

**Advising Manual**  
**for**  
**Chemistry Programs**

**in the**  
**Department of Chemistry and Physics**  
**Mansfield University**

## PREFACE

This Advising Manual was prepared for those with an interest in chemistry at Mansfield University. It is intended as a guide to the programs and specific course requirements for the degree programs in chemistry in the Department of Chemistry and Physics. At the time of revision, all information contained in this manual was currently valid. Due to the dynamic nature of academic institutions, changes may have since been made to programs or requirements. For the most up-to-date information, consult a current university catalog (contents of the current catalog are available online at "catalog.mansfield.edu") or the department web page at "www.mansfield.edu/chemistry-physics". For more information about Mansfield University, contact the Admissions Office (South Hall, Mansfield University, Mansfield, PA, 16933; by phone at 800-577-6826 or 570-662-4243) or see the web page (admissions.mansfield.edu). For more information about the Department of Chemistry and Physics, contact any of us at Grant Science Center, Mansfield University; phone and e-mail information are on the departmental web page.

## CONTENTS

Greetings	2
Chemistry and Career Options	2
Department of Chemistry and Physics	2
Opportunities and Activities	3
General Program Requirements	5
Specific Four-Year Plans	8
Bachelor of Science (B.S.) in Chemistry – Chemistry concentration	9
Bachelor of Science (B.S.) in Chemistry – Forensic Science concentration	12
Bachelor of Science (B.S.) in Chemistry – Biochemistry concentration	15
Bachelor of Science (B.S.) in Chemistry – Nanotechnology concentration	18
Course Descriptions	24

## GREETINGS

Greetings from the Department of Chemistry and Physics at Mansfield University! Since you are reading this booklet, you will possibly have some contact with us in the future. We sincerely hope that whatever contact we may have will be educational and beneficial to you. We are a small but broadly-based, challenging, and caring department interested in your educational needs and aspirations. Chemistry surrounds us in all aspects of our lives and careers. We would like to help you see its relevance to your career plans. In whatever capacity, as a major, minor, or as part of your required curriculum, we will try to help you fully realize your goals. This Advising Manual describes various aspects of the department and the institution and some programs and unique opportunities available at Mansfield University. Please contact us if you have questions about any part of the chemistry program at Mansfield University. We wish you well in your academic endeavors.

## CHEMISTRY AND CAREER OPTIONS

Chemistry is the branch of science that relates phenomena in the world around us with the properties and behavior of the atoms and molecules from which the world is made. The study of chemistry makes students aware of those relationships and prepares them for a variety of careers in business, industry, academia, and government. Opportunities within these areas range from laboratory and technical work, to sales, marketing, and customer service, to management and supervisory positions. A graduate with a chemistry major or minor has acquired many skills that employers seek, especially in the areas of problem solving and decision making.

Our programs prepare you for advanced studies in a range of professions, including medicine, dentistry, optometry, and various aspects of the law, while our more recently developed tracks in forensic science and nanotechnology focus on these rapidly-growing disciplines. Many of our Bachelor of Science (B.S.) graduates continue their chemistry studies in graduate school. Another option for B.S. chemistry majors is to pursue a career in industry immediately upon graduation. The food, pharmaceutical, petroleum, and chemical industries offer positions involving both laboratory and non-laboratory work. In addition, Mansfield University offers a teacher certification program in chemistry, resulting in the Bachelor of Science in Education (B.S.E.). These graduates find themselves in great demand due to the national shortage of qualified high school science teachers.

In addition to the programs leading to the B.S. and B.S.E., the department provides service courses for several biology, physics, geography, and health science programs and offers minors in chemistry and in forensic science. If we can give you assistance by providing additional information, please contact us.

## THE DEPARTMENT OF CHEMISTRY AND PHYSICS

The Department of Chemistry and Physics at Mansfield University is housed in Grant Science Center. Extensively renovated in 2012-13, Grant Science Center is shared with the Biology Department and contains extensive modern laboratory facilities, including lab-lecture rooms, a central instrumental laboratory, computer laboratory, planetarium, and stockroom.

