CHEMISTRY (BS)

Chair: Phillip M. Sheridan, PhD

Introduction
Chemistry or Biochemistry graduates enter a variety of professions, including careers in research and industry, the health professions, teaching, technical writing, business, sales, patent law and civil service. A major in chemistry or biochemistry is an excellent preparation for entrance into medical, dental and pharmacy schools. It also prepares students to enter a range of graduate programs including chemistry, biochemistry, biotechnology, bioinformatics, medicinal chemistry, chemical engineering, environmental science, bioengineering, business and law.

The Department of Chemistry and Biochemistry offers three tracks that lead to a BS degree in Chemistry and one track that leads to a BS degree in Chemistry with Business. The three tracks in Chemistry include the Chemistry track that is certified by the American Chemical Society (CHM ACS certified track), Chemistry Health Professions track, and Chemistry track designed for students who intend to pursue technical employment in industry. Chemistry with Business is designed for students who want to pursue administrative or sales careers in the chemical industry. It is also an excellent degree for students who what to pursue careers in patent law.

Advisors in the Department will help you choose the track that best fits your interests and career plans. Students in all program tracks will gain hands-on experience with a wide variety of modern, sophisticated laboratory instrumentation; this helps provide the experience necessary to be competitive in today’s job market and/or to gain entrance into highly ranked graduate programs.

All Chemistry tracks can be completed with a business minor. This option provides a very useful preparation for employment in sales, marketing, or other industrial professions, as well as preparing students for graduate studies in business or administration.

Please go to the Chemistry and Biochemistry website (https://www.canisius.edu/academics/programs/chemistry-and-biochemistry/) for a more detailed description of the program, faculty, facilities, and academic and co-curricular opportunities.

Qualifications
Students must attain the grade of C or greater in General Chemistry II (CHM 112) and C- or greater in Organic Chemistry II (CHM 228) in order to progress into the major. Several two-semester courses (CHM 111 and CHM 112, CHM 227 and CHM 228, BCH 301 and BCH 302) have a requirement for a minimum grade of C- in the first course to continue with the second course.

ACADEMIC Advisement
All students have an academic advisor. For students who have declared a major, an advisor is assigned in their respective academic department. For students who are still deciding on a major, they will be assigned a staff member from the Griff Center for Student Success for advisement including course selection prior to registration.

Meetings with academic advisors are required prior to students receiving their PIN for course registration each semester. All students should work closely with their advisor in discussing career expectations, choosing their major electives, developing their entire academic program and planning their co-curricular or supplemental academic experiences.

Special Programs Offered by the Department

Early Assurance Program with University at Buffalo Medical School or Syracuse Medical School
Qualified students may apply to the University at Buffalo Medical School or Syracuse University Medical School during their sophomore year. Those accepted will be admitted into the Medical School freshman class after their graduation from Canisius.

Early Assurance Program with University at Buffalo Dental School
Qualified students may apply to the University at Buffalo Dental School during their sophomore year. Those accepted will be admitted into the Dental School freshman class after their graduation from Canisius.

Pre-Medical and Pre-Dental
The Chemistry and Biochemistry BS degrees are excellent preparations for entering into medical and dental schools, and a third of the graduates from this Department typically enter into these programs. Students applying to medical or dental schools must take the Medical College Admission Test (MCAT) or Dental Admission Test (DAT).

Pre-Pharmacy
For pre-pharmacy students we recommend the CHM Health Professions track, since students in this track can meet all pharmacy school entrance requirements. Students applying to most pharmacy schools must take the Pharmacy College Admission Test (PCAT).

Major Experiences
Following their freshman year, and sometimes earlier, chemistry and biochemistry majors are encouraged to become involved in research or other professional projects. Stipends for qualified students are often available so that work can be done on these projects during the summer and school year in the Department. Summer work in industrial laboratories and research institutions is also available. Our close relationship with local industries and institutions aids students in job placement before and after graduation. Students may also choose to undertake industrial internships for advanced elective course credit.

Double Majors
Students who wish to expand their educational opportunities may decide to declare a double major. This decision may be based on career goals, planned graduate studies, and/or other student interests. Before a student declares a double major, it is important to meet with the appropriate academic departments for advisement. In order to declare a double major, the student must complete the appropriate double major request form and get the signature of each department chairperson and the appropriate associate dean.

Per college policy, each additional major requires a minimum of 15 credits that do not apply to the student’s first or subsequent major. Some double major combinations can be completed within the minimum 120 credit hour degree requirement, but in other cases additional course work may be required. Please note that students will receive only one degree, regardless
of the number of majors they complete. Both (all) majors appear on a student’s transcript.

