

# Chemistry (CHEM)

B.S. in Chemistry (ACS Certified Program) (<https://catalog.und.edu/undergraduateacademicinformation/departmentalcoursesprograms/chemistry/chem-bs/>)

B.S. with Major in Chemistry (<https://catalog.und.edu/undergraduateacademicinformation/departmentalcoursesprograms/chemistry/chem-bs-major/>)

Minor in Chemistry (<https://catalog.und.edu/undergraduateacademicinformation/departmentalcoursesprograms/chemistry/chem-minor/>)

Four Year Plan - B.S. in Chemistry - ACS Degree (p. 1)

Four Year Plan - B.S. with Major in Chemistry - Biochemistry Option (p. 1)

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## Four Year Plan - B.S. in Chemistry - ACS Degree

### Freshman Year

Fall		Credits
CHEM 101	Orientation to Chemistry	1
CHEM 221	Fundamentals of Chemistry - Concepts	3
CHEM 221L	Fundamentals of Chemistry Laboratory	1
ENGL 110	College Composition I	3
MATH 165	Calculus I <sup>1</sup>	4
Essential Studies & Other Electives		3
<b>Credits</b>		<b>15</b>

### Spring

CHEM 254	Inorganic Chemistry I	3
CHEM 254L	Inorganic Chemistry I Laboratory	1
ENGL 130	Composition II: Writing for Public Audiences	3
MATH 166	Calculus II	4
Essential Studies & Other Electives		3
<b>Credits</b>		<b>14</b>

### Sophomore Year

Fall		Credits
CHEM 333	Analytical Chemistry	3
CHEM 333L	Analytical Chemistry Laboratory	1
CHEM 341	Organic Chemistry I	3
CHEM 341L	Organic Chemistry I Laboratory	1
CHEM 361	Problem Solving in Organic Chemistry I	1
PHYS 251	University Physics I	4
MATH 265	Calculus III	4
<b>Credits</b>		<b>17</b>

### Spring

CHEM 342	Organic Chemistry II	3
CHEM 342L	Organic Chemistry II Laboratory	1
CHEM 362	Problem Solving in Organic Chemistry II	1
PHYS 252	University Physics II	4
Essential Studies & Other Electives <sup>2</sup>		6
<b>Credits</b>		<b>15</b>

### Junior Year

Fall		Credits
CHEM 454	Inorganic Chemistry II	3
CHEM 454L	Inorganic Chemistry II Laboratory	1
CHEM 443	Instrumental Analysis III - Chromatography/Mass Spectrometry <sup>3</sup>	2
CHEM 470	Thermodynamics Kinetics	3

CHEM 470R	Thermodynamics Kinetics Recitation	1
First Semester of a Foreign Language <sup>5</sup>		4
Essential Studies and Other Electives <sup>2,4</sup>		2
<b>Credits</b>		<b>16</b>

### Spring

CHEM 471	Quantum Mechanics Spectroscopy <sup>6</sup>	3
CHEM 471R	Quantum Mechanics Spectroscopy Recitation <sup>6</sup>	1
CHEM 462		3
CHEM 441	Instrumental Analysis I - Spectroscopy <sup>3</sup>	2
BIMD 301	Biochemistry	3
Second Semester of a Foreign Language <sup>5</sup>		4
<b>Credits</b>		<b>16</b>

### Senior Year

#### Fall

CHEM 492		3
Essential Studies & Other Electives <sup>2,4</sup>		9
<b>Credits</b>		<b>12</b>

#### Spring

CHEM 442	Instrumental Analysis II - Electrochemistry <sup>3</sup>	2
CHEM 495	Chemistry Capstone	3
Essential Studies & Other Electives <sup>4</sup>		10
<b>Credits</b>		<b>15</b>
<b>Total Credits</b>		<b>120</b>