In addition to the usual laboratory equipment and glassware, the department has available a large assortment of instrumentation available for student use, including:

- ICP atomic emission spectrometer
- ion chromatograph
- atomic absorption spectrometer
- gas chromatographs with interfaced mass spectrometer
- high-performance liquid chromatograph
- Fourier-transform infrared spectrometers
- UV-visible spectrophotometers
- spectrofluorometer
- nuclear magnetic resonance spectrometers

The facilities and equipment are used by students throughout their studies at Mansfield in a variety of supervised laboratory experiences, both in course work and in independent research. The entire chemistry curriculum is designed to give students a broadly-based background in the theory and practice of chemistry and is structured to meet the standards of the American Chemical Society and the needs of a small department.

Close student-faculty interaction assures students of access to and the attention of their faculty. Students and faculty often develop relationships that extend beyond the classroom, by interaction in social activities such as picnics, field trips, and athletics, to private conversations about research and career plans. During a visit to Grant Science Center, you may see students and faculty engaged in discussions of all sorts. Students often have a cup of coffee in the department office to pass a few minutes between classes, or drop in at their professor's office to chat. This informal, open spirit provides an optimal learning environment for both students and faculty.

## OPPORTUNITIES AND ACTIVITIES

A quality undergraduate degree is more than an accumulation of courses in a major. Courses must be taught by faculty who care about each student's needs and talents. At Mansfield, courses within and without the major are taught by such faculty. Courses in the major concentration must provide a solid basis for a student's future career. A list of courses required for the various chemistry degrees is presented in a later section. Additional courses required of all Mansfield students ensure a well-rounded liberal arts education.

However, a quality degree program also provides students with opportunities outside the classroom. In the Department of Chemistry and Physics, several such opportunities and activities exist for students to utilize their undergraduate experiences in non-traditional ways. All of these enhance the student's educational experience. Students should consider participating in such activities during their undergraduate experience.

*Employment/Cooperative Education.* As a chemistry major, you will have skills even before you graduate that employers are seeking. There are numerous opportunities for summer employment in academic or industrial laboratories. In academic labs, this experience involves students in current state-of-the-art research. In industrial labs, students may be involved with

different experimental techniques, often new to them. Such experiences broaden students' knowledge and increase their confidence. Announcements for these employment opportunities arrive regularly at Mansfield.

Several local industries have made arrangements with Mansfield students to continue their employment into the academic year. These students receive course credit for their work experience through a cooperative education agreement, enabling them to earn and learn at the same time.

*Research.* In addition to the experience in practical and routine laboratory practices gained by employment, there are opportunities for students to participate in faculty research projects. In these projects, students are primary researchers, working first-hand on a project and its analysis. Relationships between students and faculty become more collegial as they work toward the common goal of understanding a research problem. Engaging students actively in performing research gives them a valuable glimpse of basic research in action.

*Chemistry Club.* The Chemistry Club is a non-academic, social organization to which most chemistry majors belong. The Chemistry Club offers opportunities for students and faculty to meet in an informal setting. Activities include picnics, pizza parties, field trips, hosting speakers and school tours, and performing demonstrations for National Chemistry Week. Chemistry Club members are eligible to become student affiliate members of the American Chemical Society (ACS), the professional society for chemists in the United States. As an ACS affiliate, the student is provided with the advantages of a professional society, including a student newsletter, career opportunities, employment aids, and current scientific information.

*ACS Certification.* Our Chemistry program has been approved by the American Chemical Society, which allows us to grant ACS certification to graduates meeting specific criteria. An ACS-certified degree lets prospective employers know that a graduate has met educational standards set by one of the world's largest professional organizations.

