

Chemistry and Biochemistry

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Graduate Admission Requirements:

A minimum undergraduate grade point average of 3.0/4.0 in chemistry and cognate science and GRE score (verbal and quantitative) of 1000 on M.S. and 1120 on Ph.D. 1120 or greater are required. Students are also encouraged to take the GRE chemistry subject exam. International graduate student applicants whose native language is not English are required to submit a score for the Test of English as a Foreign Language (TOEFL) or for the International English Language Testing System (IELTS). A total score of 80 on the iBT TOEFL or 6.3 overall on the IELTS is required.

Students whose undergraduate degree is not equivalent to the American Chemical Society certified Bachelor of Science degree in chemistry shall make up any deficiencies prior to taking graduate courses in the areas where such deficiencies exist. For example, students who have not completed quantum mechanics or instrumental analysis must complete Graduate Physical Chemistry (CHM 5425) and Graduate Analytical Methods (CHM 5150). Students are required to make up deficiencies before they can be admitted into the Ph.D. program.

Every student entering the graduate program in chemistry will be required to take two entrance/proficiency examinations covering standard undergraduate-level material in organic chemistry and physical chemistry (thermodynamics and kinetics). The proficiency exams will be administered to incoming graduate students in the week preceding the fall and spring semesters. If a student does not receive a grade of "pass" on the organic chemistry proficiency exam, the student must show proficiency by completing Graduate Organic Chemistry (CHM 5225) with a grade of "B" (3.0/4.0) or higher. If a

student does not receive a grade of "pass" on the physical chemistry proficiency exam, the student must show proficiency by completing Graduate Physical Chemistry (CHM 5425) with a grade of "B" (3.0/4.0) or higher. Students must show proficiency in these two areas by the end of their first semester, or they will be dismissed from the program.

Full-time graduate students generally serve as a Teaching Assistant (TA) in the Department of Chemistry for their first semester. Ph.D. candidates must serve for not less than one year as a teaching assistant. This requirement will be waived only when, in the opinion of the department, unusual circumstances justify such action. TA's are awarded on a competitive basis, require a minimum cumulative GPA of 3.0, and are continued for up to two years for M.S. students and four years for Ph.D. students who maintain acceptable academic performance. Graduate students must maintain a 3.0/4.0 GPA (only courses required by the graduate program will be counted in the GPA). If the GPA drops below a 3.0 for one semester, the student will be placed on academic probation. A student who fails to raise his/her GPA to 3.0 or higher in two semesters will be dismissed from the program.

A limited number of Graduate Research Assistantships (RA's) are available after the student's first semester and are awarded on a competitive basis by the individual faculty members who have externally funded research projects.

Formal admission to the M.S. and Ph.D. programs and awards of teaching assistantships are granted by the Graduate Program Director based on a ranking of graduate applicants by the Graduate Committee.

Master of Science in Chemistry

The requirements for completion of the Master of Science degree are:

1. A minimum of 32 credits of course work, a grade of 'C' or higher must be obtained in all courses with a cumulative grade point average of 3.0 or higher which must include:
 - a) At least 9 credits of chemistry in at least three of the five major areas of chemistry (Analytical, Biochemistry, Inorganic, Organic, and Physical) as listed below:

Analytical

CHM 5156 Advanced Chromatography
CHM 6157 Advanced Analytical Chemistry

Biochemistry

CHM 5506 Physical Biochemistry

Inorganic

CHM 5440 Kinetics and Catalysis
CHM 5540 Group Theory in Chemistry
CHM 5650 Physical Inorganic Chemistry

Organic

CHM 5250 Organic Synthesis
CHM 5236 Spectroscopic Techniques and
Structure Elucidation
CHM 5260 Physical Organic Chemistry

Physical

CHM 5490 Physical Spectroscopy
CHM 5540 Group Theory in Chemistry
CHM 6430 Advanced Thermodynamics
CHM 6461 Statistical Thermodynamics
CHM 6480 Quantum Mechanics

CHM 5423 Atmospheric Chemistry
Courses not listed above may be counted as courses in one of the five areas with prior departmental approval.

