**Chemistry**

Emphasis areas at bachelor of science level in biochemistry, polymer and coatings science, and pre-medicine chemistry. Emphasis area at bachelor of arts level in secondary education.

Chemistry is the study of the elements, the compounds they form and the reactions they undergo.

The program of study encompasses the full range of the subject plus mathematics, physics, and, if desired, biology. Students may also pursue special interests such as analytical, biological, electrochemical, environmental, inorganic, nuclear, organic, physical or polymer chemistry.

The B.A. offers a general education degree with a chemistry focus. The B.A. degree may be appropriate for students in pre-professional programs (pre-medicine, pre-veterinary, pre-dentistry, pre-pharmacy, chemical sales and marketing).

Chemists tackle a broad range of challenges, from environmental cleanup and pollution prevention to creating the materials that will take humans to Mars. A bachelor’s degree in chemistry will provide many career possibilities. It has been called the central science because it occupies a pivotal place in many disciplines. As such it serves as the foundation for many other professions such as medicine, biotechnology, ceramics, chemical engineering, polymers, materials, metallurgy and environmental sciences.

All students are encouraged to participate in research programs during their undergraduate career. Such participation can lead to valuable experience and the possibility of publications, awards and recognition in the chemistry work place. Students may opt to participate in the campus wide “Opportunities for Undergraduate Research Experience” (OURE). Through OURE they can receive academic credit and a stipend for conducting a research project of mutual interest to the student and a faculty member.

Schrenk Hall is home to the department and where most chemistry classes and laboratories are held. The department has a broad range of modern instrumentation and equipment to prepare the student for the future.

**Bachelor of Arts Chemistry**

**Freshman Year**

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<td>HISTORY 1100</td>
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**Sophomore Year**

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**Junior Year**

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**Senior Year**

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Total Credits: 120

Students must complete a minimum of 120 credit hours for the bachelor of arts in chemistry degree. Students may have to take more than the minimum number of coursework hours to comply with the B.A. requirements due to variations in minor degree and foreign language requirements within an individual’s program of study.

Elective credits include a required minor in one of the following areas: English, economics, history, philosophy, psychology, sociology, communications, speech, media, political science, music, mathematics, statistics, foreign language, computer science, biology, or art. See Undergraduate catalog for courses required for specific minor. All chemistry majors are encouraged to do research through CHEM 4099. A total of 9 credits of a modern foreign language must also be taken as part of the electives above.

Chem Elective must be from one or more of the following: CHEM 4210 , CHEM 4297, CHEM 4410, CHEM 4510, CHEM 4610, CHEM 4619, CHEM 4620, CHEM 4710, CHEM 4810, CHEM 4819, CHEM 4850. This program of study allows students to design, in conjunction with their chemistry advisor, a program for many disciplines including pre-law, business, pre-dentistry, pre-veterinary medicine, as well as pre-medicine. An example of such a program is shown for pre-medical studies:

| BIO SCI 1113  | General Biology | 3 |
| BIO SCI 1219  | General Biology Lab | 2 |
| BIO SCI 2213  | Cell Biology    | 3 |
| BIO SCI 2219  | Cell Biology Laboratory | 1 |
| CHEM 4610    | General Biochemistry | 3 |
| CHEM 4619    | General Biochemistry Laboratory | 2 |

A grade of “C” or better is required for each Chemistry course counted towards the degree.
**Bachelor of Arts**  
**Chemistry**  
**Secondary Education Emphasis Area**

<table>
<thead>
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<td>MATH 1214</td>
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<td>BIO SCI 1113</td>
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<td>PSYCH 1101</td>
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<td>EDUC 1104</td>
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<td>PHYSICS 1135</td>
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<td>STAT 3113</td>
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<tr>
<td>EDUC 2102 or PSYCH 2300</td>
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<td>PHYSICS 2135</td>
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**Total Credits: 138**

Students must complete a minimum of 135 credit hours for the Bachelor of Arts in Chemistry degree with a Secondary Education Emphasis Area. The degree program is intended to culminate in a Certification Recommendation for an initial Missouri teaching certification. Students should also consult the Secondary Teacher Education Program section for Teacher Certification requirements through the Education department.