**Minors in Other Disciplines**

Minors provide students the opportunity to pursue additional interests but generally do not require as many courses as a major. Minors generally range from five to eight required courses. To receive a minor, the student must complete at least 9 credit hours of coursework distinct from their other credentials (i.e., majors, other minors). The minors page (http://catalog.canisius.edu/undergraduate/minors/) provides a complete list of minors and provides links to each minor. Some majors and minors can be completed within the minimum 120 credit hour degree requirement, but in some cases additional coursework may be required. Students must complete the appropriate minor request form.

**Curriculum**

An Ignatian Foundation

All undergraduate students must complete either the Canisius Core Curriculum (http://catalog.canisius.edu/undergraduate/academics/core-curriculum/) or the All-College Honors Curriculum (http://catalog.canisius.edu/undergraduate/academics/core-curriculum/all-college-honors-program/). Many schools refer to their college-wide undergraduate requirements as “general education” requirements. We believe that the core curriculum and the honors curriculum are more than a series of required classes; they provide the basis for a Jesuit education both with content and with required knowledge and skills attributes that are central to our mission.

**Free Electives**

Students may graduate with a bachelor’s degree with more but not less than 120 credit hours. Free electives are courses in addition to the Canisius Core Curriculum or All-College Honors Curriculum and major requirements sufficient to reach the minimum number of credits required for graduation. The number of credits required to complete a bachelor’s degree may vary depending on the student’s major(s) and minor(s).

**Major Requirements**

**For ACS-certified Chemistry Track**

The ACS-certified Chemistry track is recommended for students intending advanced study (pursuing a graduate degree) in Chemistry.

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<tr>
<td>CHM 112 &amp; 112L</td>
<td>General Chemistry II and General Chemistry II Laboratory</td>
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<tr>
<td>CHM 227 &amp; 227L</td>
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<td>CHM 228 &amp; 228L</td>
<td>Organic Chemistry II and Organic Chemistry II Laboratory</td>
<td>4</td>
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<tr>
<td>CHM 230 &amp; 230L</td>
<td>Analytical Chemistry and Analytical Chemistry Laboratory</td>
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<td>CHM 244</td>
<td>Inorganic Chemistry</td>
<td>3</td>
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<td>CHM 301 &amp; 301L</td>
<td>Fundamental Physical Chemistry and Fundamental Physical Chemistry Laboratory</td>
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<td>CHM 302 &amp; 302L</td>
<td>Modern Physical Chemistry and Modern Physical Chemistry Laboratory</td>
<td>4</td>
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<tr>
<td>CHM 334 &amp; 334L</td>
<td>Spectrometric Analysis and Spectrometric Analysis Lab</td>
<td>4</td>
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<td>CHM 420 &amp; 420L</td>
<td>Materials Chemistry and Materials Chemistry Laboratory</td>
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<td>Instrumental Analytical Chemistry and Instrumental Analytical Chemistry Laboratory</td>
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<tr>
<td>CHM 381</td>
<td>Scientific Literature and Communication</td>
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<td>CHM 480</td>
<td>Communicating Concepts in Chemistry</td>
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<td>Communicating Research Literature</td>
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<td>MAT 112</td>
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<td>General Physics for Physical Science Majors II and General Physics for Physical Science Majors II Laboratory</td>
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**Total Credits** 75

1. Students may use PHY 332 or PHY 226 with lab as a Chemistry Elective.

**For Chemistry Track**

Chemistry track designed for students who intend to pursue technical employment in industry.

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<td>CHM 481</td>
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<td>Introduction to Biochemistry</td>
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<tr>
<td>BIO 111 &amp; 111L</td>
<td>Introductory Biology I and Introductory Biology Laboratory I</td>
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The Health Professions Track is recommended for students preparing for a health-related profession (e.g., Medicine, Dentistry, Physician Assistant, etc.).

### Code | Title | Credits
---|---|---
MAT 111 | Calculus I | 4
MAT 112 | Calculus II (or MAT 141) | 4
PHY 201 | College Physics I and College Physics I Laboratory | 4
PHY 202 | College Physics II and College Physics II Laboratory | 4