- b) At least 9 credits of additional graduate-level chemistry courses (excluding research and seminar) approved by the thesis committee in consultation with the Graduate Program Director with the following guidelines:
 - (1) The courses must be 5000 or 6000 level chemistry courses (CHM prefixes) or approved cognates (up to a maximum of six credits) **and**
 - (2) The following courses cannot count towards the 18 credits: Graduate Analytical Methods (CHM 5150); Graduate Organic Chemistry (CHM 5225) and Graduate Physical Chemistry (CHM 5425).
 - c) Full time graduate students are required to register for one credit of CHM 6940 (Supervised Teaching) each semester they serve as teaching assistants.
 - d) Full time graduate students are required to register for one credit of CHM 6935 (Graduate Seminar) or one credit of CHM 6936 (Chemistry Colloquium) each fall and spring semester.
 - e) At least one credit of CHM 6936 (Chemistry Colloquium) is required. Each student must give a seminar at the colloquium for a letter grade in their second semester of graduate study.
 - f) At least nine credits of CHM 6970 (Thesis Research) involving independent thesis research under the direction of a faculty member in the department.
 - g) At least two credits of CHM 6971 (Thesis) taken in the semester in which the MS thesis is to be defended.
2. Submission and public presentation of a satisfactory research thesis as determined by the student's thesis committee.

The thesis committee will consist of the research advisor, a randomly-chosen committee member chosen by the graduate program director, and at least one additional committee member who has some expertise in the graduate student's research area.

Doctor of Philosophy in Chemistry

The requirements for completion of the Doctor of Philosophy degree in chemistry are:

1. A minimum of ninety (90) credits of course work. A grade of "C" or higher must be obtained in all courses with a cumulative GPA of 3.0 or higher. The courses must include:

- a) At least nine credits of chemistry courses in at least two of the five major areas of chemistry (Analytical, Biochemistry, Inorganic, Organic, and Physical) as listed below:

Analytical

CHM 5156 Advanced Chromatography
CHM 6157 Advanced Analytical Chemistry

Biochemistry

CHM 5506 Physical Biochemistry

Inorganic

CHM 5440 Kinetics and Catalysis
CHM 5650 Physical Inorganic Chemistry

Organic

CHM 5250 Organic Synthesis
CHM 5236 Spectroscopic Techniques & Structure

Elucidation

CHM 5260 Physical Organic Chemistry

Physical

CHM 5490 Physical Spectroscopy
CHM 6430 Advanced Thermodynamics
CHM 6461 Statistical Thermodynamics
CHM 6480 Quantum Mechanics
CHM 5423 Atmospheric Chemistry

Courses not listed above may be counted in one of the five areas with prior departmental approval.

- b) At least nine credits of additional graduate-level chemistry courses (excluding research and seminar) approved by the thesis committee in consultation with the Graduate Program Director with the following guidelines:

(1) The courses must be 5000 or 6000 level chemistry courses (CHM prefixes) or approved cognates (up to a maximum of six credits) **and**

(2) The following courses cannot count towards the eighteen credits (a) and (b): Graduate Analytical Methods (CHM 5150); Graduate Organic Chemistry (CHM 5225), and Graduate Physical Chemistry (CHM 5425).

c) Full time graduate students are required to register for one credit of CHM 6940 (Supervised Teaching) each semester they serve as teaching assistants.

d) Full time graduate students are required to register for one credit of CHM 6935 (Graduate Seminar) or one credit of CHM 6936 (Chemistry Colloquium) each fall and spring semester.

e) At least two credits of CHM 6936 (Chemistry Colloquium) is required. Each student must give a seminar at the colloquium for a letter grade in his/her second and fifth semester of graduate study.

f) At least eight credits of CHM 7910 (Dissertation Research) involving independent thesis research under the direction of a faculty member in the department.

g) CHM 7980 (Ph.D. Dissertation) is taken in the semester in which the Ph.D. dissertation is to be defended. Prerequisite: Admission to candidacy.