For this Bachelor of Arts degree program, the minor degree and foreign language requirements of the typical program of study are waived and there are other course substitutions in lieu of education coursework and requirements. A total of nine humanities credit hours are required to be selected from ENGLISH 1221 or ENGLISH 1222, PHILOS 1105, ART 1180, MUSIC 1150, or THEATRE 1190.

Four hours of a Chemistry Elective must be selected from one or more of the following: CHEM 4210, CHEM 4297, CHEM 4410, CHEM 4510, CHEM 4610, CHEM 4619, CHEM 4620, CHEM 4710, CHEM 4810, CHEM 4819, CHEM 4850, and CHEM 4099. CHEM 4099 may not count for more than 3 hr credit toward the degree. All chemistry majors are encouraged to do research through CHEM 4099.

A grade of “C” or better is required for each Chemistry course counted towards the degree.

**Bachelor of Science**  
**Chemistry**

A minimum of 127 credit hours is required for a Bachelor of Science degree in Chemistry and an average of at least two grade points per credit hour must be obtained. These requirements for the B.S. degree are in addition to credit received for algebra, trigonometry, and basic ROTC.

The Chemistry science curriculum requires nine semester hours in humanities and must include ENGLISH 1160 or ENGLISH 3560. A minimum of nine semester hours is required in social sciences, including either HISTORY 1300, HISTORY 1310, HISTORY 1200, or POL SCI 1200. Specific requirements for the bachelor degree are outlined in the sample program listed below.
### Chemistry

**Biochemistry Emphasis Area**

#### Freshman Year

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<tr>
<th>First Semester</th>
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<td>HISTORY 1200, or 1300, or 1310, or POL SCI 1200</td>
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Total Credits: 17

#### Sophomore Year

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<td>MATH 2222</td>
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<td>CHEM 3410</td>
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Total Credits: 17

### Notes:

**Grade Requirements:** A minimum grade of "C" is required for each chemistry course counted towards the degree.

**ROTC:** Basic ROTC may be taken in the freshman and sophomore year, but does not count towards the degree.

**Electives:** There are thirty-three (33) hours of electives, not to include Math courses that are prerequisite to calculus. Twelve (12) hours must be 2xxx, 3xxx, 4xxx (or 5xxx or higher with permission) level in chemistry or another technical area with permission of department. Six (6) elective hours must be completed in the social sciences. Six (6) elective hours are required in the humanities. Three (3) of the humanities hours must be literature.

### Chemistry

#### Biochemistry Emphasis Area

#### Freshman Year

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<td>STAT 3113 or 3115</td>
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<td>CHEM 3459</td>
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<td>ENGLISH 1160 or 3560</td>
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<td>Electives</td>
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#### Junior Year

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Total Credits: 16

### Notes:

**Grade Requirements:** A minimum grade of "C" is required for each chemistry course counted towards the degree.

**ROTC:** Basic ROTC may be taken in the freshman and sophomore years, but does not count towards the degree.

**Electives:** There are twenty-one (21) hours of electives, not to include Math courses that are prerequisite to calculus. Six (6) elective hours must be completed in the social sciences. Six (6) elective hours are required in the humanities. Three (3) of the humanities hours must be literature.

### Polymer & Coatings Science Emphasis Area

#### Freshman Year

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<td>MATH 1215</td>
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<td>HISTORY 1200, or 1300, or 1310, or POL SCI 1200</td>
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Total Credits: 17

#### Sophomore Year

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Total Credits: 17

#### Junior Year

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<td>ENGLISH 1160 or 3560</td>
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<td>CHEM 4620</td>
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</table>

Total Credits: 17

### Notes:

**Grade Requirements:** A minimum grade of "C" is required for each chemistry course counted towards the degree.

**ROTC:** Basic ROTC may be taken in the freshman and sophomore years, but does not count towards the degree.

**Electives:** There are twenty-one (21) hours of electives, not to include Math courses that are prerequisite to calculus. Six (6) elective hours must be completed in the social sciences. Six (6) elective hours are required in the humanities. Three (3) of the humanities hours must be literature.
Electives

Select one of the following sequences:

- COMP SCI 1971 & COMP SCI 1981
- COMP SCI 1972 & COMP SCI 1982
- COMP SCI 1570 & COMP SCI 1580

Junior Year

First Semester Credits Second Semester Credits
CHEM 2510 4 CHEM 3420 3
CHEM 3430 3 CHEM 3459 2
CHEM 4810 3 CHEM 4099 3
STAT 3113 or 3115 3 CHEM 4819 1
ENGLISH 1160 or 3560 3 CHEM 4850 3
Elective 3

Second Semester Credits

Elective 3

Senior Year

First Semester Credits Second Semester Credits
CHEM 2310 3 CHEM 2319 1
CHEM 3510 4 CHEM 2220 3
CHEM 4610 3 CHEM 4297 3
PHYSICS 4523 3 Electives 9
Electives 4

Second Semester Credits

Electives 3

Total Credits: 127

Notes:

Grade Requirements: A minimum grade of “C” is required for each chemistry course counted towards the degree.

ROTC: Basic ROTC may be taken in the freshman and sophomore years, but does not count towards the degree.

Undergraduate Research: The undergraduate research CHEM 4099 must be done in Polymers and Coatings Science.

Electives: There are twenty-three (23) hours of electives, not to include Math courses that are prerequisite to calculus. Six (6) elective hours must be completed in the social sciences. Six (6) elective hours are required in the humanities. Three (3) of the humanities hours must be literature.

Pre-medicine Emphasis Area

Freshman Year

First Semester Credits Second Semester Credits
CHEM 1310 4 CHEM 1320 3
CHEM 1319 1 CHEM 1510 2
CHEM 1100 1 MATH 1215 4
CHEM 1110 1 BIO SCI 1113 3
MATH 1214 4 BIO SCI 1129 2
HISTORY 1200, or 1300, or 1310, or POL SCI 1200 3 ENGLISH 1120 2

Electives 14

Second Semester Credits

Electives 17

Total Credits: 127

Notes:

Grade Requirements: A minimum grade of “C” is required for each chemistry course counted towards the degree.

ROTC: Basic ROTC may be taken in the freshman and sophomore years, but does not count towards the degree.

Electives: There are eleven (11) hours of electives, not to include Math courses that are prerequisite to calculus. Three (3) elective hours must be completed in the social sciences. Three (3) elective hours are required in the humanities, which must be literature.

Minor in Chemistry

A minor in chemistry requires a minimum of 19 hours of chemistry course work selected in conjunction with a chemistry faculty advisor. The required courses are CHEM 1100 , CHEM 1310 , CHEM 1319 , CHEM 1320 , CHEM 2210 and either CHEM 2219 or CHEM 2289 . Five additional hours of chemistry are to be selected from CHEM 1510 or other Chem 2000,
3000, and 4000-level courses. A minimum grade of "C" is required for each course counted toward the minor.

