**Chemistry**

**Department of Physical Sciences**

**Department Chair:** Peter S. Meyer

**Chemistry Program Faculty: Professors** Almeida, Cooley, Lamontagne, Knowlton, E. Magyar, J. Magyar, Williams Jr.; **Associate Professors** Leung; **Assistant Professor** Towle-Weicksel

Students **must** consult with their assigned advisor before they will be able to register for courses. This program also has specific retention requirements, which may be obtained from the advisor.

**Chemistry B.A.**

**Course Requirements**

**Courses**

|  |  |  |  |
| --- | --- | --- | --- |
| CHEM 103 | General Chemistry I | 4 | F, Sp, Su |
|  | -Or- |  |  |
| CHEM 103H | Honors General Chemistry I | 4 | F |
|  |  |  |  |
| CHEM 104 | General Chemistry II | 4 | F, Sp, Su |
|  | -Or- |  |  |
| CHEM 104H | Honors General Chemistry II | 4 | Sp |
|  |  |  |  |
| CHEM 205 | Organic Chemistry I | 4 | F, Su |
| CHEM 206 | Organic Chemistry II | 4 | Sp, Su |
| CHEM 310 | Biochemistry | 3 | F |
| CHEM 403 | Inorganic Chemistry I | 3 | F |
|  |  |  |  |
| CHEM 404 | Analytical Chemistry | 4 | Sp (even years) |
|  | -Or- |  |  |
| CHEM 416 | Environmental Analytical Chemistry | 4 | Sp (odd years) |
|  |  |  |  |
| CHEM 405 | Physical Chemistry I | 3 | F |
| CHEM 407 | Physical Chemistry Laboratory I | 1 | F |

**CHOOSE ONE OF THE OPTIONS below**

|  |  |  |  |
| --- | --- | --- | --- |
| CHEM 406 | Physical Chemistry II | 3 | Sp |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 412 | Inorganic Chemistry II | 2 | Sp |
|  | -And- |  |  |
| CHEM 413 | Inorganic Chemistry Laboratory | 1 | Sp |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 414 | Instrumental Methods of Analysis | 4 | Sp (odd years) |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 418 | Marine Environmental Chemistry | 4 | Sp (even years) |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 420 | Biochemistry of Proteins and Nucleic Acids | 3 | F, Sp (odd years) |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 425 | Advanced Organic Chemistry | 4 | F (odd years) |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 435 | Pharmacology and Toxicology | 3 | As needed |

Note: MATH 314 Calculus III is a prerequisite for CHEM 406.

**Cognates**

|  |  |  |  |
| --- | --- | --- | --- |
| MATH 212 | Calculus I | 4 | F, Sp, Su |
| MATH 213 | Calculus II | 4 | F, Sp, Su |
| PHYS 200 | Mechanics | 4 | F |
| PHYS 201 | Electricity and Magnetism | 4 | Sp |

Note: PHYS 200, PHYS 201: in unusual circumstances, PHYS 101 and PHYS 102 may be substituted for PHYS 200 and PHYS 201, with consent of department chair.

Note: Prior to enrolling in any Chemistry course students must have completed the college mathematics competency.

**Total Credit Hours: 49-50**

**Course Requirements — Concentration in Environmental Chemistry**

**Courses**

|  |  |  |  |
| --- | --- | --- | --- |
| CHEM 103 | General Chemistry I | 4 | F, Sp, Su |
| CHEM 104 | General Chemistry II | 4 | F, Sp, Su |
| CHEM 205 | Organic Chemistry I | 4 | F, Su |
| CHEM 206 | Organic Chemistry II | 4 | Sp, Su |
| CHEM 310 | Biochemistry | 3 | F |
| CHEM 403 | Inorganic Chemistry I | 3 | F |
| CHEM 405 | Physical Chemistry I | 3 | F |
| CHEM 407 | Physical Chemistry Laboratory I | 1 | F |
| CHEM 416 | Environmental Analytical Chemistry | 4 | Sp (odd years) |
| CHEM 418 | Marine Environmental Chemistry | 4 | Sp (even years) |