2. Satisfactory completion of a series of 3-hour cumulative examinations. The student will begin taking the cumulative examinations after completing the proficiency requirements but no later than the beginning of the student's second semester. Six examinations will be given per year. The student must pass 4 out of 10 consecutively-offered exams for admission to candidacy.

3. Submission, presentation, and satisfactory defense of an original research proposal and completion of a 'PreOral' examination before the end of the fourth semester (excluding summers). The examination will be conducted by the dissertation committee and is based on the student's doctoral research and includes questions from the student's major field as well as minor and cognate fields.

4. Submission and public presentation and defense of a satisfactory research dissertation as determined by the dissertation committee.

The requirements for an incoming student having either a Master's Degree or a Bachelor of Science degree are the same. Students having a M.S. in chemistry may transfer as many as 36 credits towards their Ph.D. degree, however only 6 of those credits will count to fulfill requirement (1) (formal course work requirement). Students may transfer more than 6 course work credits with special permission of the graduate committee. The number of additional course work credits required by the

graduate committee will depend on, among other things, the student's performance in course work, the date course work was completed, and the area of Ph.D. concentration chosen by the student. The graduate student's Ph.D. thesis committee will consist of the research advisor, a member from outside the department, a randomly-chosen committee member chosen by the graduate program director from the departmental research faculty, and at least two additional committee members who have some expertise in the graduate students research area. At least two members of the student's Ph.D. dissertation committee must be tenured in the Department of Chemistry. FIU courtesy professors may serve as research supervisors and co-major professors on a student's dissertation committee. It is expected that a meaningful collaboration will be established between courtesy faculty serving as co-major professors and the major professor from within the department. The degree of collaboration and expectations including co-authorship on publications resulting from such collaborations must be agreed upon in the semester in which a graduate student chooses an advisor(s).

Financial Support

Full-time graduate students who are in good academic standing are eligible for financial support. Teaching and research assistantships are available on a competitive basis. Students may also apply for a waiver of both in-state and out-of-state tuition. Inquiries concerning application to the program and availability of financial support should be directed to the Chemistry Graduate Director.

Doctor of Philosophy in Chemistry with a Forensic Science Track

To be admitted into the Ph.D. program in Chemistry with a Forensic track, a candidate must:

1. Hold a Bachelor's degree in chemistry, forensic science or a relevant discipline from an accredited college or university approved by the Chemistry graduate committee. The minimum requirement is a bachelors degree in a natural science with a least 7 semester courses (28 hours including labs) of chemistry courses including physical chemistry, analytical chemistry and biochemistry. Any deficiencies must be completed before being fully accepted to the Ph.D. program;
2. Have a 3.0/4.0 average or higher during the last two years of the undergraduate program or a Master's degree in a relevant discipline;
3. Have a combined score (verbal and quantitative) of 1120 or higher on the Graduate Record Exam;
4. Arrange to have three letters of recommendation sent to the Forensic Science Graduate Program Director evaluating the applicant's potential for graduate work;
5. Pass at least two proficiency exams in either analytical or biochemistry and either organic or physical chemistry – students who have not taken physical chemistry must take one semester of physical chemistry to make up the deficiency;
6. Recieve approval from the Forensic Science Graduate Committee*;
7. International graduate student applicants whose native language is not English are required to submit a score for the Test of English as a Foreign Language

(TOEFL) or for the International English Language Testing System (IELTS). A total score of 80 on the iBT TOEFL or 6.3 overall on the IELTS is required.

All admissions to the Chemistry Ph.D. program must be approved by the chemistry graduate committee and signed off by the chemistry graduate program director.

