

# MAJOR IN CHEMISTRY, MATERIALS CONCENTRATION

Chemists study the atomic and molecular structure of physical matter and analyze how it changes. Materials chemists study large and/or extended materials without defined molecular bounds such as polymers and extended inorganic solids. More specifically, they investigate how atoms and molecules may be combined to create materials that can produce useful or improved products. They also develop methods to measure materials properties such as strength and conductivity, enabling insight into a range of processes solar photo conversion, renewable plastics, energy storage, and drug delivery.

Chemistry majors are encouraged to participate in undergraduate research. Ample opportunities exist for undergraduate students to become involved in ground-breaking research in the laboratories of individual faculty members. Students have access to state-of-the-art equipment in faculty laboratories and the Central Instrument Facility including NMR, FTIR, UV/Vis, fluorescence, and mass spectrometers, vacuum lines, x-ray diffractometers, and many more. Undergraduate research is strongly encouraged for any student considering a career

in chemistry and many students complete supervised research for academic credit.

## Learning Objectives

Upon successful completion, students will be able to:

1. Demonstrate rigorous in-depth skills and knowledge in materials chemistry, and at least one other sub-discipline.
2. Describe how the characterization and analysis of materials is distinct from molecular species.
3. Describe one or more applications of materials that cannot be accomplished by typical molecular species.
4. Demonstrate use and analysis of data acquired by one of the methods used to analyze material, such as scanning electron microscopy, transmission electron microscopy, wide-angle x-ray diffraction, small angle x-ray diffraction, and/or dynamic light scattering.

## Requirements Effective Fall 2024

Chemistry majors must achieve a minimum grade of C (2.000) in all the listed courses required for the Major in Chemistry.

### Freshman

		AUCC	Credits
CHEM 120 <sup>1</sup>	Foundations of Modern Chemistry (GT-SC2)	3A	4
CHEM 121 <sup>1</sup>	Foundations of Modern Chemistry Laboratory (GT-SC1)	3A	1
CHEM 192	Introductory Seminar in Chemistry		2
CHEM 241 <sup>2</sup>	Foundations of Organic Chemistry		4
CHEM 242 <sup>2</sup>	Foundations of Organic Chemistry Laboratory		1
CHEM 263	Foundations of Inorganic Chemistry		4
CHEM 264	Foundations of Inorganic Chemistry Laboratory		1
CO 150	College Composition (GT-CO2)	1A	3
MATH 155 or 160	Calculus for Biological Scientists I (GT-MA1) Calculus for Physical Scientists I (GT-MA1)	1B	4
Arts and Humanities ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-and-humanities">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-and-humanities</a> )		3B	3
Diversity, Equity, and Inclusion ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-equity-inclusion">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-equity-inclusion</a> )		1C	3

**Total Credits**

**30**

### Sophomore

CHEM 231	Foundations of Analytical Chemistry		3
CHEM 232	Foundations of Analytical Chemistry Lab		2
CHEM 321 or BC 351	Foundations of Chemical Biology Principles of Biochemistry		4
CHEM 322	Foundations of Chemical Biology Laboratory		1
PH 121 or 141	General Physics I (GT-SC1) Physics for Scientists and Engineers I (GT-SC1)	3A	5
PH 122 or 142	General Physics II (GT-SC1) Physics for Scientists and Engineers II (GT-SC1)	3A	5

Select one group from the following:

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Group A:

MATH 271 Applied Mathematics for Chemists I

MATH 272	Applied Mathematics for Chemists II		
Group B:			
MATH 161	Calculus for Physical Scientists II (GT-MA1)	1B	
MATH 261	Calculus for Physical Scientists III		
<b>Total Credits</b>			<b>28</b>
<b>Junior</b>			
CHEM 311	Introduction to Nanoscale Science		3
CHEM 315	Foundations of Polymer Chemistry		3
CHEM 371	Fundamentals of Physical Chemistry		4
CHEM 372	Fundamentals of Physical Chemistry Lab	4A	1
Advanced Writing ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing</a> ) <sup>3</sup>		2	3
Arts and Humanities ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-and-humanities">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-and-humanities</a> )		3B	3
Historical Perspectives ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives</a> )		3D	3
Social and Behavioral Sciences ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences</a> )		3C	3
Advanced Elective (see list below)			4
Elective			3
<b>Total Credits</b>			<b>30</b>
<b>Senior</b>			
CHEM 461	Inorganic Chemistry		3
CHEM 462	Inorganic Chemistry Laboratory	4B	2
Select three credits from the following courses:			3
CHEM 476	Physical Chemistry II		
CHEM 477	Advanced Physical Chemistry Laboratory	4B	
CHEM 511	Solid State Chemistry		
CHEM 515	Polymer Chemistry		
ERHS 410	Environmental Health-Air and Waste Management		
Select one course from the following:			2
CHEM 493	Senior Seminar	4C	
CHEM 499 or HONR 499 <sup>4</sup>	Senior Thesis	4C	
Senior Honors Thesis			
Advanced Electives (see list below)			9
Electives <sup>5</sup>			13
<b>Total Credits</b>			<b>32</b>
<b>Program Total Credits:</b>			<b>120</b>

**Advanced Electives List**

Code	Title	Credits
ATS 350	Introduction to Weather and Climate	2
ATS 351	Introduction to Weather and Climate Lab	1
ERHS 320	Environmental Health-Water Quality	3
ERHS 332	Principles of Epidemiology	3
ERHS 400	Radiation Safety	3
ERHS 410	Environmental Health-Air and Waste Management	3
ERHS 430	Human Disease and the Environment	3
ERHS 446	Environmental Toxicology	3
ERHS 448	Environmental Contaminants	3

ERHS 450 Introduction to Radiation Biology 3

**Upper-Division regular courses (300-379; 400-479) from the following subject codes:**

AA
AB
ANEQ
BC
BIOM
BMS
BSPM
BZ
CBE

CHEM
CS
CT
ESS
FTEC
FW
HES
HORT
LIFE
MATH
MIP
NR
NSCI
PH
PSY
SOCR
STAT

take CHEM 245/CHEM 246 may complete the organic chemistry requirement by taking CHEM 343/CHEM 344. For both sets of these students, CHEM 343/CHEM 344 together count as an in-depth chemistry course.

<sup>3</sup> CHEM 301 is recommended.

<sup>4</sup> CHEM 499 by department approval. Students fulfilling the AUCC 4C requirement with CHEM 499 must write a thesis and present it to the department.

<sup>5</sup> Select enough elective credits to bring the program total to a minimum of 120 credits, of which at least 42 must be upper-division (300- to 400-level).

## Major Completion Map

### Distinctive Requirements for Degree Program:

TO PREPARE FOR FIRST SEMESTER: The curriculum for the new American Chemical Society Certified Chemistry major assumes students enter college prepared to take calculus. Entering students who are not prepared to take calculus will need to fulfill pre-calculus requirements in the first semester. CHEM 120 requires Algebra II as a prerequisite (this prerequisite is met by having Algebra II by test credit, transfer credit, or placement out of MATH 117 and MATH 118 on Math Placement Exam).  
<sup>1</sup> Earned grades of C (2.000) or better are required in all listed courses for the Major in Chemistry.

<sup>1</sup> Students who complete General Chemistry in Freshman year (CHEM 111 or CHEM 107, CHEM 112 or CHEM 108, CHEM 113, CHEM 114) do not have to take CHEM 120 and CHEM 121.

<sup>2</sup> Students may complete the organic chemistry requirement by taking CHEM 341, CHEM 343, and CHEM 344. Students who

### Freshman

Semester 1		Critical	Recommended	AUCC	Credits
CHEM 120	Foundations of Modern Chemistry (GT-SC2)	X		3A	4
CHEM 121	Foundations of Modern Chemistry Laboratory (GT-SC1)	X		3A	1
CHEM 192	Introductory Seminar in Chemistry	X			2
CO 150	College Composition (GT-CO2)	X		1A	3
Arts and Humanities ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-and-humanities">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-and-humanities</a> )			X	3B	3
Diversity and Global Awareness ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-global-awareness">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-global-awareness</a> )			X	1C	3