**Cognates**

|  |  |  |  |
| --- | --- | --- | --- |
| MATH 212 | Calculus I | 4 | F, Sp, Su |
| MATH 213 | Calculus II | 4 | F, Sp, Su |
| PHYS 200 | Mechanics | 4 | F |
| PHYS 201 | Electricity and Magnetism | 4 | Sp |
|  |  |  |  |
| PSCI 212 | Introduction to Geology | 4 | F, Su |
|  | -Or- |  |  |
| PSCI 217 | Introduction to Oceanography | 4 | Sp |

**Total Credit Hours: 54**

**Chemistry B.S**

**Course Requirements — Concentration in Biochemistry**

The B.S. degree program is approved by the American Chemical Society.

**Courses**

|  |  |  |  |
| --- | --- | --- | --- |
| CHEM 103 | General Chemistry I | 4 | F, Sp, Su |
|  | -Or- |  |  |
| CHEM 103H | Honors General Chemistry I | 4 | F |
|  |  |  |  |
| CHEM 104 | General Chemistry II | 4 | F, Sp, Su |
|  | -Or- |  |  |
| CHEM 104H | Honors General Chemistry II | 4 | Sp |
|  |  |  |  |
| CHEM 205 | Organic Chemistry I | 4 | F, Su |
| CHEM 206 | Organic Chemistry II | 4 | Sp, Su |
| CHEM 310 | Biochemistry | 3 | F |
| CHEM 403 | Inorganic Chemistry I | 3 | F |
|  |  |  |  |
| CHEM 404 | Analytical Chemistry | 4 | Sp (even years) |
|  | -Or- |  |  |
| CHEM 416 | Environmental Analytical Chemistry | 4 | Sp (odd years) |
|  |  |  |  |
| CHEM 405 | Physical Chemistry I | 3 | F |
| CHEM 407 | Physical Chemistry Laboratory I | 1 | F |
| CHEM 419 | Biochemistry Mechanisms | 3 | Sp |
| CHEM 422 | Biochemistry Laboratory | 3 | Sp |
| CHEM 491-493 | Research in Chemistry | 1 | As needed |

Note: CHEM 491, CHEM 492, CHEM 493: Research in Chemistry can be fulfilled through any combination of these courses. It is strongly suggested that students take research credits in multiple semesters, beginning in their junior year for a total of 3 credit hours.

**CHOOSE ONE OF THE OPTIONS below:**

|  |  |  |  |
| --- | --- | --- | --- |
| CHEM 406 | Physical Chemistry II | 3 | Sp |
|  | -And- |  |  |
| CHEM 408 | Physical Chemistry Laboratory II | 1 | Sp |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 412 | Inorganic Chemistry II | 2 | Sp |
|  | -And- |  |  |
| CHEM 413 | Inorganic Chemistry Laboratory | 1 | Sp |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 414 | Instrumental Methods of Analysis | 4 | Sp (odd years) |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 418 | Marine Environmental Chemistry | 4 | Sp (even years) |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 425 | Advanced Organic Chemistry | 4 | F (odd years) |

**Cognates**

|  |  |  |  |
| --- | --- | --- | --- |
| BIOL 111 | Introductory Biology I | 4 | F, Sp, Su |
| BIOL 112 | Introductory Biology II | 4 | F, Sp, Su |
| MATH 212 | Calculus I | 4 | F, Sp, Su |
| MATH 213 | Calculus II | 4 | F, Sp, Su |
| PHYS 200 | Mechanics | 4 | F |
| PHYS 201 | Electricity and Magnetism | 4 | Sp |

Note: PHYS 200, PHYS 201: In unusual circumstances, PHYS 101 and PHYS 102 may be substituted for PHYS 200 and PHYS 201, with consent of department chair.

Note: Prior to enrolling in any Chemistry course students must have completed the college mathematics competency.

**Total Credit Hours: 66-67**

**Course Requirements — Concentration in Environmental Chemistry**

The B.S. degree program is approved by the American Chemical Society.