Degree Requirements

The Ph.D. in Chemistry with a Forensic Science track consists of a minimum of 90 credits, including a dissertation based upon the student's original research. A maximum of 36 credits may be transferred from another completed graduate program with approval of the Chemistry graduate committee; however, only six credits can be used to substitute for the courses identified as required by the two concentrations. Students must choose either the Analytical or the Biochemistry concentration and follow the following curricula:

Analytical Chemistry/Trace Concentration

BSC 5406	Forensic Biology	3
CHS 5542	Forensic Chemistry	3
CHS 5539	Forensic Toxicology	3
CHS 5545	Chem Anl. Explosives	3
	or	
CHS 5538	Chem Anl of Drugs	3
	At least 2 core CHM courses ¹	6
	Elective ²	3
CHS 7981	Forensic Dissertation Proposal	1
CHS 7982	Forensic Dissertation Defense	1
CHS 7910	Forensic Dissertation Research	(min) 8
CHS 7980	Forensic Dissertation	(min) 24
CHS 6935	Forensic Colloquium	(min) 2

Biochemistry/DNA Analysis Concentration

BSC 5406	Forensic Biology	3
CHS 5542	Forensic Chemistry	3
CHS 5536	Forensic DNA Chemistry	3
PCB 5685	Population Genetics	3
	At least 2 core CHM courses ¹	6
	Elective ²	3
CHS 7981	Forensic Dissertation Proposal	1
CHS 7982	Forensic Dissertation Defense	1
CHS 7910	Forensic Dissertation Research	(min) 8
CHS 7980	Forensic Dissertation	(min) 24
CHS 6935	Forensic Colloquium	(min) 2

¹At least 2 core graduate-level courses (excluding research and seminar) chosen from the following list or approved by the Chemistry Graduate Program Director. Approved courses: CHM 5156 Advanced Chromatography; CHM 5138 Advanced Mass Spectrometry; CHM 5236 Spectroscopic Techniques; CHM 5302 Organic Chem of Nucleic Acids; CHM 5506 Physical Biochemistry; CHM 6157 Advanced Analytical Chemistry; CHM 5165 Chemometrics & Sampling; CHM 6982 Adv Biological Chemistry.

²Or courses selected from the list of electives courses approved by the forensic and chemistry graduate committees and maintained by the Chemistry Graduate Program Director.

*The Forensic Science graduate committee consists of the Forensic Science Graduate Program Director, The Chemistry Graduate Program Director, the Director of IFRI, the Chair of the Department of Biological Sciences (or delegate) and the Chair of the Department of Chemistry and Biochemistry (or a delegate).

Advancement to Candidacy

To advance to candidacy, applicants must complete all required coursework, present and defend an original research proposal on a forensic related topic and pass a comprehensive exam composed by their dissertation committee members. The forensic related topic and comprehensive exam must be approved by the dissertation advisor in consultation with the Forensic Graduate Committee.

Graduation Requirements

The candidates must submit and make a public presentation and defense of a satisfactory research dissertation by the dissertation committee.

Course Descriptions**Definition of Prefixes**

CHM-Chemistry; CHS-Chemistry-Specialized; ISC-Interdisciplinary Natural Sciences; OCC-Oceanography-Chemical.

F-Fall semester offering; S-Spring semester offering; SS-Summer semester offering.

CHM 5138 Advanced Mass Spectrometry (3). Intensive examination of the processes and techniques involved in creating, controlling and measuring ionic species by mass spectrometry. Theory of mass spectrometry, methods of ionization, instrumental designs, quantitative mass spectrometry, meta-stable ions, and tandem mass spectrometry. Prerequisites: CHM 4130, CHM 4130L or Permission of Instructor.

CHM 5139C Mass Spectrometry Workshop (2). Basic description of processes and techniques involved in creating, controlling and measuring elemental or molecular ionic species by mass spectrometry techniques. WS designed to provide hands on experience. Prerequisite: CHM 4130.

CHM 5150 Graduate Analytical Methods (3). Analysis of analytical data, electrochemistry, spectro-analytical techniques, chromatography, survey of new analytical methods. Prerequisites: Graduate standing or permission of the instructor. (S)

CHM 5156 Advanced Chromatography (3). Intensive examination of the contemporary practice of chromatography including available chromatographic techniques, their selection and application. Prerequisites: CHM 4130 or permission of the instructor.