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| CHM 111 & 111L | General Chemistry I and General Chemistry I Laboratory | 4
| CHM 112 & 112L | General Chemistry II and General Chemistry II Laboratory | 4
| CHM 227 & 227L | Organic Chemistry I and Organic Chemistry I Laboratory | 4
| CHM 228 & 228L | Organic Chemistry II and Organic Chemistry II Laboratory | 4
| CHM 230 & 230L | Analytical Chemistry and Analytical Chemistry Laboratory | 4
| CHM 244 | Inorganic Chemistry | 3
| CHM 301 | Fundamental Physical Chemistry | 3
| CHM 381 | Scientific Literature and Communication | 1
| CHM 480 | Communicating Concepts in Chemistry | 1
| CHM 481 | Communicating Research Literature | 1
| CHM or BCH course | Inorganic Chemistry | 3
| CHM or BCH course | Analytical Chemistry | 4
| CHM or BCH course | Scientific Literature and Communication | 1
| CHM or BCH course | Communicating Concepts in Chemistry | 1
| CHM or BCH course | Communicating Research Literature | 1

For Chemistry for Health Professions Track

### Code | Title | Credits
---|---|---
CHM 111 & 111L | General Chemistry I and General Chemistry I Laboratory | 4
CHM 112 & 112L | General Chemistry II and General Chemistry II Laboratory | 4
CHM 227 & 227L | Organic Chemistry I and Organic Chemistry I Laboratory | 4
CHM 228 & 228L | Organic Chemistry II and Organic Chemistry II Laboratory | 4
CHM 301 | Fundamental Physical Chemistry | 3

Choose one of the following:

- CHM 230 & 230L Analytical Chemistry and Analytical Chemistry Laboratory
- CHM 334 Spectrometric Analysis & 334L and Spectrometric Analysis Lab
- CHM 430 Instrumental Analytical Chemistry & 430L and Instrumental Analytical Chemistry Laboratory

Choose a Chemistry or Biochemistry Elective (any 300- or 400- level CHM or BCH course) 1

### Code | Title | Credits
---|---|---
ACC 201 | Financial Accounting | 3
ECO 101 | Principles of Macroeconomics | 3
ECO 102 | Principles of Microeconomics | 3
FIN 201 | Introduction to Corporate Finance | 3
MGT 101 | Introduction to Management | 3
MKT 201 | Principles of Marketing | 3

Select one course in business, law, or science 2

### Total Credits 77

1. Students may use PHY 332 or PHY 226 with lab as a Chemistry Elective.
2. Students minoring in business may take ECO 255 in lieu of MAT 112 or MAT 141.
3. Students minoring in business may take ECO 255 in lieu of MAT 112 or MAT 141.

### For Chemistry with Business Track

Chemistry with Business is designed for students who want to pursue administrative or sales careers in the chemical industry. It is also an excellent degree for students who want to pursue careers in patent law.

### Code | Title | Credits
---|---|---
CHM 111 & 111L or MAT 141 | General Chemistry I and General Chemistry I Laboratory | 3
CHM 112 & 112L | General Chemistry II and General Chemistry II Laboratory | 3
CHM 227 & 227L | Organic Chemistry I and Organic Chemistry I Laboratory | 4
CHM 228 & 228L | Organic Chemistry II and Organic Chemistry II Laboratory | 4
CHM 301 | Fundamental Physical Chemistry | 3

1. Students minoring in business may take ECO 255 in lieu of MAT 112 or MAT 141.

### Required Science Courses

- CHM 230 & 230L Analytical Chemistry and Analytical Chemistry Laboratory
- CHM 334 Spectrometric Analysis & 334L and Spectrometric Analysis Lab
- CHM 430 Instrumental Analytical Chemistry & 430L and Instrumental Analytical Chemistry Laboratory

Choose one of the following:

### Code | Title | Credits
---|---|---
CHM 230 & 230L Analytical Chemistry and Analytical Chemistry Laboratory | 4
CHM 334 Spectrometric Analysis & 334L and Spectrometric Analysis Lab | 4
CHM 430 Instrumental Analytical Chemistry & 430L and Instrumental Analytical Chemistry Laboratory | 4

Choose a Chemistry or Biochemistry Elective (any 300- or 400- level CHM or BCH course)

### Required Business Courses

ACC 201 | Financial Accounting | 3
ECO 101 | Principles of Macroeconomics | 3
ECO 102 | Principles of Microeconomics | 3
FIN 201 | Introduction to Corporate Finance | 3
MGT 101 | Introduction to Management | 3
MKT 201 | Principles of Marketing | 3

Select one course in business, law, or science

### Total Credits 77

1. CHM 481 does not satisfy this requirement.
2. Students in this track may take ECO 255 in lieu of MAT 112 or MAT 141.
Choose two courses from the following: CSC 111, IBUS 301, PSC 320, PSC 321, ACC 202, any 200-level or higher ECO course, or any 300- or 400-level course in CHM, BCH, BIO, PHY, MGT, or MKT.