**Courses**

|  |  |  |  |
| --- | --- | --- | --- |
| CHEM 103 | General Chemistry I | 4 | F, Sp, Su |
|  | -Or- |  |  |
| CHEM 103H | Honors General Chemistry I | 4 | F |
|  |  |  |  |
| CHEM 104 | General Chemistry II | 4 | F, Sp, Su |
|  | -Or- |  |  |
| CHEM 104H | Honors General Chemistry II | 4 | Sp |
|  |  |  |  |
| CHEM 205 | Organic Chemistry I | 4 | F, Su |
| CHEM 206 | Organic Chemistry II | 4 | Sp, Su |
| CHEM 310 | Biochemistry | 3 | F |
| CHEM 403 | Inorganic Chemistry I | 3 | F |
| CHEM 405 | Physical Chemistry I | 3 | F |
| CHEM 407 | Physical Chemistry Laboratory I | 1 | F |
| CHEM 414 | Instrumental Methods of Analysis | 4 | Sp (odd years) |
| CHEM 416 | Environmental Analytical Chemistry | 4 | Sp (odd years) |
| CHEM 418 | Marine Environmental Chemistry | 4 | Sp (even years) |
| CHEM 491-493 | Research in Chemistry | 1 | As needed |

Note: CHEM 491, CHEM 492, CHEM 493: Research in Chemistry can be fulfilled through any combination of these courses. It is strongly suggested that students take research credits in multiple semesters, beginning in their junior year, for a total of 3 credit hours.

**CHOOSE one of the options below:**

|  |  |  |  |
| --- | --- | --- | --- |
| CHEM 406 | Physical Chemistry II | 3 | Sp |
|  | -And- |  |  |
| CHEM 408 | Physical Chemistry Laboratory II | 1 | Sp |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 412 | Inorganic Chemistry II | 2 | Sp |
|  | -And- |  |  |
| CHEM 413 | Inorganic Chemistry Laboratory | 1 | Sp |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 420 | Biochemistry of Proteins and Nucleic Acids | 3 | F, Sp (odd years) |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 425 | Advanced Organic Chemistry | 4 | F (odd years) |

**Cognates**

|  |  |  |  |
| --- | --- | --- | --- |
| BIOL 111 | Introductory Biology I | 4 | F, Sp, Su |
| MATH 212 | Calculus I | 4 | F, Sp, Su |
| MATH 213 | Calculus II | 4 | F, Sp, Su |
| PHYS 200 | Mechanics | 4 | F |
| PHYS 201 | Electricity and Magnetism | 4 | Sp |
| PSCI 212 | Introduction to Geology | 4 | F, Su |

Note: PHYS 200, PHYS 201: In unusual circumstances, PHYS 101 and PHYS 102 may be substituted for PHYS 200 and PHYS 201, with consent of department chair.

Note: Prior to enrolling in any Chemistry course students must have completed the college mathematics competency.

**Total Credit Hours: 68-69**

**Course Requirements ­— Concentration in Professional Chemistry**

The B.S. degree program is approved by the American Chemical Society.

**Courses**

|  |  |  |  |
| --- | --- | --- | --- |
| CHEM 103 | General Chemistry I | 4 | F, Sp, Su |
|  | -Or- |  |  |
| CHEM 103H | Honors General Chemistry I | 4 | F |
|  |  |  |  |
| CHEM 104 | General Chemistry II | 4 | F, Sp, Su |
|  | -Or- |  |  |
| CHEM 104H | Honors General Chemistry II | 4 | Sp |
|  |  |  |  |
| CHEM 205 | Organic Chemistry I | 4 | F, Su |
| CHEM 206 | Organic Chemistry II | 4 | Sp, Su |
| CHEM 310 | Biochemistry | 3 | F |
| CHEM 403 | Inorganic Chemistry I | 3 | F |
|  |  |  |  |
| CHEM 404 | Analytical Chemistry | 4 | Sp (even years) |
|  | -Or- |  |  |
| CHEM 416 | Environmental Analytical Chemistry | 4 | Sp (odd years) |
|  |  |  |  |
| CHEM 405 | Physical Chemistry I | 3 | F |
| CHEM 406 | Physical Chemistry II | 3 | Sp |
| CHEM 407 | Physical Chemistry Laboratory I | 1 | F |
| CHEM 408 | Physical Chemistry Laboratory II | 1 | Sp |
| CHEM 414 | Instrumental Methods of Analysis | 4 | Sp (odd years) |
| CHEM 491-493 | Research in Chemistry | 1 | As needed |

Note: CHEM 491, CHEM 492, CHEM 493: Research in Chemistry can be fulfilled through any combination of these courses. It is strongly suggested that students take research credits in multiple semesters, beginning in their junior year for a total of 3 credit hours.