CHM 5165 Chemometrics and Sampling (3). Methods of evaluating analytical chemistry data. Planning sampling design for water, air and solids. Sample preparation and extraction techniques. Prerequisite: CHM 4130.

CHM 5181 Special Topics in Analytical Chemistry (VAR). An intensive examination of one or more areas selected by instructor and students. Core course Prerequisites: CHM 4130 or permission of the instructor.

CHM 5225 Graduate Organic Chemistry (3). Advanced topics in organic chemistry. Structure of organic molecules, reaction mechanisms, organic synthesis, and natural product chemistry. Prerequisites: Graduate standing or permission of the instructor. (F)

CHM 5236 Spectroscopic Techniques and Structures Elucidation (3). Advanced techniques for the

spectroscopic identification of organic compounds. Interpretation of spectral information for determination of structures of various classes of organic compounds. Prerequisites: CHM 4220 and CHM 4230L.

CHM 5250 Organic Synthesis (3). Use of classical and modern reactions in the design and construction of complex organic molecules including natural products. Some topics covered will be construction reactions, refunctionalization, stereochemistry and conformational analysis. Prerequisites: CHM 4220 or permission of the instructor.

CHM 5251 Organometallic Chemistry (3). Fundamentals and applications of organometallic chemistry. Structures and bonding, ligand types, organometallic reactions, physical methods of characterization. Prerequisites: CHM 4610, CHM 3411.

CHM 5252 Asymmetric Synthesis (3). Recent advances in asymmetric synthesis for the selective design and construction of tetrahedral stereocenters. Focus on principles of configuration in transition state assemblies. Prerequisite: CHM 4220.

CHM 5260 Physical Organic Chemistry (3). A series of topics will be discussed including molecular orbital theory as it pertains to organic molecules, kinetic and thermodynamic approaches to the study of reaction mechanisms, quantitative approaches to conformational analysis, etc. Prerequisites: CHM 4220 and physical chemistry or permission of the instructor.

CHM 5280 Natural Products Chemistry and Biosynthesis (3). Studies of the chemical origins (biosynthesis), properties, and synthesis of the various classes of naturally occurring compounds: terpenes, steroids, alkaloids, acetogenins. Prerequisites: CHM 4220 or permission of the instructor.

CHM 5302 Organic Chemistry of Nucleic Acids (3). Organic chemistry of ribose sugars, nucleoside heterocyclic bases, mechanism-based inhibitors of enzymes involve in nucleic acid metabolism, and chemical synthesis of DNA. Prerequisites: CHM 4220 or permission of the instructor.

CHM 5305 Graduate Biological Chemistry (3). Structures of biological molecules; Biochemical reaction mechanisms; Enzyme kinetics; Biomolecular thermodynamics; Biomolecular spectroscopy. Prerequisites: Graduate standing or permission of instructor.

CHM 5306 Special Topics in Biological Chemistry (3). Investigation of one or more areas of biologically related chemistry. Prerequisites: CHM 4305 or permission of the instructor.

CHM 5325 Physical Chemistry of Proteins (3). Protein structures, dynamics and functions. Use of spectroscopic methods. Thermodynamics of protein folding and ligand binding. Enzyme Kinetics. Prerequisites: Biological Chemistry and Physical Chemistry or permission of instructor.

CHM 5351 Computer Modeling of Biological Molecules (3). Introduces use of computers in studying biological macromolecules. Simulations, visualization methods, software, databases. Prerequisite: CHM 3411, Biochemistry recommended.

CHM 5380 Special Topics in Organic Chemistry (VAR).

An intensive examination of one or more areas selected by instructor and students. Prerequisites: CHM 4220 and physical chemistry or permission of the instructor.

CHM 5423 Atmospheric Chemistry (3). Chemical processes in atmospheres. Photochemistry, chemical kinetics, tropospheric and stratospheric chemical reactions, anthropogenic effects on the earth's atmosphere and chemistry of planetary atmospheres. Prerequisites: CHM 3411, or permission of the instructor.