Additional Course Considerations
MAT 211 is highly recommended for students interested in pursuing a PhD degree. In addition, MAT 219 and MAT 222 are highly recommended for students interested in pursuing a PhD degree in physical, inorganic, or analytical chemistry.

Roadmap
Recommended Semester Schedule for Major Course Requirements

CHM ACS Certified Track

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<td>CHM 111  &amp; 111L</td>
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Sophomore

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Junior

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<td>MKT 201</td>
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Senior

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<td>ACC 201</td>
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CHM Track

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Sophomore

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Junior

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Senior

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CHM ACS Certified Track with Business Minor

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**CHM Track with Business Minor**

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<td>PHY 202 &amp; 202L</td>
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**CHM Health Professions Track**

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**CHM with Business Track**

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<td>CHM 228 &amp; 228L</td>
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<tr>
<td></td>
<td>PHY 201 &amp; 201L</td>
<td>PHY 202 &amp; 202L</td>
</tr>
<tr>
<td></td>
<td>ECO 101</td>
<td>MGT 101</td>
</tr>
</tbody>
</table>
Learning Goals & Objectives

Student Learning Goal 1:
Knowledge; Demonstrate an understanding of fundamental chemical concepts.
Students will:
- Objective A Demonstrate broad knowledge of chemical concepts.
- Objective B Analyze and predict the effects of chemical changes.

Student Learning Goal 2:
Professional Skills; Work effectively in a professional or laboratory setting.
Students will:
- Objective A Carry out experiments (follow directions, manipulate materials and lab apparatus, record data).
- Objective B Use modern instrumentation (prepare samples, operate systems, troubleshoot common problems, organize and label data).
- Objective C Demonstrate knowledge of chemical, instrumental and workplace safety.

Student Learning Goal 3:
Communication; Be proficient in the communication of chemical information.
Students will:
- Objective A Construct and deliver an effective oral presentation.
- Objective B Write an effective, properly formatted scientific report.
- Objective C Identify, access and use chemical literature sources.

Minor
Students majoring in various disciplines such as biology, mathematics, physics, bioinformatics, computer science, psychology and business can benefit from pursuing a minor in chemistry. The chemistry minor requires a student to complete the following sequence of courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM 112</td>
<td>General Chemistry II &amp; General Chemistry II Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CHM 227</td>
<td>Organic Chemistry I &amp; Organic Chemistry I Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CHM 228</td>
<td>Organic Chemistry II &amp; Organic Chemistry II Laboratory</td>
<td>4</td>
</tr>
</tbody>
</table>

Select one of the following:
- CHM 230 & 230L Analytical Chemistry and Analytical Chemistry Laboratory
- CHM 334 & 334L Spectrometric Analysis and Spectrometric Analysis Lab
- CHM 430 & 430L Instrumental Analytical Chemistry and Instrumental Analytical Chemistry Laboratory

Select one of the following:
- CHM 244 Inorganic Chemistry
- CHM 301 Fundamental Physical Chemistry

Select one 300 level course or higher in CHM or BCH.

Total Credits 26

1 CHM 381, CHM 480, or CHM 481 individually do not satisfy this requirement.

Minors are an important part of the undergraduate curriculum. If students declare a minor by sophomore year, they can usually complete it in a timely manner. Students should work with their advisor to determine if it is possible that the minor can be completed by graduation.

To receive a minor, a student must complete at least 9 credit hours of coursework distinct from their major(s) and from other minors, and students must complete more than 50% of the coursework required for the minor at Canisius. Please note that “ancillary/supporting” courses required for a major may still count as distinct courses as long as the remaining coursework still meets the 30 credit-hours required for a major. For more information about minor policies, please see the Declaring Majors and Minors page in the catalog.

Courses

CHM 104 Energy, Environment, and Society 3 Credits
Designed to provide a better understanding of energy and our environment, including man’s interaction with his environment and the consequences facing society today.
Fulfills College Core: Field 6 (Natural Sciences), Global Awareness
Offered: every fall.

CHM 109 General Chemistry I with Review - Part I 3 Credits
General Chemistry I for science majors, Part I. This course reviews some mathematical concepts, emphasizes dimensional analysis, inorganic nomenclature, stoichiometry, solutions, basic chemical reactions, and thermochemistry. Three lectures and one recitation per week.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: every fall.
CHM 110 General Chemistry I with Review - Part II  
3 Credits  
General Chemistry I for science majors, Part II, three lectures, one laboratory, and one recitation per week. This course emphasizes atomic and molecular structure, periodic properties, gas laws, and states of matter. The CHM 109 and CHM 110 sequence is equivalent to CHM 111 and a free elective. Students completing the CHM 109 and CHM 110 sequence are eligible to take CHM 112.  
Prerequisite: minimum grade of C- in CHM 109. Corequisite: CHM 111L.  
Offered: every fall.