REQUIRED 120 credits (36 of which must be numbered 300 or above and 30 of which must be from UND) including: I. Essential Studies Requirements (see University ES guidelines and course listings Essential Studies requirements. (<https://und.edu/academics/essential-studies/>)). II. The following Curriculum: Major Requirements - 53 hours of Chemistry and Biochemistry including the courses listed above. FOOTNOTES: 1 = If a student is not ready for MATH 165, the math sequence may be moved back one semester, and Math 107 (also MATH 103, if needed) should be taken in the first semester. 2 = Suggested electives are courses in Physics, Mathematics, Biochemistry, Biology, Languages, Computer Science, Chemical Engineering, Business Management, and Speech. 3 = CHEM 44x (441, 442, and 443) courses are offered within a regular, two-year cycle. Students can take CHEM 44x courses in any order and that order may differ from the one shown above. To complete the degree in 4 years, students must start their Junior Year by taking the first available CHEM 44x course of the cycle. 4 = Other undergraduate and graduate-level courses in chemistry may be taken as electives. 5 = Two semesters of a foreign language are required. If a student wishes to pursue Study Abroad, taking language courses earlier is recommended. 6 = Chem 471 and 471 are offered in spring odd years.

## Four Year Plan - B.S. with Major in Chemistry - Biochemistry Option

### Freshman Year

Fall		Credits
CHEM 101	Orientation to Chemistry	1
CHEM 121	General Chemistry I	3
CHEM 121L	General Chemistry I Laboratory	1
ENGL 110	College Composition I	3
BIOL 150	General Biology I <sup>1</sup>	3
BIOL 150L	General Biology I Laboratory <sup>1</sup>	1
Essential Studies Electives		3
<b>Credits</b>		<b>15</b>

### Spring

CHEM 122	General Chemistry II	3
CHEM 122L	General Chemistry II Laboratory	1
ENGL 130	Composition II: Writing for Public Audiences	3
MATH 146	Applied Calculus I <sup>2</sup>	3
BIOL 151	General Biology II	3

BIOL 151L	General Biology II Laboratory	1
Essential Studies Electives		
<b>Credits</b>		<b>14</b>
<b>Sophomore Year</b>		
<b>Fall</b>		
CHEM 333	Analytical Chemistry	3
CHEM 333L	Analytical Chemistry Laboratory	1
CHEM 341	Organic Chemistry I	3
CHEM 341L	Organic Chemistry I Laboratory	1
CHEM 361	Problem Solving in Organic Chemistry I	1
PHYS 211	College Physics I	4
Essential Studies Electives		3
<b>Credits</b>		<b>16</b>
<b>Spring</b>		
CHEM 342	Organic Chemistry II	3
CHEM 342L	Organic Chemistry II Laboratory	1
CHEM 362	Problem Solving in Organic Chemistry II	1
PHYS 212	College Physics II	4
Essential Studies Electives <sup>3</sup>		6
<b>Credits</b>		<b>15</b>
<b>Junior Year</b>		
<b>Fall</b>		
BIOL 315	Genetics <sup>4</sup>	3
or BIOL 341	or Cell Biology	
First Semester of a World Language <sup>5</sup>		4
Electives <sup>3</sup>		9
<b>Credits</b>		<b>16</b>
<b>Spring</b>		
BIMD 301	Biochemistry	3
CHEM 466	Fundamentals of Physical and Biophysical Chemistry	3
CHEM 467		2
Second Semester of a World Language <sup>5</sup>		4
Electives <sup>3</sup>		3
<b>Credits</b>		<b>15</b>
<b>Senior Year</b>		
<b>Fall</b>		
BIMD 401	Advanced Biochemistry	3
BIMD 494	Directed Studies	2
Electives		9
<b>Credits</b>		<b>14</b>
<b>Spring</b>		
CHEM 495	Chemistry Capstone	3
Electives <sup>3</sup>		12
<b>Credits</b>		<b>15</b>
<b>Total Credits</b>		<b>120</b>

REQUIRED 120 credits (36 of which must be numbered 300 or above and 30 of which must be from UND) including: I. Essential Studies Requirements (see University ES listing). II. The Following Curriculum: Major Requirements - 40 hours of Chemistry including the courses listed above.

**FOOTNOTES:**

1 = Biology 150 and 151 can be taken in the sophomore year. They are prerequisites to other required biology courses.