CHM 5425 Graduate Physical Chemistry (4). Prequantum physics, the Schrodinger equation and its solutions, atoms and molecules, rotational, vibrational, and electronic spectroscopy. Prerequisites: Graduate standing or permission of the instructor.

CHM 5426 Graduate Physical Chemistry II (4). Gas laws; thermodynamics and equilibrium, electrochemistry, and chemical kinetics. Prerequisite: Graduate standing or permission of the instructor.

CHM 5440 Kinetics and Catalysis (3). Theory of elementary reactions, activated complex theory, mechanisms of complex reactions. Prerequisites: CHM 3411, MAP 3302.

CHM 5490 Physical Spectroscopy (3). Introduction to atomic and molecular quantum states, selection rules, and fundamental principles of spectroscopy. Introduction to group theory and to the theory of UV/visible, infrared, Raman, microwave, nmr, photo-electron, and mass spectroscopies, and the applications of these methods to the determination of fundamental physical properties and the structure of organic and inorganic molecules. Prerequisite: Physical Chemistry.

CHM 5490L Physical Spectroscopy Lab (1). The theory of spectroscopy and the use of modern instrumentation to investigate molecular structure. Prerequisites: CHM 2211, 2211L. Corequisites: PHY 4604 or CHM 5490.

CHM 5503 Physical Chemistry of Nucleic Acids (3). Physical chemistry of nucleic acids including spectroscopic determination of structures of DNAs, RNAs, and DNA-protein complexes and thermodynamic and kinetic studies of nucleic acid-ligand complexes and nucleic acid structures. Prerequisites: CHM 4305 or permission of the instructor.

CHM 5506 Physical Biochemistry (3). Physical properties of biomolecules, molecular conformation; thermodynamic, kinetic, and spectroscopic properties of biomolecules. Prerequisites: CHM 4305 or permission of the instructor.

CHM 5517 Solid State (3). Crystalline form of solids, lattice dynamics, metals, insulators, semiconductors, and dielectric materials. Prerequisites: CHM 5490 or PHY 4604.

CHM 5540 Group Theory In Chemistry (3). The fundamental Theory is developed with emphasis given to Representations. Specific applications covered, with emphasis on molecular orbital theory and spectroscopy. Prerequisite: CHM 3411.

CHM 5581 Special Topics in Physical Chemistry (VAR). An intensive examination of one or more areas

selected by instructor and students. Prerequisites: CHM 3411 or permission of the instructor.

CHM 5586 Computational Chemistry (3). Surveys computational methods for studying issues pertinent to organic and biological chemistry. Emphasis on developing an understanding of principles and putting methods to use. Includes methods for studying reaction thermodynamics, reaction mechanisms and NMR spectral properties. Prerequisites: CHM 3410, CHM 3411.

CHM 5650 Physical Inorganic Chemistry (3). Introduction to use of physical methods to determine the structure of inorganic compounds. Prerequisites: CHM 4610 or permission of the instructor.

CHM 5681 Special Topics in Inorganic Chemistry (VAR). An intensive examination of one or more areas selected by instructor and students. Prerequisites: CHM 4610 or permission of the instructor.

CHM 5765 Aquatic Chemistry (3). Redox chemistry, chemistry of sediments, organic biogeochemistry, chemodynamics, and fates of organic pollutants in aqueous environments. Prerequisites: CHM 2211, CHM 4130, or permission of the instructor.

CHM 5931 Special Topics (3). A course covering selected special topics in chemistry.

CHM 5932 Special Topics (3). A course covering selected special topics in chemistry.

CHM 5936 Special Topics in Environmental Chemistry (3). An intensive examination of one or more areas selected by the instructor and students. Prerequisite: Permission of the instructor.

CHM 6157 Advanced Analytical Chemistry (3). Modern analytical methods, applications, and instrumentation. Topics include spectroscopy, chromatography, electrochemistry, optimization theory, and computerized instrumentation. Prerequisites: CHM 4130 or permission of the instructor.