CHM 111 General Chemistry I  
3 Credits  
General Chemistry I for science majors. Inorganic nomenclature, stoichiometry, solutions, basic chemical reactions, thermochemistry, atomic and molecular structure, periodic properties, gas laws, and states of matter. Three lectures and one recitation per week.  
Corequisite: CHM 111L.  
Fulfills College Core: Field 6 (Natural Sciences)  
Offered: every fall.

CHM 111L General Chemistry I Laboratory  
1 Credit  
Covers techniques of measurements, decantation, and filtration; use of a data acquisition system with temperature probe, pressure sensor, and spectrophotometer; analysis of data and developing a conclusion based on data trends. One three-hour lab per week.  
Corequisite: CHM 110 or CHM 111.  
Offered: every fall.

CHM 112 General Chemistry II  
3 Credits  
General Chemistry II for science majors. Properties of solutions (including colligative properties), kinetics, chemical equilibrium concepts, calculations involving acid/base and precipitation equilibria, thermodynamics (second and third law), electrochemistry, nuclear chemistry, and chemistry of the environment. A minimum grade of C in CHM 112 is required for all chemistry and biochemistry majors. Three lectures and one recitation per week.  
Prerequisite: minimum grade of C- in either CHM 110 or CHM 111.  
Corequisite: CHM 112L.  
Fulfills College Core: Field 6 (Natural Sciences)  
Offered: every spring.

CHM 112L General Chemistry II Laboratory  
1 Credit  
Builds on techniques developed in CHM 111L and covers solution dilution, titration, pipetting, and use of a pH electrode and current probe. One three-hour lab per week.  
Prerequisite: minimum grade of C- in CHM 111L. Corequisite: CHM 112.  
Offered: every spring.

CHM 227 Organic Chemistry I  
3 Credits  
Fundamental treatment of organic chemistry. Bonding, structure, nomenclature, and stereochemistry of organic functional groups. Mechanisms and reactivity in substitution and elimination reactions. Three lectures and one recitation per week.  
Prerequisite: minimum grade of C- in either CHM 110 or CHM 111.  
Corequisite: CHM 227L.  
Offered: every fall.

CHM 227L Organic Chemistry I Laboratory  
1 Credit  
One four-hour lab per week. Techniques for synthesis, separation, purification, and analysis of organic compounds.  
Prerequisite: minimum grade of C- in CHM 111L. Corequisite: CHM 227.  
Offered: every fall.

CHM 228 Organic Chemistry II  
3 Credits  
Continuation of organic chemistry. Chemistry and reaction mechanisms of unsaturated compounds, and oxygen and nitrogen-containing functional groups. Introduction to the organic chemistry of carbohydrates, lipids and peptides. Three lectures and one recitation per week.  
Prerequisite: minimum grade of C- in CHM 227. Corequisite: CHM 228L.  
Offered: every spring.

CHM 228L Organic Chemistry II Laboratory  
1 Credit  
One four-hour lab per week. Expands on techniques for synthesis, separation, purification, and analysis of organic compounds.  
Prerequisite: minimum grade of C- in CHM 227L. Corequisite: CHM 228.  
Offered: every spring.

CHM 230 Analytical Chemistry  
3 Credits  
Principles and methodology of modern analytical chemistry presented with particular emphasis on statistical error analysis, titrations, solution equilibrium, and potentiometry. Three lectures and one recitation per week.  
Prerequisite: minimum grade of C in CHM 112. Corequisite: CHM 230L.  
Offered: spring of even-numbered years.

CHM 230L Analytical Chemistry Laboratory  
1 Credit  
One four-hour lab per week. Fundamental techniques of quantitative analysis including titrations in multiple reaction paradigms, potentiometry, absorption spectrometry, and separation technologies.  
Prerequisite: minimum grade of C- in CHM 112L. Corequisite: CHM 230.  
Offered: spring of even-numbered years.

CHM 232 Environmental Analytical Chemistry  
3 Credits  
Environmental applications of analytical chemistry. Sampling techniques and statistical analysis of data. Soil chemistry, aquatic chemistry and atmospheric chemistry. Trace analysis with electroanalytical, liquid and gas chromatography, atomic absorption spectroscopy and ion selective electrodes. Three lectures and one recitation per week.  
Prerequisite: CHM 112. Corequisite: CHM 232L.  
Offered: anticipated spring 2023.

CHM 232L Environmental Analytical Chemistry Laboratory  
1 Credit  
One four-hour lab per week.  
Prerequisite: CHM 112L. Corequisite: CHM 232.  
Offered: anticipated spring 2023.