2 = If a student is not ready for MATH 146, MATH 103 should be taken in the first semester. If a student would like the option to change into the B.S. in Chemistry or the B.S. with a Major in Chemistry with emphasis on the Physical Science Option at a later date, be aware that MATH 165, 166, and 265 are required. If a student who begins either the B.S. in Chemistry or the B.S. with

a Major in Chemistry with emphasis on the Physical Science Option wishes to change to the Biochemistry Option, Math 165 will substitute for Math 146.

3 = Other undergraduate and graduate-level courses in Chemistry may be taken as electives. Inorganic Chemistry I (Chem 254/L) is especially recommended for broader chemistry knowledge. Other suggested electives are courses in Physics, Mathematics, Biochemistry, Biology, Languages, Computer Science, Chemical Engineering, Business Management, and Speech. You must complete enough electives to bring total credit hours up to 120. Special Emphasis courses can fulfill an essential studies requirement. Please Note: Every student must fulfill all University, Departmental, and Essential Studies requirements. (<https://und.edu/academics/essential-studies/>)

4 = Instead of Cell Biology (BIOL 341) or Genetics (BIOL 315), students may take Microbiology (BIMD 302/L).

5 = Two semesters of a world language are required. If a student wishes to pursue Study Abroad, taking language courses earlier is recommended.

## Four Year Plan - B.S. with Major in Chemistry - Physical Science Option

<b>Freshman Year</b>		
<b>Fall</b>		
CHEM 101	Orientation to Chemistry	1
CHEM 121	General Chemistry I	3
CHEM 121L	General Chemistry I Laboratory	1
ENGL 110	College Composition I	3
MATH 165	Calculus I <sup>1</sup>	4
Essential Studies & Other Electives <sup>2</sup>		3
<b>Credits</b>		<b>15</b>
<b>Spring</b>		
CHEM 122	General Chemistry II	3
CHEM 122L	General Chemistry II Laboratory	1
ENGL 130	Composition II: Writing for Public Audiences	3
MATH 166	Calculus II	4
Essential Studies & Other Electives <sup>2</sup>		3
<b>Credits</b>		<b>14</b>
<b>Sophomore Year</b>		
<b>Fall</b>		
CHEM 333	Analytical Chemistry	3
CHEM 333L	Analytical Chemistry Laboratory	1
CHEM 341	Organic Chemistry I	3
CHEM 341L	Organic Chemistry I Laboratory	1
CHEM 361	Problem Solving in Organic Chemistry I	1
PHYS 251	University Physics I	4
MATH 265	Calculus III	4
<b>Credits</b>		<b>17</b>
<b>Spring</b>		
CHEM 342	Organic Chemistry II	3
CHEM 342L	Organic Chemistry II Laboratory	1
CHEM 362	Problem Solving in Organic Chemistry II	1
PHYS 252	University Physics II	4
Essential Studies & Other Electives <sup>2,4</sup>		6
<b>Credits</b>		<b>15</b>
<b>Junior Year</b>		
<b>Fall</b>		
CHEM 443	Instrumental Analysis III - Chromatography/Mass Spectrometry <sup>3</sup>	2
CHEM 470	Thermodynamics Kinetics	3
CHEM 470R	Thermodynamics Kinetics Recitation	1
First Semester of a World Language <sup>5</sup>		4

Essential Studies & Other Electives <sup>2,4</sup>	5
<b>Credits</b>	<b>15</b>
<b>Spring</b>	
CHEM 471 Quantum Mechanics Spectroscopy <sup>6</sup>	3
CHEM 471R Quantum Mechanics Spectroscopy Recitation <sup>6</sup>	1
CHEM 462	3
CHEM 441 Instrumental Analysis I - Spectroscopy <sup>3</sup>	2
Second Semester of a World Language <sup>5</sup>	4
Essential Studies & Other Electives <sup>2,4</sup>	2
<b>Credits</b>	<b>15</b>
<b>Senior Year</b>	
<b>Fall</b>	
Essential Studies & Other Electives <sup>2,4</sup>	15
<b>Credits</b>	<b>15</b>
<b>Spring</b>	
CHEM 442 Instrumental Analysis II - Electrochemistry <sup>3</sup>	2
CHEM 495 Chemistry Capstone	3
Essential Studies & Other Electives <sup>2,4</sup>	9
<b>Credits</b>	<b>14</b>
<b>Total Credits</b>	<b>120</b>