## PROGRAM REQUIREMENTS

B.S. in Chemistry

The Department of Chemistry and Physics offers a major program (120 credits total) leading to the Bachelor of Science (B.S.) in Chemistry with four different concentrations: chemistry, forensic science, biochemistry, and nanotechnology.

The four concentrations share a common core of 49 credits of chemistry, physics, and math courses (course descriptions may be found at the end of this manual):

CHM 1111	General Chemistry I	4	MA 2231	Calculus I	4
CHM 1112	General Chemistry II	4	MA 2232	Calculus II	4
CHM 3301	Organic Chemistry I	4	MA xxxx	Math Elective (1125	
CHM 3302	Organic Chemistry II	4		or higher)	3
CHM 3311	Quantitative Analysis	4	PHY 2210	General Physics I	4
CHM 3321	Physical Chemistry I	4	PHY 2211	General Physics II	4
CHM 3332	Instrumental Analysis	4			
CHM 4410	Seminar (twice)	2 (i each)			

The four concentrations differ in their requirements for upper-level courses:

Chemistry Concentration: (21-22 credits)

CHM 3322	Physical Chemistry II	4
CHM 4420	Qualitative Organic Chemistry	3
CHM 4431	Advanced Inorganic Chemistry	4
CHM xxxx	Chemistry Electives (3341, 4421, 4432)	6-7
MA 2233	Calculus III	4

Forensic Science Concentration: (20 credits)

CHM 3264	Chemical Methods in Forensic Science	3
CHM 4420	Qualitative Organic Chemistry	3
PHY 3264	Physical Methods in Forensic Science	3
MA 2233	Calculus III	4
SCI 1104	Introduction to Forensic Science	3

Two of the following:

BI 3370	Cell Biology	4
CHM 3322	Physical Chemistry II	4
CHM 3341	Biochemistry	4
CHM 4431	Advanced Inorganic Chemistry	4

One of the following:

CJA	3262	Criminal Interviewing and Interrogation	3
CJA	3354	Criminal Law	3
PSY	4441	Forensic Psychology	3

Biochemistry Concentration: (21-23 credits)

BI	3370	Cell Biology	4
BI	xxxx	Biology Electives (3310, 3371, 3372, 3374, 3375)	6-8
CHM	3341	Biochemistry	4

One of the following:

CHM	3322	Physical Chemistry II	4
CHM	4431	Advanced Inorganic Chemistry	4

One of the following:

CHM	4420	Qualitative Organic Chemistry	3
CHM	4421	Advanced Organic Chemistry	3

Nanotechnology Concentration: (21-22 credits)

SCI	3270	Nanotechnology Laboratory Experience	18
-----	------	--------------------------------------	----

One of the following:

CHM	3322	Physical Chemistry II	4
CHM	4420	Qualitative Organic Chemistry	3
CHM	4421	Advanced Organic Chemistry	3
CHM	4431	Advanced Inorganic Chemistry	4

American Chemical Society Certification

Students in the Chemistry and Biochemistry concentrations can earn certification by the American Chemical Society by completing CHM 3341 (Biochemistry) and 2-3 credits of research (CHM 4497).

## General Education

Besides the course requirements for the major programs, all four-year students at Mansfield University must complete a General Education program. The General Education program includes coursework in four clusters:

### *Foundations of Knowledge:*

First-Year Seminar (FYS 1100)	3
Oral Communication (COM 1101, 1102, or 1103)	3
Composition I (ENG 1112)	3
Composition II (ENG 3313)	3

### *Approaches to Knowledge:*

Humanities (2 courses with different prefixes)	6
Natural and Physical Sciences	3-4
Social and Behavioral Sciences (2 courses with different prefixes)	6
Mathematics	3-4

### *Unity and Diversity of Humanity:*

#### Global Perspectives (6 credits):

Option 1: two consecutive courses in a language other than English

Option 2: Western and Non-Western Global Cultures (2 courses with different prefixes)

#### Themes (6 credits from at least two strands):

Ethics and Civic Responsibility (3)

Environmental, Economic, Social, and Personal Sustainability (1-3)

Arts & the Human Experience (1-3)

*Capstone Project:* (this is accomplished within the major)

There is a University graduation requirement that at least 40% of your coursework (48 semester hours) be at the upper level (3000 or higher).