**Cynthia Pearl Bolon**, Lecturer  
PHD University of Missouri-Rolla

**Terry Lynn Bone**, Lecturer  
PHD University of Missouri-Rolla

**Amitava Choudhury**, Assistant Professor  
PHD Indian Institute of Science

**Richard Dawes**, Assistant Professor  
PHD University of Manitoba

**Nuran Ercal**, Professor  
PHD Hacettepe University, Turkey

**Gary Grubbs**, Assistant Professor  
PHD University of North Texas

**Shubhender Kapila**, Professor  
PHD Dalhousie University, Halifax

**Nicholas Leventis**, Curators Professor  
PHD Michigan State University

**Gary John Long**, Professor  
PHD Syracuse University

**Yinfa Ma**, Curator Teaching Professor  
PHD Iowa State University

**Paul Ki Souk Nam**, Associate Professor  
PHD University of Missouri-Columbia

**Manashi Nath**, Assistant Professor  
PHD Indian Institute of Science

**V Prakash Reddy**, Associate Professor  
PHD Case Western Reserve University

**Emmalou Theresa Satterfield**, Assistant Teaching Professor  
MASTER Missouri S&T

**Thomas Schuman**, Associate Professor  
PHD University of Alabama-Huntsville

**Honglan Shi**, Associate Research Professor  
PHD Missouri S&T

**Chariklia Sotiriou-Leventis**, Professor  
PHD Michigan State University

**Pericles Stavropoulos**, Associate Professor  
PHD Imperial College, London, UK

**Jay A Switzer**, Professor  
PHD Wayne State University

**Michael R Van De Mark**, Associate Professor  
PHD Texas A&M University

**Risheng Wang**, Assistant Professor  
PHD New York University

**Philip D Whitefield**, Professor  
PHD University of London (UK)

**Jeffrey G. Winiarz**, Associate Professor  
PHD SUNY at Buffalo

**Klaus Hubert Woelk**, Associate Professor  
PHD University of Bonn-Germany

**CHEM 1000 Special Problems**  
(IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

**CHEM 1001 Special Topics**  
(IND 0.0-6.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM 1100 Introduction To Laboratory Safety & Hazardous Materials**  
(LEC 1.0)  
A systematic study of safe laboratory operations and pertinent regulations of state and federal agencies.

**CHEM 1110 Introduction To Chemistry**  
(LEC 1.0)  
Introduction to chemistry, its intellectual and professional opportunities. Students will be acquainted with various areas of chemistry and with departmental and campus facilities useful to their future studies. Required of all freshman chemistry majors; encouraged for undergraduate transfer chemistry majors.

**CHEM 1111 Invitational Seminar**  
(LEC 1.0)  
This invitational seminar will introduce the student to research in chemistry. A series of seminars will be presented by faculty and outside speakers on current topics in chemical research. Prerequisite: Chem 1310 or Chem 1351.

**CHEM 1301 General Chemistry For Non-Science Majors**  
(LEC 3.0)  
A one semester introduction to chemistry designed to acquaint the student with the philosophy of the chemist’s approach to problem solving and the contribution of chemistry to society. Prerequisite: Entrance requirements.

**CHEM 1310 General Chemistry I**  
(RSD 2.0 and LEC 2.0)  
A comprehensive study of general chemistry concepts with focus on the atomic and molecular nature of matter. Fundamental scientific principles will be applied to solve chemistry problems and describe macroscopic physical properties. Prerequisite: Entrance requirements.

**CHEM 1319 General Chemistry Laboratory**  
(LAB 1.0)  
The laboratory work accompanying general chemistry consists of experiments designed to supplement lectures in Chem 1310. Prerequisite: Preceded or accompanied by both Chem 1310 and Chem 1100.

**CHEM 1310 - MOTR CHEM 100: Essentials in Chemistry**

**CHEM 1310 - MOTR CHEM 150: Chemistry I**

**CHEM 1310 - MOTR CHEM 150L: Chemistry I with Lab**

**CHEM 1319 General Chemistry Laboratory**  
(LAB 1.0)  
The laboratory work accompanying general chemistry consists of experiments designed to supplement lectures in Chem 1310. Prerequisite: Preceded or accompanied by both Chem 1310 and Chem 1100.

**CHEM 1319 - MOTR CHEM 150L: Chemistry I with Lab**
CHEM 1320 General Chemistry II (LEC 3.0)
In-depth analysis of chemical reactions with an introduction to thermodynamics and kinetics including applications to electrochemistry and nuclear chemistry. Prerequisites: Chem 1310 with a grade of "C" or better and Chem 1319.

CHEM 1510 Qualitative Analysis (LAB 2.0)
This course is to accompany the study of the metals in general chemistry and is devoted to the qualitative separation and detection of the metals. Prerequisite: Preceded or accompanied by both Chem 1320 and Chem 1100.

CHEM 1550 Elementary Quantitative Chemical Analysis (LEC 2.0)
A treatise of the fundamental principles of analytical chemistry and their application in analytical methods. Prerequisite: Preceded or accompanied by Chem 1320 or to be accompanied by Chem 1559.

CHEM 1559 Elementary Quantitative Chemical Analysis (LAB 2.0)
The application of the principles of analytical chemistry in gravimetric and volumetric determinations. Prerequisite: To be accompanied by Chem 1550 and preceded or accompanied by Chem 1100.

CHEM 2000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

CHEM 2001 Special Topics (RSD 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

CHEM 2002 Cooperative Work Training (IND 1.0-3.0)
On-the-job experience gained through cooperative education with industry, with credit arranged through departmental advisor. Grade received on quality of reports submitted and work supervisor's evaluation.

CHEM 2010 Seminar (IND 0.0-6.0)
Discussion of current topics.

