospectus. Does not count toward residency requirements. S/U grading only.

CHEM 699. DISSERTATION RESEARCH*1-12 credits/semester*

Research for and preparation of the dissertation. Does not count toward residency requirements. S/U grading only.

CHEM 700. CONTINUOUS REGISTRATION*1 credit/semester*

Required for maintenance of matriculated status in graduate program. No credit toward graduate degree requirements.

CHEM 707. RESEARCH SKILLS*1-4 credits*

Development of research skills required within graduate programs. May not be applied toward course credits for any graduate degree. Prerequisite: approval of relevant graduate program directors or department chairs.