## SPECIFIC FOUR-YEAR PLANS

The following pages list recommended four-year sequences of coursework for the programs described above. Because some upper-level courses are not offered every year, course sequences will vary somewhat depending whether a student begins in an odd or an even year.

These suggested sequences show only required or recommended courses; students should plan to take at least 15 credits each semester, registering for General Education or elective courses in addition to those specifically indicated.

Descriptions for each program are followed by a checklist which students should complete as they complete the various requirements.

B.S. Chemistry, Chemistry Concentration  
(odd-year start)

Fall 2015	CHM 1111	4	Spring 2016	CHM 1112	4
	MA 1165	3		MA 2231	4
	COM 1101 or ENG 1112	3		ENG 1112 or COM 1101	3
	FYS 1100	3			
	Totals ( $\geq 15$ )				
Fall 2016	CHM 3301	4	Spring 2017	CHM 3302	4
	CHM 3311	4		CHM 3332	4
				PHY 2210	4
				MA 2232	4
	Totals ( $\geq 15$ )				
Fall 2017	CHM 3321	4	Spring 2018	CHM 4410	1
	CHM 4420	3		CHM 4431	4
	PHY 2211	4		CHM or other elective	3
	MA 2233	4			
	Totals ( $\geq 15$ )				
Fall 2018	CHM elective	3-6	Spring 2019	CHM 3322	4
				CHM 4410	1
	Totals ( $\geq 15$ )				
					Total ( $\geq 120$ )

B.S. Chemistry, Chemistry Concentration  
(even-year start)

Fall 2014	CHM 1111	4	Spring 2015	CHM 1112	4
	MA 1165	3		MA 2231	4
	COM 110X or ENG 1112	3		ENG 1112 or COM 110X	3
	FYS 1100	3			
	Totals ( $\geq 15$ )				
Fall 2015	CHM 3301	4	Spring 2016	CHM 3302	4
	CHM 3311	4		CHM 3332	4
				PHY 2210	4
				MA 2232	4
	Totals ( $\geq 15$ )				
Fall 2016	CHM 3321	4	Spring 2017	CHM 3322	4
	CHM or other elective	3		CHM 4410	1
	PHY 2211	4			
	MA 2233	4			
	Totals ( $\geq 15$ )				
Fall 2017	CHM 4420	3	Spring 2018	CHM 4410	1
	CHM or other elective	3		CHM 4431	4
				CHM or other elective	3
	Totals ( $\geq 15$ )				
				Total ( $\geq 120$ )	

## B.S. Chemistry, Chemistry Concentration

General Education Requirements

Foundations of Knowledge	Grade	Date
FYS 1100		
COM 110X		
ENG/ESL 1112		
ENG 3313		
Approaches to Knowledge		
Humanities (6 cr.):		
Mathematics (3-4 cr.):		
Natural and Physical Sciences (3-4 cr.):		
Social and Behavioral Sciences (6 cr.):		
Unity and Diversity of Humanity		
Global Perspectives (6 cr.):		
Themes (6 cr.):		
Capstone Project		

Major Requirements

Core Requirements	Grade	Date
CHM 1111		
CHM 1112		
CHM 3301		
CHM 3302		
CHM 3311		
CHM 3321		
CHM 3332		
CHM 4410		
CHM 4410		
MA elective:		
MA 2231		
MA 2232		
PHY 2210		
PHY 2211		
Concentration requirements		
CHM 3322		
CHM 4420		
CHM 4431		
CHM elective:		
CHM elective:		
(choose electives from 3341, 4421, 4432)		
MA 2233		