CHEM 2100 Master Student (LEC 1.0)
Master Student is an orientation course for new and transfer students that addresses transition needs.

CHEM 2210 Organic Chemistry I (LEC 4.0)
This course consists of four parts: 1) Structure, bonding, and nomenclature; 2) hydrocarbons (alkanes, alkenes, and alkynes), conjugated systems, ultraviolet and visible spectroscopy, sterochemistry, resonance, and molecular orbital theory; 3) substitution and elimination reactions, and 4) identification of organic compounds via infrared and NMR spectroscopy. Prerequisites: Chem 1310, 1319, 1320; or Chem 1351.

CHEM 2219 Organic Chemistry I Lab (LAB 1.0)
Laboratory involves purification techniques, simple and multistep synthesis and spectroscopic identification of organic functional groups. Prerequisites: Preceded or accompanied by Chem 2210 and Chem 1100.

CHEM 2220 Organic Chemistry II (LEC 4.0)
This course consists of three parts. The first part will cover aromaticity and reactions of aromatic compounds, the second part will cover carbonyl compounds, amines and their reactions, and the third part will cover bioorganic compounds that include carbohydrates, aminoacids, peptides, proteins, lipids, nucleosides, nucleotides, and nucleic acids. Prerequisites: Grade of "C" or better in Chem 2210.

CHEM 2229 Organic Chemistry II Lab (LAB 1.0)
Continuation of Chem 2219. Prerequisites: Chem 2219 or Chem 2289, preceded or accompanied by both Chem 2220 and Chem 1100.

CHEM 2289 Organic Chemistry Lab (LAB 1.0)
The use of organic chemical laboratory procedures. For chemical engineering majors only. Prerequisites: Preceded or accompanied by both Chem 2210 and Chem 1100.

CHEM 2310 Inorganic Chemistry I (LEC 3.0)
A study of modern concepts of atomic structure, chemical bonding, thermodynamics and kinetics as related to the periodic relationship of the elements. Reference to topics of current interests as applied to the above areas.

CHEM 2319 Inorganic Chemistry Laboratory (LAB 1.0)
Synthesis and characterization of inorganic chemicals, high and low temperature syntheses, inert atmosphere and vacuum manipulations, electrochemistry, magnetoochemistry, spectroscopy (NMR, IR, UV/VIS), superconductivity. Prerequisites: Preceded or accompanied by Chem 2310 and Chem 1100.

CHEM 2320 Inorganic Chemistry II (LEC 3.0)
A study of coordination chemistry, organometallics, bioinorganic and solid-state inorganic chemistry. Reference to topics of current interest as applied to the above areas. Prerequisites: CHEM 2310.

CHEM 2320H Inorganic Chemistry - H (LEC 3.0)

CHEM 2510 Analytical Chemistry I (LAB 1.0 and LEC 3.0)
A study of analytical chemistry including an introduction to experimental error, statistics, principles of gravimetric and combustion analysis, chemical equilibrium, acid - base titrations, and electro-analytical determinations. Prerequisites: Chem 1320 and preceded or accompanied by Chem 1100.

CHEM 2510H Analytical Chemistry I - Honors (LAB 1.0 and LEC 2.0)

CHEM 3100 Lab Safety and Environmental Safety (LEC 1.0)
A systematic study of safe laboratory operations and pertinent regulations of state and federal agencies. This course is primarily intended for secondary education science teachers. Credit will not be given for both Chemistry 1100 and Chemistry 2100. Prerequisite: Entrance requirements for the MST program.
CHEM 3319 MST General Chemistry Lab (LAB 1.0)
The laboratory work accompanying the MST chemistry courses consists of experiments designed to supplement the lecture work in chemistry. This course is primarily intended for secondary education science teachers. Credit will not be given for both Chemistry 1319 and Chemistry 2319. Prerequisite: Entrance requirements for the MST program and preceded or accompanied by either Chem 1100 or Chem 2100.

CHEM 3410 Chemical Thermodynamics I (LEC 3.0)
A study of the laws of thermodynamics and their applications to the states of matter, solutions, and equilibria. Prerequisites: Physics 1111 or Physics 1135; accompanied or preceded by either Math 1215 or Math 1221.