CHM 6166 Hyphenated Analytical Techniques (3). Covers hyphenated analytical techniques required for the analysis of trace elements and organic compounds in environmental and biomedical sciences. Prerequisites: CHM 4130 or equivalent.

CHM 6281 Environmental Organic Chemistry (3). Characteristics, origin, fate and transformation of organic compounds in air, water, sediments and biota. Prerequisites: CHM 2211, CHM 3411, or permission of the instructor.

CHM 6340 Organic Geochemistry (3). Organic geochemistry of recent and ancient environments. Characteristics, origin, and transformation of organic matter in the geosphere, including formation of crude oil. Prerequisites: CHM 2211, CHM 3411, CHM 4130, GLY 1010, or permission of the instructor.

CHM 6382 Advanced Biological Chemistry (3). In depth exploration of one or more biological chemistry areas, for example, use of multinuclear NMR in examining nuclear acids and proteins; biosynthesis of toxins, roles of porphyrins. Topics covered vary with instructor. Prerequisites: Biological Chemistry and Physical Chemistry or permission of instructor.

CHM 6430 Advanced Thermodynamics (3). The laws of classical thermodynamics and their application. Open and closed systems, irreversible processes, high and low temperature systems, solids, liquids, and gases. Core course. Prerequisites: CHM 3411 or permission of the instructor.

CHM 6449 Photochemistry (3). Fundamentals of photochemistry. Excited states, energy, and electron transfer processes, photo-oxidation, reactive species, and environmental photochemistry. Prerequisites: CHM 4220 or permission of the instructor.

CHM 6461 Statistical Thermodynamics (3). Principles of statistical thermodynamics. Ensembles, classical and quantum statistics, ideal and nonideal gases, equilibrium, crystals, liquids, and polymers. Prerequisites: CHM 3411 or permission of the instructor.

CHM 6480 Quantum Mechanics (3). Introduction to quantum mechanics. The Schrodinger equation and its solutions, approximation methods, spin, symmetry, structure of atoms and molecules. Prerequisites: CHM 3411 or permission of the instructor.

CHM 6511 Polymer Chemistry (3). A quantitative study of polymers. Mechanism of formation, configuration of polymer chains, and the relationship between physical properties and chemical constitution. Prerequisite: CHM 3411 or permission of the instructor.

CHM 6621 Inorganic Reaction Mechanisms (3). Review of kinetics and determination of mechanism. Study of mechanism of reactions of coordination complexes including, electron transfer reactions, ligand substitution reactions, coordinated ligand reactions of importance in homogeneous catalysis. Prerequisite: Physical Chemistry I (Kinetics).

CHM 6624 Coordination Chemistry (3). Electronic structure of metals and transition metal complexes; redox reactions; introduction to organometallic and Bioinorganic Chemistry. Symmetry and group theory applied to Transition Metal Complexes. Physical methods in Inorganic Chemistry. Prerequisites: CHM 3410 Physical Chemistry (Kinetics), CHM 3411 Physical Chemistry II (Quantum Mechanics).

CHM 6905 Independent Study in Chemistry (1-6). Independent study and problems in an area of chemistry, under faculty supervision. May be repeated. Prerequisite: Permission of the instructor.

CHM 6910L Graduate Research in Chemistry (VAR). The student works directly with a professor on a research project. Credit is assigned on the basis of four hr/wk per credit hour. Results to be presented as a seminar. Permission of the instructor.

CHM 6935 Graduate Seminar (1). An examination of various current research topics in chemistry. Prerequisite: Graduate standing.

CHM 6936 Chemistry Colloquium (1). Analysis of current developments and topics presented by faculty members and registered students. Prerequisite: Admission to graduate program in chemistry.

CHM 6940 Supervised Teaching (1-3). Graduate student serves as lecturer and demonstrator in undergraduate

laboratories coordinated and supervised by a faculty member. May be repeated. A maximum of three hours may apply to the Master's degree. Prerequisite: Full graduate standing.

CHM 6949 Industrial Internship (3). A semester of supervised work in an outside laboratory. Prerequisite: Permission of the instructor.