REQUIRED 120 credits (36 of which must be numbered 300 or above and 30 of which must be from UND) including: I. Essential Studies Requirements (see University ES guidelines and course listings Essential Studies requirements (<https://und.edu/academics/essential-studies/>)). II. The following Curriculum: Major Requirements - 43 hours of Chemistry including the courses listed above. FOOTNOTES: 1 = If a student is not ready for MATH 165, the math sequence may be moved back one semester and MATH 107 (also MATH 103, if needed) should be taken in the first semester. 2 = Suggested electives are courses in Physics, Mathematics, Biochemistry, Biology, Languages, Computer Science, Chemical Engineering, Business Management, and Speech. 3 = CHEM 44x (441, 442 and 443) courses are offered within a regular, two-year cycle. Students can take CHEM 44x courses in any order and that order may differ from the one shown above. To complete the degree in 4 years, students must start their Junior Year by taking the first available CHEM 44x course of the cycle. 4 = Other undergraduate and graduate-level courses in Chemistry may be taken as electives. Inorganic Chemistry I (CHEM 254/L) is especially recommended for broader chemistry knowledge. If the Chemistry Capstone (CHEM 495) is not taken for Essential Studies fulfillment, then one credit hour must be taken of either Special Problems in Chemistry (CHEM 392) or Senior Research (CHEM 492). 5 = Two semesters of a world language are required. If a student wishes to pursue Study Abroad, taking language courses earlier is recommended. 6 = Chem 471 and 471R are offered in spring odd years.

#### CHEM 101. Orientation to Chemistry. 1 Credit.

This seminar course will introduce 1st year students pursuing either a BS in Chemistry or BS with major in Chemistry degree, and provide acquaintance with relevant UND learning resources. Students will have the opportunity to meet faculty and senior undergraduate and graduate students providing exposure to research in chemistry, exploring what it means to perform scientific research. Prerequisite or Corequisite: CHEM 121 or CHEM 221. F.

#### CHEM 110. Survey of Chemistry. 4 Credits.

A course designed specifically for non-science majors who wish to obtain a basic understanding of chemistry as applied in the world today. Does not serve as a prerequisite for any other chemistry course. Includes laboratory. F,S.

#### CHEM 115. Introductory Chemistry. 3 Credits.

First semester of CHEM 115/CHEM 116 sequence. A basic introduction to measurements, ionic and covalent compounds, chemical calculations, states of matter, energy, solutions, reactions, chemical bonding, equilibrium, kinetics, thermodynamics, acid-base reactions and nuclear reactions. Does not satisfy the prerequisite for any advanced chemistry course. F,S,SS.

#### CHEM 115L. Introductory Chemistry Laboratory. 1 Credit.

Laboratory to accompany CHEM 115. Corequisite: CHEM 115. F,S,SS.

#### CHEM 116. Introduction to Organic and Biochemistry. 3 Credits.

A continuation of CHEM 115 with emphasis on basic principles of organic chemistry and biochemistry. Includes structures and simple reactions of common organic functional groups, carbohydrates, lipids, amino acids, proteins, and nucleic acids. Does not satisfy the prerequisite for any advanced chemistry course. Prerequisite: CHEM 115 and CHEM 115L, or CHEM 121 and CHEM 121L; a minimum of a C in either course is required. F,S,SS.

#### CHEM 116L. Introduction to Organic and Biochemistry Laboratory. 1 Credit.

Laboratory to accompany CHEM 116. Prerequisite: CHEM 115 and CHEM 115L, or CHEM 121 and CHEM 121L. Corequisite: CHEM 116. F,S,SS.

#### CHEM 121. General Chemistry I. 3 Credits.

Open to all students; no high school credit in chemistry required. Elementary principles and theories of chemistry; matter, measurement, atoms, ions, molecules, reactions, chemical calculations, thermochemistry, bonding, molecular geometry, periodicity, gases. Prerequisite or Corequisite: MATH 103, MATH 107, MATH 146, MATH 165, or higher. F,S,SS.