CHEM 3419 Physical Chemistry Laboratory I (LAB 1.0)
Some typical operations of experimental physical chemistry. Prerequisites: Preceded or accompanied by both Chem 3410 and Chem 1100.

CHEM 3420 Introduction To Quantum Chemistry (LEC 3.0)
A study of molecular structures and spectroscopy, statistical thermodynamics, kinetic theory, chemical kinetics, crystals, and liquids. Prerequisites: Physics 2135 or Physics 2111; preceded or accompanied by Math 2222.

CHEM 3429 Physical Chemistry Laboratory II (LAB 1.0)
A continuation of Chem 3419. Prerequisites: Preceded or accompanied by both Chem 3420 and Chem 1100.

CHEM 3430 Chemical Kinetics I (LEC 3.0)
A study of kinetic theory, chemical kinetics, electromotive force and ionic equilibria. Prerequisite: Chem 3410.

CHEM 3459 Accelerated Physical Chemistry Laboratory (LAB 2.0)
A combined and accelerated version of Chem 3419 and Chem 3429 consisting of exploratory physical chemistry experiments. Prerequisites: Preceded or accompanied by both Chem 3420 and Chem 1100.

CHEM 3510 Analytical Chemistry II (LAB 1.0 and LEC 3.0)
A study of analytical chemistry including separation techniques for chemical and biochemical analysis, atomic - molecular mass spectrometry, atomic - molecular spectroscopy, surface analysis with electron spectroscopy, X-ray and mass spectrometry. Prerequisites: Chem 1100, Chem 2510, Chem 2220 and Chem 3410.

CHEM 4000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Prerequisite: Preceded or accompanied by Chem 1100 or an equivalent training program approved by S&T. Consent of instructor required.

CHEM 4001 Special Topics (LEC 1.0 and LAB 2.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

CHEM 4010 Undergraduate Seminar (RSD 1.0)
Written and oral presentations of current topics in chemistry. This course may serve as part of the capstone requirement for chemistry majors.

CHEM 4099 Undergraduate Research (IND 0.0-6.0)
Designed for the undergraduate student who wishes to engage in research. Does not lead to the preparation of a thesis. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor. Preparation of a written, detailed report is required of the student. Prerequisite: Must meet departmental requirements for instruction in laboratory safety. Consent of instructor required.

CHEM 4210 Intermediate Organic Chemistry I (LEC 3.0)
An advanced course designed to give the student a mastery of the fundamentals of organic chemical reactions and theory. Prerequisite: Chem 2220.

CHEM 4220 Intermediate Organic Chemistry II (LEC 3.0)
A systematic study of organic reactions, their mechanisms and synthetic applications. Prerequisite: Chem 2220.

CHEM 4297 Organic Synthesis And Spectroscopic Analysis (LEC 1.0 and LAB 2.0)

CHEM 4310 Selected Topics In Inorganic Chemistry (LEC 3.0)
A study of inorganic chemistry with emphasis on physical methods. General subjects covered include: molecular structure, bonding, complexes, spectroscopy, and reaction rates.

CHEM 4410 Chemical Thermodynamics II (LEC 3.0)
A study of the laws of thermodynamics with application to chemical systems. Emphasis is placed on partial molal functions. Prerequisites: Chem 3420.

CHEM 4420 Chemical Kinetics II (LEC 3.0)
Advanced treatments of topics in physical chemistry including statistical mechanics and kinetics. Prerequisites: Chem 3420.

CHEM 4450 Instrumental Methods Of Chemical Analysis (LEC 3.0 and LAB 1.0)
Principles and analytical applications of molecular spectroscopy, chromatographic separations, mass spectrometry, and radiochemistry. A brief overview of instrument electronics, signal generation and processing, and automated analysis is also provided. Prerequisites: Chem 3510 and Chem 3430.

CHEM 4610 General Biochemistry (LEC 3.0)
A resume of the important aspects of quantitative and physical chemistry in biochemical processes. General subjects covered include: proteins, nucleic acids, enzymes, carbohydrates and lipids. Prerequisite: Chem 2220.