**CHOOSE one of the options below:**

|  |  |  |  |
| --- | --- | --- | --- |
| CHEM 412 | Inorganic Chemistry II | 2 | Sp |
|  | -And- |  |  |
| CHEM 413 | Inorganic Chemistry Laboratory | 1 | Sp |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 418 | Marine Environmental Chemistry | 4 | Sp (even years) |
|  |  |  |  |
|  | -Or- |  |  |
| CHEM 425 | Advanced Organic Chemistry | 4 | F (odd years) |

**Cognates**

|  |  |  |  |
| --- | --- | --- | --- |
| MATH 212 | Calculus I | 4 | F, Sp, Su |
| MATH 213 | Calculus II | 4 | F, Sp, Su |
| MATH 314 | Calculus III | 4 | F, Sp |
| PHYS 200 | Mechanics | 4 | F |
| PHYS 201 | Electricity and Magnetism | 4 | Sp |

Note: PHYS 200, PHYS 201: In unusual circumstances, PHYS 101 and PHYS 102 may be substituted for PHYS 200 and PHYS 201, with consent of department chair.

Note: Prior to enrolling in any Chemistry course students must have completed the college mathematics competency.

**Total Credit Hours: 64-65**

**Chemistry Minor**

**Course Requirements**

The minor in chemistry consists of a minimum of 19 credit hours (five courses), as follows:

**Courses**

|  |  |  |  |
| --- | --- | --- | --- |
| CHEM 103 | General Chemistry I | 4 | F, Sp, Su |
| CHEM 104 | General Chemistry II | 4 | F, Sp, Su |
| CHEM 205 | Organic Chemistry I | 4 | F, Su |
| CHEM 206 | Organic Chemistry II | 4 | Sp, Su |

and one chemistry course at the 300 or 400-level (3-4 credits).

Note: Prior to enrolling in any Chemistry course students must have completed the college mathematics competency.

**Total Credit Hours: 19-20**

**CHEM - Chemistry**

**CHEM 103 - General Chemistry I (4)**

Topics include atomic theory, periodicity, bonding, reactions, stoichiometry, gas laws, and thermochemistry. Laboratory experiments illustrate these concepts and develop laboratory techniques. Lecture and laboratory.

General Education Category: Natural Science.

Prerequisite: Completed college mathematics competency.

Offered: Fall, Spring, Summer.

**CHEM 103H - Honors General Chemistry I (4)**

For students with a good background in science and mathematics. Topics are listed in and experiments are similar to CHEM 103, with increased emphasis on instrumentation and independent work. Lecture and laboratory.

General Education Category: Natural Science.

Prerequisite: Completed college mathematics competency.

Offered: Fall.

**CHEM 104 - General Chemistry II (4)**

Topics include states of matter, solutions, kinetics, acids and bases, equilibrium theory, thermodynamics, and electrochemistry. Lecture and laboratory.

General Education Category: Advanced Quantitative/Scientific Reasoning.

Prerequisite: CHEM 103 or equivalent with a minimum grade of C-.

Offered: Fall, Spring, Summer.

**CHEM 104H - Honors General Chemistry II (4)**

For students with a good background in science and mathematics. Topics are listed in and experiments are similar to CHEM 104, with increased emphasis on instrumentation and independent work. Lecture and laboratory.

General Education Category: Advanced Quantitative/Scientific Reasoning.

Prerequisite: CHEM 103H or equivalent with a minimum grade of C-.

Offered: Spring.

**CHEM 105 - General, Organic and Biological Chemistry I (4)**

General chemistry in preparation for studying organic and biochemistry is introduced, including structure, bonding, energy, reactions, rates, equilibrium, acids and bases; and from organic chemistry, alkanes and alkenes. Lecture and laboratory.

