CHEMISTRY, BACHELOR OF SCIENCE (B.S.) WITH A CONCENTRATION IN CHEMICAL MODELING

The curriculum in chemistry prepares students for graduate study in chemistry and related fields and for admission to schools of medicine, dentistry, pharmacy and veterinary medicine. It prepares students to teach in secondary schools or to work in chemical and industrial laboratories and in related fields of business and industry. The department also offers required and elective courses in chemistry to students in other programs of study.

The Department of Chemistry offers five areas of concentration for completing the Bachelor of Science in Chemistry: chemical science, professional chemist, professional chemist with honors, biochemistry and chemical modeling. With proper selection of electives, the degree satisfies admission requirements to most schools of medicine, dentistry, pharmacy and veterinary medicine.

The chemical modeling concentration emphasizes areas of overlap between chemistry and the mathematical sciences and computer science. Students in this concentration will focus on learning the chemistry and computer technology for modeling the structure, properties and reactivity of molecules.

Student learning outcomes

Upon completing this program, students will know how to do the following:

**Chemistry core outcomes**

- Demonstrate proficiency in the major concepts and theoretical principles of chemistry, critical thinking and problem-solving skills
- Demonstrate proficiency in laboratory skills, including wet chemistry and instrumental methods, and laboratory safety practices
- Demonstrate communication skills, both written and oral, needed to explain chemical phenomenon
- Demonstrate proficiency in scientific literacy skills including searching and reading scientific publications
- Demonstrate an understanding of the need for ethical practices in chemistry

**Chemical modeling concentration-specific outcome**

- Demonstrate proficiency in computer programming and advanced math topics applied to molecular modeling

**Special requirements**

Students must complete 39-40 credits in chemistry and related major courses and 47 credits of ancillary requirements in addition to general education requirements.

A minimum grade of C is required in each prerequisite course except for CHEM 100, which requires a minimum of B.

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 Course | Title | Hours  
-------|-------|--------
 CHEM 101 | General Chemistry I | 3  
 CHEM 102 | General Chemistry II | 3  
 CHEM 301 | Organic Chemistry | 3  
 CHEM 302 | Organic Chemistry | 3  
 CHEM 309 | Quantitative Analysis | 3  
 CHEM 313 | Physical Chemistry I | 3  
 or CHEM 314 | Physical Chemistry I with Math Modules | 3  
 CHEZ 101 | General Chemistry Laboratory I | 1  
 CHEZ 102 | General Chemistry Laboratory II | 1  
 CHEZ 301 | Organic Chemistry Laboratory I | 2  
 CHEZ 302 | Organic Chemistry Laboratory II | 2  
 CHEZ 309 | Quantitative Analysis Laboratory | 2  

VCU students in other programs who wish to declare chemistry as their major must complete CHEM 101, CHEZ 101, CHEM 102 and CHEZ 102, each with a minimum grade of C and have a minimum GPA in their chemistry courses of 2.0.

**Degree requirements for Chemistry, Bachelor of Science (B.S.) with a concentration in chemical modeling**

Course | Title | Hours  
-------|-------|--------
 Select 30 credits of general education courses in consultation with an adviser. | 30  

**Major requirements**

- Major core requirements
  - CHEM 102 & CHEZ 102: General Chemistry II and General Chemistry Laboratory II | 4  
  - CHEM 301 & CHEZ 301: Organic Chemistry and Organic Chemistry Laboratory I | 5  
  - CHEM 302 & CHEZ 302: Organic Chemistry and Organic Chemistry Laboratory II | 5  
  - CHEM 309 & CHEZ 309: Quantitative Analysis and Quantitative Analysis Laboratory | 5  
  - CHEM 313 & CHEZ 314: Physical Chemistry I and Physical Chemistry I with Math Modules | 3-4  
  - CHEM 315: Physical Chemistry II | 3  
  - CHEM 320: Inorganic Chemistry I | 3  
  - CHEM 398: Professional Practices and Perspectives Seminar | 1  
  - CHEM 499: Chemistry Capstone Experience | 1  
  - CHEZ 313: Physical Chemistry Laboratory I | 2  