#### CHEM 121C. General Chemistry I. 3 Credits.

Open to all students; no high school credit in chemistry required. Elementary principles and theories of chemistry; matter, measurement, atoms, ions, molecules, reactions, chemical calculations, thermochemistry, bonding, molecular geometry, periodicity, gases. F,S,SS.

#### CHEM 121L. General Chemistry I Laboratory. 1 Credit.

Laboratory to accompany CHEM 121. Prerequisite or Corequisite: CHEM 121. F,S,SS.

#### CHEM 121R. General Chemistry I Recitation. 1 Credit.

CHEM 121R provides additional academic support for students who need more time and guidance to be successful in CHEM 121. Prerequisite: Department consent. Corequisite: CHEM 121. On demand.

#### CHEM 122. General Chemistry II. 3 Credits.

Elementary principles and theories of chemistry; Intermolecular forces, liquids, solids, kinetics, equilibria, acids and bases. Solution of chemistry, precipitation, thermodynamics, electrochemistry. Prerequisite: CHEM 121 with a grade of C or better. F,S,SS.

#### CHEM 122C. General Chemistry II. 3 Credits.

Elementary principles and theories of chemistry; Intermolecular forces, liquids, solids, kinetics, equilibria, acids and bases. Solution of chemistry, precipitation, thermodynamics, electrochemistry. F,S,SS.

#### CHEM 122L. General Chemistry II Laboratory. 1 Credit.

Laboratory to accompany CHEM 122. Prerequisite: CHEM 121 and CHEM 121L. Corequisite: CHEM 122. F,S,SS.

#### CHEM 221. Fundamentals of Chemistry - Concepts. 3 Credits.

Atomic and molecular structure, stoichiometry, states of matter, thermodynamics, periodicity and descriptive inorganic chemistry. Prerequisite: High school chemistry. Corequisite: CHEM 221L. Prerequisite or Corequisite: MATH 165. F.

#### CHEM 221L. Fundamentals of Chemistry Laboratory. 1 Credit.

Laboratory to accompany CHEM 221. Prerequisite: High school chemistry and MATH 103 or appropriate Math PLacement score. Corequisite: CHEM 221. F.

#### CHEM 254. Inorganic Chemistry I. 3 Credits.

Required for chemistry majors. Chemistry of the elements with emphasis on occurrence, preparation, physical properties, chemical reactivity, uses, nomenclature, structure, and periodic behavior. Includes chemical kinetics and thermodynamics. Prerequisite: CHEM 122 or CHEM 221. Corequisite: CHEM 254L. S.

#### CHEM 254L. Inorganic Chemistry I Laboratory. 1 Credit.

Qualitative and quantitative inorganic chemistry, including precipitation, acid-base reactions, and redox reactions in aqueous solutions. The preparation and isolation of main-group element and transition metal compounds. The characterization of these compounds with standard chemical and instrumental methods. Determinations of the rates of chemical reactions and of bond parameters. Prerequisite: CHEM 122 or CHEM 221. Corequisite: CHEM 254. S.

**CHEM 294. Introduction to Undergraduate Research. 0-3 Credits.**

Introductory experience as a research assistant working alongside graduate researchers or faculty. A total of 45 hours is typically required over the course of the semester per credit. Prerequisite: Consent of Instructor. Repeatable to 6.00 credits. S/U grading. F,S,SS.

**CHEM 333. Analytical Chemistry. 3 Credits.**

For all science majors interested in using analytical chemistry techniques in a modern science laboratory. Principles of quantitative and qualitative chemical analysis as applied to environmental, clinical and forensic science are covered. Prerequisite: CHEM 122 or CHEM 221. Corequisite: CHEM 333L. F.

**CHEM 333L. Analytical Chemistry Laboratory. 1 Credit.**

Laboratory to accompany CHEM 333. Principles of quantitative and qualitative chemical analysis as applied to environmental, clinical and forensic science are covered. Prerequisite: CHEM 122 or CHEM 221. Corequisite: CHEM 333. F.