CHEM 4619 General Biochemistry Laboratory (LAB 2.0)
Experiments are integrated with the lectures and cover the chemical and physical properties of proteins, enzymes, nucleic acids, carbohydrates and lipids. Prerequisites: Preceded or accompanied by both Chem 4610 and Chem 1100.
**CHEM 4620 Metabolism** (LEC 3.0)  

**CHEM 4630 Introduction to Bio-Nanotechnology** (LEC 3.0)  
This course will educate on the interdisciplinary areas of bio-nanotechnology. Goal is for students to understand how biomacromolecules such as nucleic acids, proteins, and lipids self-assemble to form the functional units of an intact cell. Emphasis will be on current application in DNA/protein nanotechnology, drug delivery and environmental biosensors. Prerequisite: At least junior standing.

**CHEM 4710 Principles of Environmental Monitoring** (LEC 3.0)  
This course provides an overview of environmental monitoring methodologies. Discussion covers thermodynamic and kinetic processes that affect chemical transport and fate in the environment. Federal environmental regulations and remediation technologies are also covered with specific examples. Prerequisites: Chem 2210; Physics 1111 or Physics 1135.

**CHEM 4810 Chemistry and Inherent Properties of Polymers** (LEC 3.0)  
A basic study of the organic chemistry of natural and synthetic high polymers, their inherent properties and their uses in plastic, fiber, rubber, resin, food, paper and soap industries. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with MS&E 4819).

**CHEM 4819 Polymer Science Laboratory** (LAB 1.0)  
Lectures and laboratory experiments dealing with polymerization reactions, solution properties and bulk or solid properties will be presented. Each student will prepare polymers and carry out characterization experiments on actual samples. Prerequisite: Chem 4810 or MS&E 4810 and preceded or accompanied by Chem 1100. (Co-listed with MS&E 4819).

**CHEM 4850 Fundamentals of Protective Coating I** (LEC 3.0)  
Study of the basic principles of protective coatings with particular reference to the paint and varnish industry. Classifications, manufacture, properties and uses of protective coatings. Prerequisite: Chem 1320. (Co-listed with MS&E 4850).

**CHEM 5000 Special Problems** (IND 0.0-6.0)  
Problems or readings on specific subjects or projects in the department. Prerequisite: Preceded or accompanied by Chem 1100 or an equivalent training program approved by S&T. Consent of instructor required.

**CHEM 5001 Special Topics** (LEC 1.0 and LAB 2.0)  
This course is designed to give the department an opportunity to test a new course. Variable title.

**CHEM 5099 Master Research** (IND 0.0-6.0)  
Master level research with the intent to lead to the preparation of a master degree thesis. Not more than six (6) credit hours allowed for graduate credit. Subject and credit to be arranged with the instructor. Preparation of a written, detailed report culminating in a thesis is required of the student. Prerequisite: Must meet departmental training requirements for laboratory safety. Consent of instructor required.

**CHEM 5100 Laboratory Safety & Hazardous Materials** (LEC 1.0)  
A systematic study of safe laboratory operations and pertinent regulations of state and federal agencies. Prerequisites: Graduate standing.

**CHEM 5210 Fundamentals of Organic Reactions** (LEC 3.0)  
An advanced course designed to give the student a mastery of the fundamentals of organic chemical reactions and theory. Graduate students are required to demonstrate a higher level of learning on assessments. Prerequisite: Chem 2220.

**CHEM 5220 Synthetic Organic Chemistry** (LEC 3.0)  
A systematic study of organic reactions, their mechanisms and synthetic applications. Graduate students are expected to demonstrate a higher level of proficiency during assessments. Prerequisite: Chem 2220.

**CHEM 5310 Introduction to Inorganic Chemistry** (LEC 3.0)  
A study of inorganic chemistry with emphasis on physical methods. General subjects covered include: molecular structure, bonding, complexes, spectroscopy, and reaction rates. Graduate students are required to demonstrate a higher level of proficiency during assessments.

**CHEM 5410 Advanced Chemical Thermodynamics** (LEC 3.0)  
A study of the laws of thermodynamics with application to chemical systems. Emphasis is placed on partial molal functions. Credit will not be given for both Chem 5410 and Chem 4410. Prerequisites: Chem 3420.

**CHEM 5420 Elemental Quantum Chemistry** (LEC 3.0)  
A study of molecular structures and spectroscopy, statistical thermodynamics, kinetic theory, chemical kinetics, crystals, and liquids. Prerequisites: Math 2222; Physics 2135 or Physics 2111.