- Concentration requirements
  - CHEM 510 | Atomic and Molecular Structure | 3  
  - CHEM 512 | Applied Molecular Modeling | 3  
  - CHEZ 413 | Advanced Physical Chemistry Laboratory | 2  

- Major electives
  - Select from the list below. | 3  

**Ancillary requirements**
**Bachelor of Science (B.S.) with a concentration in chemical modeling**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 101 &amp; CHEZ 101</td>
<td>General Chemistry I and General Chemistry Laboratory I (both satisfy general education BOK for natural sciences and AOI for scientific and logical reasoning)</td>
<td>4</td>
</tr>
<tr>
<td>CMSC 255</td>
<td>Introduction to Programming</td>
<td>4</td>
</tr>
<tr>
<td>HUMS 202</td>
<td>Choices in a Consumer Society</td>
<td>1</td>
</tr>
<tr>
<td>MATH 200</td>
<td>Calculus with Analytic Geometry I (satisfies general education quantitative foundations)</td>
<td>4</td>
</tr>
<tr>
<td>MATH 201</td>
<td>Calculus with Analytic Geometry II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 302</td>
<td>Numerical Calculus</td>
<td>3</td>
</tr>
<tr>
<td>or MATH 310</td>
<td>Linear Algebra</td>
<td></td>
</tr>
<tr>
<td>MATH 307</td>
<td>Multivariate Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MEDC 541</td>
<td>Survey of Molecular Modeling Methods</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 207 &amp; PHYS 208</td>
<td>University Physics I and University Physics II (PHYS 207 satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)</td>
<td>10</td>
</tr>
<tr>
<td>STAT 210 or STAT 212</td>
<td>Basic Practice of Statistics or Concepts of Statistics</td>
<td>3</td>
</tr>
</tbody>
</table>

**Experiential fine arts**

1-3

**Foreign language through the 102 level (by course or placement)**

0-6

**Open electives**

Select any course.

15-24

**Total Hours**

120

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Students in this concentration meet the capstone requirement by taking CHEM 510 (http://bulletin.vcu.edu/search/?P=CHEM%20510) or CHEM 512 (http://bulletin.vcu.edu/search/?P=CHEM%20512) and CHEZ 413 (http://bulletin.vcu.edu/search/?P=CHEZ%20413).

**Course offered by the School of the Arts**

The minimum number of credit hours required for this degree is 120.

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**Major electives**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 306</td>
<td>Industrial Applications of Inorganic Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 391</td>
<td>Topics in Chemistry</td>
<td>1-4</td>
</tr>
<tr>
<td>CHEM 403</td>
<td>Biochemistry I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 404</td>
<td>Biochemistry II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 406</td>
<td>Inorganic Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 409</td>
<td>Instrumental Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 492</td>
<td>Independent Study</td>
<td>3</td>
</tr>
<tr>
<td>or CHEM 392</td>
<td>Directed Study</td>
<td></td>
</tr>
<tr>
<td>CHEM 504</td>
<td>Advanced Organic Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 510</td>
<td>Atomic and Molecular Structure (may select course not taken as major requirement)</td>
<td>3</td>
</tr>
<tr>
<td>or CHEM 512</td>
<td>Applied Molecular Modeling</td>
<td></td>
</tr>
<tr>
<td>CHEM 511</td>
<td>Chemical Thermodynamics and Kinetics</td>
<td>3</td>
</tr>
<tr>
<td>CHEZ 400</td>
<td>Exploring the Frontiers of Chemistry: Research Methods</td>
<td>2</td>
</tr>
<tr>
<td>CHEZ 404</td>
<td>Biochemistry Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>MATH 301</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>OPER 327</td>
<td>Mathematical Modeling</td>
<td>3</td>
</tr>
<tr>
<td>STAT 321</td>
<td>Introduction to Statistical Computing</td>
<td>3</td>
</tr>
</tbody>
</table>

What follows is a sample plan that meets the prescribed requirements within a four-year course of study at VCU. Please contact your adviser before beginning course work toward a degree.