**CHEM 340. Survey of Organic Chemistry. 4 Credits.**

For all students interested in a one-semester survey of organic chemistry. Structure and bonding, nomenclature; hydrocarbons: alkanes, alkenes, alkynes, aromatics; substituted hydrocarbons: alkyl halides, stereochemistry, alcohols, phenols, ethers, amines; carbonyls: aldehydes, ketones; carboxylic acids, esters, amides. Prerequisite: CHEM 122 with a grade of C or better and CHEM 122L; or CHEM 254 and CHEM 254L. S.

**CHEM 340L. Survey of Organic Chemistry Laboratory. 1 Credit.**

Laboratory to accompany CHEM 340. Prerequisite: CHEM 122L or CHEM 254L. Corequisite: CHEM 340. S.

**CHEM 341. Organic Chemistry I. 3 Credits.**

Designed for science and pre-professional students. Structure and bonding, acid-base reactions, nomenclature, stereochemistry, functional groups, alkanes, alkenes, alkynes, alkyl halides and alcohols. Application of spectrometric methods (NMR, IR and MS) for identification of organic compounds. Prerequisite: CHEM 122 with a grade of C or better and CHEM 122L; or CHEM 254 and CHEM 254L. F,S.

**CHEM 341C. Organic Chemistry I. 3 Credits.**

On-line course designed for science and pre-professional students. Structure and bonding, acid-base reactions, nomenclature, stereochemistry, functional groups, alkanes, alkenes, alkynes, alkyl halides and alcohols. Application of spectrometric methods (NMR, IR and MS) for identification of organic compounds. Prerequisite: CHEM 122 with a grade of C or better and CHEM 122L; or CHEM 254 and CHEM 254L. On demand.

**CHEM 341L. Organic Chemistry I Laboratory. 1 Credit.**

Laboratory to accompany CHEM 341. Required for chemistry majors. Prerequisite: CHEM 122L or CHEM 254L. Prerequisite or Corequisite: CHEM 341. F,S.

**CHEM 342. Organic Chemistry II. 3 Credits.**

Designed for science and pre-professional students. Structure and reactivity, organometallic compounds, aldehydes, ketones, carboxylic acids and their derivatives, aromatic compounds, amines, multi-step synthesis. Prerequisite: CHEM 341 with a grade of C or better and CHEM 341L. F,S.

**CHEM 342C. Organic Chemistry II. 3 Credits.**

On-line course designed for science and pre-professional students. Structure and reactivity, organometallic compounds, aldehydes, ketones, carboxylic acids and their derivatives, aromatic compounds, amines, multi-step synthesis. Prerequisite: CHEM 341 or CHEM 341C with a grade of C or better. On demand.

**CHEM 342L. Organic Chemistry II Laboratory. 1 Credit.**

Required for all chemistry majors. Laboratory to accompany CHEM 342. Prerequisite: CHEM 341 and CHEM 341L. Prerequisite or Corequisite: CHEM 342. F,S.

**CHEM 361. Problem Solving in Organic Chemistry I. 1 Credit.**

Reaction mechanisms and multi-step syntheses based on the reactions of alkenes, alkynes, alkyl halides and alcohols. Prerequisite: CHEM 122, with a grade of C or better and CHEM 122L; or CHEM 254 and CHEM 254L. Corequisite: CHEM 341 and CHEM 341L. F.

**CHEM 362. Problem Solving in Organic Chemistry II. 1 Credit.**

Reaction mechanisms and multi-step syntheses involving organometallic compounds, aldehydes, ketones, carboxylic acids and their derivatives, aromatic compounds and amines. Prerequisite: CHEM 341 with a grade of C or better, CHEM 341L, and CHEM 361. Corequisite: CHEM 342 and CHEM 342L. S.

**CHEM 366. Polymers and the Environment. 3 Credits.**

The chemical and physical properties of plastics, microplastics, and their additives as well as the chemistry of plastic degradation and recycling. The effect of plastics on the environment. The use of various methods for analyzing plastics and microplastics. Prerequisite or Corequisite: CHEM 340 or CHEM 342. S, even years.

**CHEM 370. Drug Chemistry and Toxicology. 3 Credits.**

Students will gain a foundation in drug chemistry, focusing on forensically relevant drugs and their metabolites. Furthermore, the course will cover analytical methods so students can use suitable approaches for sample preparation, analysis, and data interpretation. This course is intended for students interested in Forensic Science with a knowledge foundation in chemistry. Prerequisite: CHEM 340 and CHEM 340L or CHEM 341 and CHEM 341L. F, even years.