CHM 244 Inorganic Chemistry  
3 Credits  
Electronic configuration of atoms, periodic classification of the elements, nature of chemical bonding, symmetry and application of group theory to molecular orbitals, structures and thermodynamics of solids, bonding in metals and semiconductors, acid/base concepts, electrochemistry, isomerism, bonding, reactions and spectroscopy of coordination compounds, and other aspects of modern inorganic chemistry. Three lectures and one recitation per week.  
Prerequisite: minimum grade of C in CHM 112.  
Offered: every fall.

CHM 301 Fundamental Physical Chemistry  
3 Credits  
Fundamental topics in thermodynamics, kinetics, and quantum chemistry. Three lectures and one recitation per week.  
Prerequisite: minimum grade of C in CHM 112, successful completion of MAT 111 or MAT 110, and a year of physics (PHY 201 & PHY 202 or PHY 223 & PHY 224).  
Offered: every fall.
CHM 301L Fundamental Physical Chemistry Laboratory 1 Credit
Selected experiments demonstrating principles of thermodynamics and chemical kinetics. One four-hour lab per week.
Prerequisite: minimum grade of C in CHM 230L & C in CHM 301 (or concurrent registration in CHM 301).
Fulfills College Core: Advanced Writing-Intensive
Offered: fall of even-numbered years.

CHM 302 Modern Physical Chemistry 3 Credits
Introduction to quantum chemistry with applications to the structure of atoms and molecules. Molecular spectroscopy. Three lectures and one recitation per week.
Prerequisite: minimum grade of C in CHM 112, CHM 244, successful completion of MAT 111 or MAT 110, MAT 112, a year of physics (PHY 201 & PHY 202 or PHY 223 & PHY 224).
Offered: spring of even-numbered years.

CHM 302L Modern Physical Chemistry Laboratory 1 Credit
Selected spectroscopy experiments with applications to molecular structure. One four-hour lab per week.
Prerequisite: CHM 302 (or concurrent registration in CHM 302) & minimum grade of C in CHM 230L, CHM 301L, CHM 334L or CHM 430L.
Offered: spring of even-numbered years.

CHM 334 Spectrometric Analysis 3 Credits
Spectrometric methods for the elucidation of chemical structures. Includes nuclear magnetic resonance, infrared, ultraviolet and mass spectrometry. Emphasis on organic compounds. Three lectures per week.
Prerequisite: CHM 228.
Offered: every fall.

CHM 334L Spectrometric Analysis Lab 1 Credit
One four-hour lab per week. Nuclear magnetic resonance, infrared, ultraviolet and mass spectrometry of organic compounds.
Prerequisite: CHM 228L.
Offered: every fall.

CHM 344 Metal Ions in Biological Systems 3 Credits
Chemical processes in biological systems, which include participation of metal ions, are covered. The course begins with the principles of coordination chemistry and structural biochemistry. The rest of the course is organized according to the functions performed by the metal centers: gene expression and signal transduction, digestion, bioenergetics and electron transfer, oxygen transport, liver functions and anticancer drugs.
Prerequisite: CHM 228.
Offered: occasionally.

CHM 381 Scientific Literature and Communication 1 Credit
First of three student-faculty seminars for majors. Introduces scientific literature, technical writing and oral communication in chemistry and allied fields.
Prerequisite: CHM 228 & junior standing.
Offered: every fall.

CHM 420 Materials Chemistry 3 Credits
A survey of topics and applications in modern materials chemistry including solid state materials, semiconductors, polymers, nanomaterials, and introductions to mechanical properties, device fabrication, and structure-activity relationships.
Prerequisite: CHM 228 & CHM 244 (or concurrent registration in CHM 244). Corequisite: CHM 420L.
Offered: anticipated spring 2023.

CHM 420L Materials Chemistry Laboratory 1 Credit
This laboratory develops concepts introduced in the lecture component of Materials Chemistry, CHM 420, including solid-state structure, mechanical properties, semiconductors, polymers, and nanomaterials. The lab meets for four hours per week.
Prerequisite: CHM 228L (may be taken concurrently). Corequisite: CHM 420.
Offered: anticipated spring 2023.

CHM 430 Instrumental Analytical Chemistry 3 Credits
Advanced instrumental methods of analysis including spectroscopy, chromatography and various electrochemical techniques. Three lectures per week.
Prerequisite: CHM 112 & CHM 228 (or concurrent registration in CHM 228).
Offered: spring of odd-numbered years.