#### Total Credits

16

Semester 2		Critical	Recommended	AUCC	Credits
CHEM 241	Foundations of Organic Chemistry	X			4
CHEM 242	Foundations of Organic Chemistry Laboratory	X			1
CHEM 263	Foundations of Inorganic Chemistry	X			4
CHEM 264	Foundations of Inorganic Chemistry Laboratory	X			1
MATH 155 or 160	Calculus for Biological Scientists I (GT-MA1) Calculus for Physical Scientists I (GT-MA1)	X		1B	4

#### Total Credits

14

### Sophomore

Semester 3		Critical	Recommended	AUCC	Credits
CHEM 231	Foundations of Analytical Chemistry	X			3
CHEM 232	Foundations of Analytical Chemistry Lab	X			2
PH 121 or 141	General Physics I (GT-SC1) Physics for Scientists and Engineers I (GT-SC1)	X		3A	5
Select one course from the following:		X			4

Group A:

MATH 271 Applied Mathematics for Chemists I

Group B:

MATH 161	Calculus for Physical Scientists II (GT-MA1)			1B	
<b>Total Credits</b>					<b>14</b>
<b>Semester 4</b>					
		<b>Critical</b>	<b>Recommended</b>	<b>AUCC</b>	<b>Credits</b>
CHEM 321 or BC 351	Foundations of Chemical Biology Principles of Biochemistry	X			4
CHEM 322	Foundations of Chemical Biology Laboratory	X			1
PH 122 or 142	General Physics II (GT-SC1) Physics for Scientists and Engineers II (GT-SC1)	X		3A	5
Select one course from the following:		X			4
Group A:					
MATH 272	Applied Mathematics for Chemists II				
Group B:					
MATH 261	Calculus for Physical Scientists III				
<b>Total Credits</b>					<b>14</b>
<b>Junior</b>					
<b>Semester 5</b>					
		<b>Critical</b>	<b>Recommended</b>	<b>AUCC</b>	<b>Credits</b>
CHEM 311	Introduction to Nanoscale Science	X			3
CHEM 371	Fundamentals of Physical Chemistry	X			4
CHEM 372	Fundamentals of Physical Chemistry Lab	X		4A	1
Advanced Writing ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing</a> )			X	2	3
Social and Behavioral Sciences ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences</a> )			X	3C	3
<b>Total Credits</b>					<b>14</b>
<b>Semester 6</b>					
		<b>Critical</b>	<b>Recommended</b>	<b>AUCC</b>	<b>Credits</b>
CHEM 315	Foundations of Polymer Chemistry	X			3
Arts and Humanities ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-and-humanities">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-and-humanities</a> )			X	3B	3
Historical Perspectives ( <a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives</a> )			X	3D	3
Advanced Elective (see list on Program Requirements tab)			X		4
Elective			X		3
<b>Total Credits</b>					<b>16</b>
<b>Senior</b>					
<b>Semester 7</b>					
		<b>Critical</b>	<b>Recommended</b>	<b>AUCC</b>	<b>Credits</b>
Select three credits from the following courses:		X			3
CHEM 476	Physical Chemistry II				
CHEM 477	Advanced Physical Chemistry Laboratory			4B	
CHEM 511	Solid State Chemistry				
CHEM 515	Polymer Chemistry				
ERHS 410	Environmental Health-Air and Waste Management				
Advanced Electives (See list on Program Requirements page.)		X			6
Electives			X		7
<b>Total Credits</b>					<b>16</b>
<b>Semester 8</b>					
		<b>Critical</b>	<b>Recommended</b>	<b>AUCC</b>	<b>Credits</b>
CHEM 461	Inorganic Chemistry	X			3
CHEM 462	Inorganic Chemistry Laboratory	X		4B	2
Select one course from the following:		X			2
CHEM 493	Senior Seminar			4C	
CHEM 499 or HONR 499	Senior Thesis Senior Honors Thesis			4C	
Advanced Elective (see list on Program Requirements tab)		X			3
Electives			X		6

The benchmark courses for the 8th semester are the remaining courses in the entire program of study. X

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<b>Total Credits</b>	<b>16</b>
<b>Program Total Credits:</b>	<b>120</b>