CHM 6970 Thesis Research (1-10). Research toward completion of Master's Thesis. Repeatable. Prerequisite: Permission of the department.

CHM 6971 Master's Thesis (1-6). Completion of thesis. Prerequisite: Permission of major professor.

CHM 7910 Dissertation Research (1-10). Research towards the completion of a doctoral dissertation. Repeatable. Prerequisite: Graduate Standing.

CHM 7980 Ph.D. Dissertation (1-12) Completion of doctoral dissertation. Prerequisite: Permission of Major Professor and Doctoral Candidacy. May be repeated.

CHS 5502 Forensic Chemistry for Teachers (3). Incorporates concepts and techniques from the application of analytical chemistry, molecular biology, biochemistry, toxicology, and microscopy to forensic casework. Exposure to teaching resources in these areas and case study format of presentation. Open to education majors only. Prerequisites: CHM 3120, CHM 3120L, CHM 2211, and CHM 2211L or permission of instructor.

CHS 5531 Forensic Analysis (3). Advanced topics on the role that physical evidence plays in their criminal justice system. Topics include crime scene methods, laboratory management and the legal framework as it relates towards physical evidence. Prerequisites: CHM 3120, CHM 3120L, CHM 2211, CHM 2211L, or permission of the instructor. (Does not count towards chemistry elective requirement).

CHS 5531L Forensic Analysis Lab (1). Laboratory to accompany Forensic Analysis CHS 5531. Prerequisites: CHM 3120, CHM 3120L, CHM 2211, CHM 2211L or permission of the instructor.

CHS 5536 Forensic DNA Chemistry (3). Chemical basis for current methodologies of DNA analysis. DNA sequencing, PCR, STR, AFLP, mass spectrometry. Prerequisites: CHM 4304 or permission of instructor.

CHS 5538C Chemistry and Analysis of Drugs (3). Introduction to the chemistry of drugs of abuse, including reactivity, synthesis and the principles of analysis from solid doses and from body fluids. Laboratory analysis through the determination of unknown samples. Prerequisites: CHM 4130, CHM 4130L, CHM 4304, CHM 4304L.

CHS 5539 Forensic Toxicology (3). Provides the basic concepts of forensic toxicology as it applies to drug and body fluid analysis. Prerequisites: CHM 2211+L, CHM 3120+L, CHM 4305+L (BCH 3033+L) or permission of instructor.

CHS 5542 Forensic Chemistry (3). Advanced Analytical methods in Forensic Chemistry for application to the analysis of controlled substances, materials (ie., paint, glass, and fibers), flammable and explosives residues with an emphasis on new methods and method development.

CHS 5545 Chemistry and Analysis of Explosives (3).

Chemistry and reactivity, including thermochemistry, of modern industrial and military explosives with an emphasis on the analysis of explosives residues from post-blast debris and from samples of environmental interest. Prerequisites: CHM 4130, CHM 4130L.

CHS 5XXXC Forensic Glass Examination (2).

Forensic glass examinations and comparison including lectures and hands-on laboratory exercises in a workshop format. Prerequisites: CHM 4130 and CHM 4130L.

CHS 5XXXC Forensic Paint Examinations (2).

Forensic paint examinations and comparison including lectures and hands-on laboratory exercises in a workshop format. Prerequisites: CHM 4130 and CHM 4130L.

CHS 5XXXC Forensic Textile Fiber Examinations (2).

Forensic textile fiber examinations and comparison including lectures and hands-on laboratory exercises in a workshop format. Prerequisites: CHM 4130 and CHM 4130L.

CHS 6905 Independent Study in Forensic Science (1-

6). Independent study and problems in an area of forensic science under faculty supervision. Prerequisite: Permission of instructor.

CHS 6946 Graduate Forensic Internship (1-6).

Internship in an operational forensic laboratory, contributing in a specific manner on an assigned research project. Six hours a week minimum residence time per credit in the lab under the supervision of a host lab scientist and a faculty member is required. A final written report and presentation required. Prerequisite: Core courses in Forensic M.S. Program.