**CHEM 395. Experiential Learning. 0-3 Credits.**

A practical work or volunteer experience associated with the student's academic program of study. Arranged by mutual agreement among student, department, and site location. A total of 45 hours is typically required over the course of the semester per credit. Prerequisite: Instructor consent. F,S,SS.

**CHEM 397. Cooperative Education. 1-2 Credits.**

May be repeated for a maximum of 6 credits. Prerequisite: Any two courses from CHEM 333, CHEM 340, CHEM 341, CHEM 342, or BMD 301. Repeatable to 6.00 credits. S/U grading. F,S,SS.

**CHEM 401. Nanotechnology & Nanomaterials. 3 Credits.**

Introduction to the underlying synthetic principles and applications of the emerging field of nanotechnology. Intended for a multidisciplinary audience with a variety of backgrounds. Introduces characterization tools and principles relevant at the nanoscale dimension. Discusses current and future nanotechnology applications in biology, energy, electronics and engineering. Prerequisite: CHEM 333 and CHEM 341 or CHEM 340. F, odd years.

**CHEM 402. Trends in Forensic and Environmental Analytical Chemistry. 3 Credits.**

Approaches to the characterization of complex samples using separation methods. The topics will include characteristics compounds relevant to forensic and environmental fields. Methods of sample preparation and analysis. Prerequisite: CHEM 333 and CHEM 341 or CHEM 340. F, even years.

**CHEM 431. Selected Topics in Chemistry. 1-5 Credits.**

Repeatable with different topics. Repeatable. On demand.

**CHEM 441. Instrumental Analysis I - Spectroscopy. 2 Credits.**

Topics ranging from the fundamentals of spectroscopic analysis to contemporary techniques (including atomic absorption spectroscopy, atomic emission spectroscopy, atomic fluorescence spectroscopy, UV-vis molecular spectroscopy, fluorescence molecular spectroscopy, and infrared spectroscopy) are explored in the classroom and in laboratory exercises. Prerequisite: CHEM 333 and CHEM 333L. S, even years.

**CHEM 442. Instrumental Analysis II - Electrochemistry. 2 Credits.**

Topics ranging from the fundamentals of electrochemistry (including thermodynamics, kinetics, and mass transfer) to contemporary techniques of electroanalysis (such as potentiometry, coulometry, amperometry, and voltammetry) are explored in classroom and laboratory exercises. Prerequisite: CHEM 333 and CHEM 333L. S, odd years.

**CHEM 443. Instrumental Analysis III - Chromatography/Mass Spectrometry. 2 Credits.**

Topics involving the fundamentals of gas and liquid chromatography (GC and LC) and mass spectrometry (MS) as well as their practical considerations in the method development (including sample preparation and MS interpretation) are covered. The modern chromatographic techniques (GC, GC/MS, and high resolution MS) are explored in classroom and laboratory exercises. Prerequisite: CHEM 333 and CHEM 333L. F, odd years.

**CHEM 454. Inorganic Chemistry II. 3 Credits.**

Chemistry of inorganic compounds in terms of modern theories and concepts. Prerequisite: CHEM 254 and CHEM 342. Corequisite: CHEM 454L. F, even years.

**CHEM 454L. Inorganic Chemistry II Laboratory. 1 Credit.**

A course in laboratory techniques as applied to inorganic systems, including modern methods for synthesizing inorganic compounds and their analyses by spectroscopic and diffraction techniques. Prerequisite: CHEM 254 and CHEM 254L. Corequisite: CHEM 454. F.

**CHEM 455. Spectroscopy and Structure. 3 Credits.**

Applications of spectroscopic techniques to the determination of molecular structure. Prerequisite: CHEM 342 or CHEM 466. On demand.

**CHEM 463. Advanced Synthesis Laboratory. 3 Credits.**

Advanced synthetic, separatory and characterization methods currently used in modern laboratory practice will be emphasized. Prerequisite: CHEM 462 or CHEM 467, and CHEM 455. S.