Graduation Requirements

120 credits		
48 credits upper-level (program provides 42-43), two additional upper-level courses (minimum 6 credits):		





## B.S. Chemistry, Forensic Science Concentration

General Education Requirements

Foundations of Knowledge	Grade	Date
FYS 1100		
COM 110X		
ENG/ESL 1112		
ENG 3313		
Approaches to Knowledge		
Humanities (6 cr.):		
Mathematics (3-4 cr.):		
Natural and Physical Sciences (3-4 cr.):		
Social and Behavioral Sciences (6 cr.):		
Unity and Diversity of Humanity		
Global Perspectives (6 cr.):		
Themes (6 cr.):		
Capstone Project		

Major Requirements

Core Requirements	Grade	Date
CHM 1111		
CHM 1112		
CHM 3301		
CHM 3302		
CHM 3311		
CHM 3321		
CHM 3332		
CHM 4410		
CHM 4410		
MA elective:		
MA 2231		
MA 2232		
PHY 2210		
PHY 2211		
Concentration requirements		
CHM 3264		
CHM 4420		
CHM/BI elective:		
(choose elective from BI 3370 or CHM 3322, 3341, or 4431)		
MA 2233		
PHY 3264		
SCI 1104		
CJA/PSY elective:		
(choose elective from CJA 3262 or 3354, or PSY 4441)		

Graduation Requirements

120 credits		
48 credits upper-level (program provides 41), 2-3 additional upper-level courses (minimum 7 credits):		

B.S. Chemistry, Biochemistry Concentration  
(odd-year start)

Fall 2015	CHM 1111	4	Spring 2016	CHM 1112	4
	MA 1165	3		MA 2231	4
	COM 110X or ENG 1112	3		ENG 1112 or COM 110X	3
	FYS 1100	3			
	Totals ( $\geq 15$ )				
Fall 2016	CHM 3301	4	Spring 2017	CHM 3302	4
	CHM 3311	4		CHM 3332	4
				MA 2232	4
				PHY 2210	4
	Totals ( $\geq 15$ )				
Fall 2017	CHM 3321	4	Spring 2018	CHM 4410	1
	CHM 3341	4		BI 3370	4
	PHY 2211	4		CHM or BI electives	3-8
	Totals ( $\geq 15$ )				
Fall 2018	CHM or BI electives	3-8	Spring 2019	CHM 4410	1
				CHM or BI electives	3-8
	Totals ( $\geq 15$ )				
				Total ( $\geq 120$ )	



B.S. Chemistry, Biochemistry Concentration  
(even-year start)

Fall 2014	CHM 1111	4	Spring 2015	CHM 1112	4
	MA 1165	3		MA 2231	4
	COM 110X or ENG 1112	3		ENG 1112 or COM 110X	3
	FYS 1100	3			
	Totals ( $\geq 15$ )				
Fall 2015	CHM 3301	4	Spring 2016	CHM 3302	4
	CHM 3311	4		CHM 3332	4
				MA 2232	4
				PHY 2210	4
	Totals ( $\geq 15$ )				
Fall 2016	CHM 3321	4	Spring 2017	CHM 4410	1
	CHM 3341	4		BI 3370	4
	PHY 2211	4		CHM or BI electives	3-8
	Totals ( $\geq 15$ )				
Fall 2017	CHM or BI electives	3-8	Spring 2018	CHM 4410	1
				CHM or BI electives	3-8
	Totals ( $\geq 15$ )				
				Total ( $\geq 120$ )	

## B.S. Chemistry, Biochemistry Concentration

General Education Requirements

Foundations of Knowledge	Grade	Date
FYS 1100		
COM 110X		
ENG/ESL 1112		
ENG 3313		
Approaches to Knowledge		
Humanities (6 cr.):		
Mathematics (3-4 cr.):		
Natural and Physical Sciences (3-4 cr.):		
Social and Behavioral Sciences (6 cr.):		
Unity and Diversity of Humanity		
Global Perspectives (6 cr.):		
Themes (6 cr.):		
Capstone Project		