CHM 430L Instrumental Analytical Chemistry Laboratory 1 Credit
One four-hour lab per week. Atomic absorption spectroscopy, chromatography and various electrochemical techniques. 
Prerequisite: CHM 112L & CHM 228L (or concurrent registration in CHM 228L). Corequisite: CHM 430.
Offered: spring of odd-numbered years.

CHM 450 Research in Chemistry 3 Credits
Independent research under the direction of the chemistry faculty. Students are required to spend 9 hours per week conducting research. CHM 450 may be taken in place of a chemistry elective without lab. Research and consultation times to be arranged after approval of department chair.
Prerequisite: permission of department chair.
Offered: fall & spring.

CHM 451 Research in Chemistry 4 Credits
Independent research under the direction of the chemistry faculty. Students are required to spend 12 hours per week conducting research. CHM 451 may be taken in place of a chemistry elective with lab. Research and consultation times to be arranged after approval of department chair.
Prerequisite: permission of department chair.
Offered: fall & spring.

CHM 455 Medicinal Chemistry 3 Credits
Chemical principles are used to explain the interaction of drugs with biological targets. Strategies used in the design and development of medicines are discussed.
Prerequisite: minimum grade of C- in both CHM 228 & BCH 301.
Offered: spring of even-numbered years.

CHM 480 Communicating Concepts in Chemistry 1 Credit
Second of three student-faculty seminars for majors. Students give a 25-minute presentation on an advanced coursework topic. Emphasis is placed on the process and the mechanics of constructing a scientific talk.
Prerequisite: CHM 228, CHM 381, & junior standing.
Offered: every spring.

CHM 481 Communicating Research Literature 1 Credit
Third of three student-faculty seminars for majors. Students give a 45-minute presentation on a scientific work from the chemical literature. Emphasis is placed on constructing a narrative and gaining a working understanding of the scientific issues in the presented paper.
Prerequisite: CHM 228, CHM 381, & junior standing.
Fulfills College Core: Oral Communication
Offered: every fall.
CHM 490 Chemistry Internship

Internships in chemical or biochemical industry under the direction of company and faculty supervisors.

Prerequisite: permission of department chair & associate dean.

Offered: fall & spring.

CHM 499 Independent Study

Independent study under the direction of the chemistry faculty. Independent studies require an application and approval by the associate dean.

Prerequisite: permission of the instructor, department chair, & associate dean.

Offered: fall & spring.

The Dual Degree Program (http://catalog.canisius.edu/graduate/school-education-human-services/educator-preparation/dual-degree-content-and-msed-sw/#curriculumtext) offers a BS in Chemistry as well as a MSEd in Adolescence 7-12 Teaching Students with Disabilities Generalist. This program leads to Initial Adolescence Certification in Chemistry as well as Initial Certification in Adolescence 7-12 SWD Generalist. Since it leads to two teaching certificates, candidates must meet the content requirements for both over the course of their curriculum. In most cases, the content area major covers those requirements. In some instances New York State has additional requirements. Please note, this dual degree program can be completed in as little as 5 years.

Curriculum

An Ignatian Foundation

All undergraduate students must complete either the Canisius Core Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/core-curriculum/) or the All-College Honors Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/all-college-honors-program/). Many schools refer to their college-wide undergraduate requirements as “general education” requirements. We believe that the core curriculum and the honors curriculum are more than a series of required classes; they provide the basis for a Jesuit education both with content and with required knowledge and skills attributes that are central to our mission.

Free Electives

Students may graduate with a bachelor’s degree with more but not less than 120 credit hours. Free electives are courses in addition to the Canisius Core Curriculum or All-College Honors Curriculum and major requirements sufficient to reach the minimum number of credits required for graduation. The number of credits required to complete a bachelor’s degree may vary depending on the student’s major(s) and minor(s).

Major Requirements

Undergraduate Courses

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<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tr>
<td>CHM 111</td>
<td>General Chemistry I</td>
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<tr>
<td>&amp; 111L</td>
<td>and General Chemistry I Laboratory</td>
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</tr>
<tr>
<td>CHM 112</td>
<td>General Chemistry II</td>
<td>4</td>
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<tr>
<td>&amp; 112L</td>
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</tr>
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<td>CHM 227</td>
<td>Organic Chemistry I</td>
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<tr>
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<td>and Organic Chemistry I Laboratory</td>
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<tr>
<td>CHM 228</td>
<td>Organic Chemistry II</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 228L</td>
<td>and Organic Chemistry II Laboratory</td>
<td></td>
</tr>
<tr>
<td>CHM 244</td>
<td>Inorganic Chemistry</td>
<td>3</td>
</tr>
</tbody>
</table>