**CHEM 5430 Advanced Chemical Kinetics** (LEC 3.0)  
Introductory graduate treatment of special topics of physical chemistry including statistical mechanics and kinetics. Prerequisites: Chem 3430.

**CHEM 5510 Introduction to Chemical Analysis** (LEC 3.0)  
Principles and analytical applications of molecular spectroscopy, chromatographic separations, mass spectrometry, and radiochemistry. A brief overview of instrument electronics, signal generation and processing, and automated analysis is also provided. Graduate students are expected to achieve a higher level of proficiency on application and assessments compared to Chem 4510 students. Prerequisites: Chem 1100, Chem 2510, Chem 2220, Chem 3430.

**CHEM 5610 Biochemistry** (LEC 3.0)  
A resume of the important aspects of quantitative and physical chemistry in biochemical processes. General subjects covered include: proteins, nucleic acids, enzymes, carbohydrates and lipids. Credit may not be given for both Chem 5610 and Chem 4610. Prerequisites: Chem 1100, Chem 2510, and Chem 4610. Prerequisites: Chem 2220.

**CHEM 5619 Biochemistry Laboratory** (LAB 2.0)  
Experiments are integrated with the lectures and cover the chemical and physical properties of proteins, enzymes, nucleic acids, carbohydrates and lipids. Credit may not be given for both Chem 5619 and Chem 4619. Prerequisites: Preceded or accompanied by Chem 5610 and Chem 1100 or an equivalent training program approved by S&T.
CHEM 5620 Biochemical Metabolism (LEC 3.0)
A continuation of Chem 5610. Catabolism and anabolism of carbohydrates, lipids, proteins, and nucleic acids. Photosynthesis, oxidative phosphorylation and membranes. Credit may not be given for both Chem 5620 and Chem 4620. Prerequisite: Chem 4610 or 5610.

CHEM 5630 Biochemical Nanotechnology (LEC 3.0)
This course will educate on the interdisciplinary areas of bio-nanotechnology. Student will investigate the potential of nanoscience in advanced applications including DNA/protein nanotechnology, drug delivery, environmental biosensor and emerging biotechnology industries. Credit may not be given for both Chem 5630 and Chem 4630. Prerequisite: At least junior standing.

CHEM 5640 Neurochemistry with Clinical Correlations (LEC 3.0)
This course explores the chemical underpinnings of neurological phenomena. It covers the overall structure and function of neurons and glial cells, neurotransmission, signal transduction, and metabolism. A central focus of the course is relating these topics to processes such as learning and memory, as well as various pathological states. Chem 4610.

CHEM 5710 Environmental Monitoring (LEC 3.0)
This course provides an overview of environmental monitoring methodologies. Discussion covers thermodynamic and kinetic processes that affect chemical transport and fate in the environment. Federal environmental regulations and remediation technologies are also covered with specific examples. Credit may not be given for both Chem 5710 and Chem 4710. Prerequisites: Chem 2210, Physics 2111.

CHEM 5810 Introduction to Polymeric Materials (LEC 3.0)
A basic study of the organic chemistry of natural and synthetic high polymers, their inherent properties and their uses in plastic, fiber, rubber, resin, food, paper and soap industries. Credit may not be given for both Chem 5810 and Chem 4810. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with MS&E 5810).

CHEM 5819 Polymer Synthesis and Characterization Lab (LAB 1.0)
Laboratory experiments dealing with polymerization syntheses and solution, bulk and solid properties will be presented. Each student will prepare polymers and carry out all characterization experiments on actual samples. Credit may not be given for both Chem 5819 and Chem 4819. Prerequisite: Chem 4810 or MS&E 4810 or Chem 5810 or MS&E 5810 or Chem Eng 5310, preceded or accompanied by Chem 1100 or Chem 5100 or an equivalent training program approved by S&T. (Co-listed with MS&E 5819).

CHEM 5850 Introduction to Coating Chemistry (LEC 3.0)
Study of the basic principles of protective coatings with particular reference to the paint and varnish industry. Classifications, manufacture, properties and uses of protective coatings. Credit may not be given for both Chem 5850 and Chem 4850. Prerequisite: Chem 1320 or Met Eng 1210. (Co-listed with MS&E 5850).