Major Requirements

Core Requirements	Grade	Date
CHM 1111		
CHM 1112		
CHM 3301		
CHM 3302		
CHM 3311		
CHM 3321		
CHM 3332		
CHM 4410		
CHM 4410		
MA elective:		
MA 2231		
MA 2232		
PHY 2210		
PHY 2211		
Concentration requirements		
CHM 3341		
CHM 4420 or 4421		
CHM 3322 or 4431		
BI 3370		
BI elective:		
BI elective:		
(choose electives from BI 3310, 3371, 3372, 3374, or 3375)		

Graduation Requirements

120 credits	
48 credits upper-level (program provides 46-48), may need one additional upper-level course (minimum 3 credits):	



B.S. Chemistry, Nanotechnology Concentration  
(even-year start)

Fall 2014	CHM 1111	4	Spring 2015	CHM 1112	4
	MA 1165	3		MA 2231	4
	COM 110X or ENG 1112	3		ENG 1112 or COM 110X	3
	FYS 1100	3			
	Totals ( $\geq 15$ )				
Fall 2015	CHM 3301	4	Spring 2016	CHM 3302	4
	CHM 3311	4		CHM 3332	4
				MA 2232	4
				PHY 2210	4
	Totals ( $\geq 15$ )				
Fall 2016	CHM 3321	4	Spring 2017	CHM 4410	1
	CHM or other elective	3		CHM or other elective	3-4
	PHY 2211	4			
	MA 2233	4			
	Totals ( $\geq 15$ )				
Fall 2017	SCI 3270	18	Spring 2018	CHM 4410	1
				CHM or other elective	3-4
	Totals ( $\geq 15$ )				
				Total ( $\geq 120$ )	

## B.S. Chemistry, Nanotechnology Concentration

General Education Requirements

Core Requirements	Grade	Date
FYS 1100		
COM 110X		
ENG/ESL 1112		
ENG 3313		
Approaches to Knowledge		
Humanities (6 cr.):		
Mathematics (3-4 cr.):		
Natural and Physical Sciences (3-4 cr.):		
Social and Behavioral Sciences (6 cr.):		
Unity and Diversity of Humanity		
Global Perspectives (6 cr.):		
Themes (6 cr.):		
Capstone Project		

Major Requirements

Core Requirements	Grade	Date
CHM 1111		
CHM 1112		
CHM 3301		
CHM 3302		
CHM 3311		
CHM 3321		
CHM 3332		
CHM 4410		
CHM 4410		
MA elective:		
MA 2231		
MA 2232		
PHY 2210		
PHY 2211		
Concentration requirements		
CHM elective:		
(choose elective from 3322, 4420, 4421, or 4431)		
SCI 3270		
<u>Graduation Requirements</u>		
120 credits		
48 credits upper-level (program provides 46-47), one additional upper-level course (minimum 3 credits):		

## CHEMISTRY/PHYSICS COURSE DESCRIPTIONS

For other course descriptions (BI, MA, SCI, etc.), consult the current catalog.

\*CHM 1111 GENERAL CHEMISTRY I 4 cr. [3, 0, 3]

For science majors. A study of the fundamental principles of chemistry from the standpoint of stoichiometry, gases, states of matter, solution reactions, bonding, atomic and molecular structure. Laboratory sessions stress the chemical principles discussed in the lecture.

CHM 1112 GENERAL CHEMISTRY II 4 cr. [3, 0, 3]

A continuation of 1111: kinetics, thermodynamics, oxidation-reduction, acid-base theory and equilibrium are studied. Prerequisite: CHM 1111.

CHM 3264 CHEM MTDS FOREN SCI 3 cr. [2, 0, 2]

An advanced treatment of the chemical methods used in the investigation of criminal activities. The use and reliability of chemical tests, solubilities, and reactions as well as the chemistry of chromatographic, spectroscopic and instrumental analysis will be included. Prerequisites: CHM 1110, SCI 1104, SCI 1107.