General Education Category: Natural Science.

Prerequisite: Completed college mathematics competency.

Offered: Fall, Spring, Summer.

**CHEM 106 - General, Organic, and Biological Chemistry II (4)**

Topics include alcohols, carbonyl compounds, amines, amides, carbohydrates, lipids, proteins, enzymes, bioenergetics, catabolism, biosynthesis, nucleic acids, hormones, and neurotransmitters. Lecture and laboratory.

General Education Category: Advanced Quantitative/Scientific Reasoning.

Prerequisite: CHEM 105 with a minimum grade of C-.

Offered: Fall, Spring, Summer.

**CHEM 205 - Organic Chemistry I (4)**

Topics include structure, stereochemistry, nomenclature, and chemistry of hydrocarbons and alkyl halides, spectroscopy, reaction mechanisms, and computational chemistry. Lecture and laboratory.

Prerequisite: CHEM 104 with a minimum grade of C-.

Offered: Fall, Summer.

**CHEM 206 - Organic Chemistry II (4)**

Topics include reactions of functional groups, synthesis and mechanism, spectroscopic identification, and topics in biochemistry and computational chemistry. Lecture and laboratory.

Prerequisite: CHEM 205.

Offered: Spring, Summer.

**CHEM 310 - Biochemistry (3)**

Topics include biological macromolecule structure, function and interactions, catalysis and kinetics of biochemistry, acid-base equilibrium in biological systems, and thermodynamics of binding and recognition. Lecture.

Prerequisite: CHEM 206.

Offered: Fall.

**CHEM 403 - Inorganic Chemistry I (3)**

Topics include the electronic structure of atoms, molecular symmetry, bond theories, acid-base chemistry, solids, redox, and coordination chemistry.

Prerequisite: CHEM 206

Offered: Fall.

**CHEM 404 - Analytical Chemistry (4)**

Topics include the principles and applications of volumetric, gravimetric, and selected instrumental methods of analysis, including potentiometric and spectroscopic methods. Lecture and laboratory.

Prerequisite: CHEM 104.

Offered: Spring (even years).

**CHEM 405 - Physical Chemistry I (3)**

Through rigorous quantitative approaches, properties of gases, kinetic molecular theory, thermodynamics, statistical mechanics, and chemical and phase equilibrium are presented. Differential and integral calculus are used extensively. Lecture.

Prerequisite: CHEM 104, MATH 213, and PHYS 102 or PHYS 201.

Offered: Fall.

**CHEM 406 - Physical Chemistry II (3)**

Through rigorous quantitative approaches, quantum mechanics, atomic structure, atomic spectra, chemical bonding, molecular spectra, and chemical kinetics are presented. Differential and integral calculus are used extensively. Lecture.

Prerequisite: CHEM 104, MATH 314, and PHYS 102 or PHYS 201.

Offered: Spring.

**CHEM 407 - Physical Chemistry Laboratory I (1)**

Experiments involving topics covered in CHEM 405 are performed. The experimental methods of physical chemistry are developed. Error analysis, statistical methods, and computer applications are emphasized.

Prerequisite: Prerequisite or corequisite: CHEM 405.

Offered: Fall.

**CHEM 408 - Physical Chemistry Laboratory II (1)**

This is a continuation of CHEM 407. Experiments involving chemical kinetics, molecular spectroscopy, photochemistry, computational chemistry, and other topics covered in CHEM 406 are performed.

Prerequisite: Prerequisite or corequisite: CHEM 406.

Offered: Spring.

**CHEM 412 - Inorganic Chemistry II (2)**

Topics include molecular orbital theory, symmetry, spectral and magnetic properties of coordination compounds, and selected main group and organometallic chemistry.

Prerequisite: CHEM 403.

Offered: Spring.

**CHEM 413 - Inorganic Chemistry Laboratory (1)**

Experiments illustrate main group periodicity, coordination and organometallic compounds' properties, and techniques, including the use of inert atmospheres and microwave acceleration of rates.

Prerequisite: Prior or concurrent enrollment in CHEM 406 and CHEM 412.