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**Freshman year**

**Fall semester**

<table>
<thead>
<tr>
<th>Course</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>CHEM 101 &amp; CHEZ 101</td>
<td>General Chemistry I and General Chemistry Laboratory I (both satisfy general education BOK for natural sciences and AOI for scientific and logical reasoning)</td>
<td>4</td>
</tr>
<tr>
<td>MATH 200</td>
<td>Calculus with Analytic Geometry I (satisfies general education quantitative foundations)</td>
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<tr>
<td>STAT 210 or STAT 212</td>
<td>Basic Practice of Statistics or Concepts of Statistics</td>
<td>3</td>
</tr>
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**Experiential fine arts**

1-3

**Foreign language through the 102 level (by course or placement)**

0-6

**Total Hours**

14-17

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**Sophomore year**

**Fall semester**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 102 &amp; CHEZ 101</td>
<td>General Chemistry II and General Chemistry Laboratory II (both satisfy general education BOK for natural sciences and AOI for scientific and logical reasoning)</td>
<td>4</td>
</tr>
<tr>
<td>HUMS 202</td>
<td>Choices in a Consumer Society</td>
<td>1</td>
</tr>
<tr>
<td>MATH 201</td>
<td>Calculus with Analytic Geometry II</td>
<td>4</td>
</tr>
<tr>
<td>STAT 210 or STAT 212</td>
<td>Basic Practice of Statistics or Concepts of Statistics</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Hours**

15-17

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**Spring semester**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 301 &amp; CHEZ 301</td>
<td>Organic Chemistry and Organic Chemistry Laboratory I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)</td>
<td>5</td>
</tr>
<tr>
<td>PHYS 207</td>
<td>University Physics I (satisfies AOI for scientific and logical reasoning)</td>
<td>5</td>
</tr>
</tbody>
</table>

**Total Hours**

3

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**Experiential fine arts**

1-3

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**Course offered by the School of the Arts**

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**The minimum number of credit hours required for this degree is 120.**
Chemistry, Bachelor of Science (B.S.) with a concentration in chemical modeling

Spring semester
CHEM 302 Organic Chemistry 5
& CHEZ 302 and Organic Chemistry Laboratory II
CHEM 309 Quantitative Analysis 5
& CHEZ 309 and Quantitative Analysis Laboratory
CHEM 398 Professional Practices and Perspectives Seminar 1
PHYS 208 University Physics II 5

Term Hours: 16

Junior year
Fall semester
CHEM 313 Physical Chemistry I 3-4
or CHEM 314 Physical Chemistry I with Math Modules
CHEM 320 Inorganic Chemistry I 3
CHEZ 313 Physical Chemistry Laboratory I 2
CMSC 255 Introduction to Programming 4
Foreign language 101 3

Term Hours: 15-16

Spring semester
CHEM 315 Physical Chemistry II 3
Foreign language 102 3
General education course 1 3
General education course 1 3
Major elective 3

Term Hours: 15

Senior year
Fall semester
CHEM 510 Atomic and Molecular Structure 3
or CHEM 512 Applied Molecular Modeling
MEDC 541 Survey of Molecular Modeling Methods 1
Open electives 9

Term Hours: 13

Spring semester
CHEM 499 Chemistry Capstone Experience 2 0
CHEZ 413 Advanced Physical Chemistry Laboratory 2
MATH 302 Numerical Calculus 3
or MATH 310 Linear Algebra
Open electives 9

Term Hours: 14

Total Hours: 120-123

1 At least three additional general education courses (nine credits) are required. Three credits come from each of the following areas of inquiry: diversities in the human experience; creativity, innovation and aesthetic inquiry; and global perspectives. The latter two areas of inquiry courses should also fulfill the breadth of knowledge requirement from the areas of humanities/fine arts and social/behavioral sciences.

2 Students in this concentration meet the capstone requirement by taking CHEM 510 (http://bulletin.vcu.edu/search/?P=CHEM%20510) or CHEM 512 (http://bulletin.vcu.edu/search/?P=CHEM%20512) and CHEZ 413 (http://bulletin.vcu.edu/search/?P=CHEZ%20413).

The minimum number of credit hours required for this degree is 120.