CHM 301  Fundamental Physical Chemistry

CHM 230  Analytical Chemistry

& 230L  and Analytical Chemistry Laboratory

CHM 381  Scientific Literature and Communication

CHM 480  Communicating Concepts in Chemistry

BCH 301  Introduction to Biochemistry

& 301L  and Introduction to Biochemistry Laboratory

Chemistry or Biochemistry Elective

BIO 111  Introductory Biology I

& 111L  and Introductory Biology Laboratory I

BIO 112  Introductory Biology II

& 112L  and Introductory Biology Laboratory II

MAT 111  Calculus I

MAT 141  Inferential Statistics and Computers for Science

PHY 201  College Physics I

& 201L  and College Physics I Laboratory

PHY 202  College Physics II

& 202L  and College Physics II Laboratory

Required Education Courses

EDS 101  Human Growth and Social Development: Adolescence

EDS 223  Foundations of Adolescent Literacy

EDS 360  Evaluation and Teaching Strategies

EDS 405  Methods of Teaching Science: Adolescence

EDU 250  Foundations of Education

EDU 356  Assessment for Diverse Learners

SPE 311  Nature/Needs of Childhood Students with Intellectual Disabilities & Autism Spectrum Disorders

SPE 341  Inclusive Strategies

Total Credits

83

Please note, two math, two science, and two history courses are needed for SWD certification. Candidates also need to take 3 credit hours in a LOTE (Language other than English).

Graduate Courses

The education curriculum is provided below for the graduate MSEd portion of the dual degree program. Several foundation courses are taken at the undergraduate level listed above with the requirements for the history major. The graduate courses begin at the 500 level and continue until completion. These courses can be taken during a student’s senior year. Refer to the roadmap for further details.

<table>
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<tr>
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<tr>
<td>EDU 556</td>
<td>Assessment for Diverse Learners</td>
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<tr>
<td>or EDU 356</td>
<td>Assessment for Diverse Learners</td>
<td>3</td>
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<tr>
<td>EDU 595</td>
<td>Child Abuse Workshop</td>
<td>0</td>
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<tr>
<td>EDU 596</td>
<td>Prevention of School Violence Workshop</td>
<td>0</td>
</tr>
<tr>
<td>EDU 597</td>
<td>Dignity for All Students Workshop</td>
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<tr>
<td>EDU 615</td>
<td>Research Methods</td>
<td>3</td>
</tr>
<tr>
<td>SPE 580</td>
<td>Classroom Management</td>
<td>3</td>
</tr>
<tr>
<td>SPE 631</td>
<td>Reading and Writing Process for Students with Learning and Behavioral Disorders</td>
<td>3</td>
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<tr>
<td>SPE 640</td>
<td>Learning and Behavioral Disabilities (LBD); Etiology and Research Based Interventions</td>
<td>3</td>
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<tr>
<td>SPE 644</td>
<td>Collaborative Practices on a Transdisciplinary Team</td>
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<tr>
<td>Course Code</td>
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<tr>
<td>SPE 649</td>
<td>Transition Issues for Adolescents with Disabilities</td>
<td>3</td>
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<tr>
<td>or SPE 311</td>
<td>Nature/Needs of Childhood Students with Intellectual Disabilities &amp; Autism Spectrum Disorders</td>
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<tr>
<td>SPE 652</td>
<td>Functional Curriculum for Students with Severe Disabilities and ASD</td>
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<tr>
<td>SPE 698</td>
<td>Seminar in Teaching and Assessment</td>
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<tr>
<td>SPE 693</td>
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<td>SPE 697</td>
<td>Student Teaching Seminar</td>
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<td>Total Credits</td>
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</table>

1 These courses may be taken at either the undergraduate or graduate level. The graduate level courses are recommended for those students coming into this program during their junior year.

Roadmap

Freshman

Fall
- CHM 111
- & 111L

Spring
- CHM 112
- & 112L

Sophomore

Fall
- CHM 227
- & 227L
- PHY 201
- & 201L
- EDS 101
- EDU 250

Spring
- CHM 228
- & 228L
- PHY 202
- & 202L
- SPE 341
- HIS

Junior

Fall
- BCH 301
- & 301L
- CHM 244
- CHM 230
- CHM 381
- CHM/BCH Elective
- EDS 223
- EDS 405
- EDS 360

Spring
- CHM 230
- & 230L

Senior

Fall
- CHM 301
- SPE 311
- EDU 356
- SPE 644

Spring
- SPE 649
- EDU 615
- EDU 595
- EDU 596
- EDU 597

Fifth Year

Fall
- SPE 580
- SPE 631
- SPE 640

Spring
- EDU 595
- EDU 596
- EDU 597