**CHEM 466. Fundamentals of Physical and Biophysical Chemistry. 3 Credits.**

Required for students pursuing a B.S. with a Major in Chemistry degree, Biochemistry track. Survey of topics in physical and biophysical chemistry with an emphasis on the life sciences. Topics include chemical thermodynamics, kinetics, introductory quantum mechanics, and spectroscopy. Prerequisite: CHEM 340 or CHEM 342, MATH 146 or MATH 165, and PHYS 211 or PHYS 251. S, even years.

**CHEM 466L. Fundamentals of Physical and Biophysical Chemistry Laboratory. 1 Credit.**

Required for B.S. with a Major in Chemistry, Biochemistry Emphasis, majors. The solution of chemical problems in the laboratory using physical and biophysical methods. Prerequisite or Corequisite: CHEM 466. S, even years.

**CHEM 470. Thermodynamics & Kinetics. 3 Credits.**

The use of energy concepts in studying and understanding the nature of matter, equilibria, reactivity, kinetics, criteria for reactions, entropy. Prerequisite: CHEM 340 or CHEM 341, MATH 265, and PHYS 252. F.

**CHEM 470L. Physical Chemistry Laboratory. 1 Credit.**

Required for B.S. in Chemistry and B.S. with Major in Chemistry Physical Science Emphasis majors. The solution of chemical problems in the laboratory using modern physical and analytical methods. Prerequisite: CHEM 470. S, even years.

**CHEM 470R. Thermodynamics & Kinetics Recitation. 1 Credit.**

CHEM 470R provides a physical perspective on material covered in CHEM 470. In addition, CHEM 470R introduces and uses mathematical concepts to solve some numerically challenging problems assigned in CHEM 470. Corequisite: CHEM 470. F.

**CHEM 471. Quantum Mechanics & Spectroscopy. 3 Credits.**

Theory and nature of bonding and structure, spectroscopy, and optics. Prerequisite: CHEM 470, MATH 265, and PHYS 252. S, even years.

**CHEM 471R. Quantum Mechanics & Spectroscopy Recitation. 1 Credit.**

CHEM 471R is the Recitation/Discussion section of CHEM 471 to help students in developing essential skills in connecting Calculus, Physics and Chemistry. Corequisite: CHEM 471. S, even years.

**CHEM 475. Materials Chemistry. 3 Credits.**

Materials' synthesis, material chemistry, preparation methods and case studies in materials science. Prerequisite: CHEM 340 or CHEM 342. S, odd years.

**CHEM 488. Undergraduate Seminar. 1 Credit.**

Introduction to current research in chemistry and to professional chemistry seminar preparation. On demand.

**CHEM 489. Senior Honors Thesis. 1-8 Credits.**

Supervised independent study culminating in a thesis. Repeatable to 9 credits. Repeatable to 9.00 credits.

**CHEM 493. Instructional Experiences. 0-3 Credits.**

Students will receive training and practical experiences in providing instruction at the collegiate level. Such experiences include serving as an undergraduate teaching assistant or tutor for courses with a faculty mentor. Prerequisite: Instructor consent. F,S,SS.

**CHEM 494. Senior Research. 0-3 Credits.**

An opportunity for advanced students to work on research problems under close faculty guidance. A total of 45 hours is typically required over the course of the semester per credit. Prerequisite: Instructor consent and CHEM 342 or CHEM 340. Repeatable to 6.00 credits. F,S,SS.

**CHEM 495. Chemistry Capstone. 3 Credits.**

Designed for all senior students majoring in Chemistry. Discussion of current research topics in chemistry. Practice critical thinking skills and the knowledge gained in various chemistry courses to interpret and evaluate chemistry research data. Process information from different sources to provide an original interpretation of a given chemical phenomenon. Prepare a professional research paper and poster or oral presentation. Prerequisite or Corequisite: CHEM 466L or CHEM 470L. S.

**CHEM 497. Internship. 0-8 Credits.**

Supervised experience consistent with a student's career objectives. Formal application and/or interview to internship site required. A total of 75 hours is typically required over the course of the semester per credit. Prerequisite: Instructor consent. F,S,SS.