Offered: Spring.

**CHEM 414 - Instrumental Methods of Analysis (4)**

Emphasis is on the areas of spectroscopy, electrochemistry, chromatography, and other identification and separation techniques using instrumental methods. Lecture and laboratory.

Prerequisite: CHEM 404 or CHEM 416

Offered: Spring (odd years).

**CHEM 416 - Environmental Analytical Chemistry (4)**

Topics include the principles and applications of volumetric, gravimetric, and selected instrumental methods of analysis, including potentiometric and spectroscopic methods, with emphasis on environmental applications. Lecture and laboratory.

Prerequisite: CHEM 104

Offered: Spring (odd years)

**CHEM 418 - Marine Environmental Chemistry (4)**

Examines biogeochemical cycling of material in the environment, including major and trace element distributions in seawater, environmental chemical equilibria, nutrient distributions and role of ocean in global climate. Students cannot receive credit for both CHEM 417 and CHEM 418.

Prerequisite: CHEM 206.

Offered: Spring (even years).

**CHEM 419 - Biochemistry Mechanisms (3)**

Mechanistic approaches to metabolic processes are discussed, including but not limited to glycolysis, citric acid cycle, oxidative phosphorylation and photosynthesis. Lecture.

Prerequisite: CHEM 310 or consent of department chair.

Offered: Spring.

**CHEM 420 - Biochemistry of Proteins and Nucleic Acids (3)**

The physical and chemical properties and metabolism of proteins and nucleic acids are discussed. Students cannot receive credit for both CHEM 420 and BIOL 420. Lecture.

Prerequisite: CHEM 206 and either BIOL 320 or CHEM 310.

Offered: Fall, Spring (odd years).

**CHEM 421 - Biochemistry of Energy Metabolism (3)**

The physical and chemical properties of carbohydrates and lipids are presented. Students cannot receive credit for both CHEM 421 and BIOL 421. Lecture. (Formerly CHEM 411: Advanced Biochemistry.)

Prerequisite: CHEM 206 and either BIOL 320 or CHEM 310.

Offered: As needed.

**CHEM 422 - Biochemistry Laboratory (3)**

Topics include basic laboratory concepts, including notebook documentation, ethics, and data interpretation, as well as experiments involving DNA cloning, protein purification, spectroscopic analysis, and functional assays. Laboratory.

Prerequisite: CHEM 310 or consent of department chair.

Offered: Spring.

**CHEM 425 - Advanced Organic Chemistry (4)**

Synthesis, structure determination, and mechanism are discussed in the context of natural product and bio-organic chemistry. Spectroscopic and computational methods are emphasized. Lecture and laboratory.

Prerequisite: CHEM 206.

Offered: Fall (odd years).

**CHEM 435 - Pharmacology and Toxicology (3)**

The relationship between the chemical structure and biological activity of organic compounds is studied. Historical and current drug development and use are emphasized in relation to the biochemistry of disease.

Prerequisite: CHEM 205 and CHEM 206, or consent of department chair.

Offered: As needed.

**CHEM 467 - Honors Colloquium in Chemistry (05)**

Advanced level topics in science are examined through participation in department colloquia with outside speakers and through a series of seminars. This course may be repeated for credit with a change in content. Graded S, U.

Prerequisite: CHEM 206 or consent of department chair.

Offered: Annually.

**CHEM 490 - Independent Study in Chemistry (3)**

Students study under the guidance of a member of the chemistry faculty. The particular area of chemistry is selected on the basis of the interest of the student and instructor.

Prerequisite: Consent of department chair.

Offered: As needed.

**CHEM 491-493 - Research in Chemistry (1)**

The student conducts original research in an area selected after consultation with the instructor and prepares a report on the work. A maximum of 6 credit hours may be earned in these courses.

Prerequisite: Consent of department chair.

Offered: As needed.

**CHEM 519 - Biochemistry for Health Professionals (3)**

This course is designed to provide nurse anesthetist students with a strong foundation of biochemistry.

Prerequisite: CHEM 105 and CHEM 106 or equivalent, enrollment in the M.S.N. nurse anesthesia program or consent of the instructor.

Offered: Fall.