CHM 3301 ORGANIC CHEMISTRY I 4 cr. [3, 0, 4]

Fundamentals of organic chemistry are presented. Modern theory, reaction mechanisms and stereochemistry are included along with nomenclature, preparation, reactions and properties of organic compounds. The laboratory stresses syntheses, chemical and physical properties and an introduction to instrumental techniques. The laboratory period includes one hour of lecture on theory and techniques of laboratory operations. Prerequisite: CHM 1112.

CHM 3302 ORGANIC CHEMISTRY II 4 cr. [3, 0, 4]

A continuation of 3301. The laboratory period includes one hour of lecture on theory and techniques of laboratory operations. Prerequisite: CHM 3301.

CHM 3311 QUANTITATIVE ANALYSIS 4 cr. [3, 0, 4]

An introductory course in analytical chemistry emphasizing classical titrimetric and gravimetric methods and related theories. Prerequisite: CHM 1112.

CHM 3321 PHYSICAL CHEMISTRY I 4 cr. [3, 0, 4]

An introduction to the methods and topics of physical chemistry. Topics include introduction to thermodynamics, equilibria, kinetics, atomic structure, and molecular spectroscopy. Prerequisite: CHM 1112, 3302, MA 2231, PHY 2210 and 2211.

CHM 3322 PHYSICAL CHEMISTRY II 4 cr. [3, 0, 4]

A continuation of 3321. Advanced study of the methods and topics covered in physical chemistry I. MA 2233 is required. Prerequisite: CHM 3321 and MA 2232.

CHM 3332 INSTRUMENTAL ANALYSIS 4 cr. [3, 0, 4]

Deals with the principles and applications of instrumental methods in chemical analysis. Studies include electroanalytical, spectrophotometric, and chromatographic techniques. Prerequisite: CHM 3311.

CHM 3341 BIOCHEMISTRY 4 cr. [3, 0, 3]

A study of carbohydrates, lipids, proteins, enzymes, nucleic acids, vitamins, and hormones in terms of structure, function, and synthesis in living systems. The laboratory includes the isolation, identification, and chemical behavior of biochemically important molecules. Prerequisite: CHM 3302 or permission of instructor.

**CHM 4410 SEMINAR 1 cr. [1, 0, 0]**

Deals with reports emphasizing chemical literature searches and/or current research.

Prerequisite: upper division chemistry major.

**CHM 4420 QUALITATIVE ORGANIC CHEMISTRY 3 cr. [2, 0, 4]**

The identification of organic compounds by various classical and instrumental techniques. Prerequisite: CHM 3302.

**CHM 4421 ADVANCED ORGANIC CHEMISTRY 3 cr. [3, 0, 0]**

An advanced lecture course designed to deepen and expand knowledge in the field.

Topics such as reactions, mechanisms, reactive intermediates, photochemistry, kinetics, stereochemistry, natural products, and spectroscopy may be stressed. Prerequisite: CHM 3302 and 3321.

**CHM 4431 ADVANCED INORGANIC CHEMISTRY 4 cr. [3, 0, 4]**

A presentation of atomic structure and periodic properties. In addition to other topics; valence bond, molecular orbital, crystal and ligand field theories are treated.

Laboratory sessions include one hour of lecture on theory and techniques in the preparation of representative compounds. Prerequisite: CHM 1112 and 3321.

**CHM 4432 STRUCTURAL CHEMISTRY 3 cr. [3, 0, 0]**

The symmetry and structural properties of molecular systems are utilized to determine their energy levels. The electronic and vibrational spectroscopic properties of these systems will be predicted also utilizing symmetry properties. These spectra-structure correlations will be made on organic and inorganic systems. Prerequisite: CHM 3302 and 3321.

**CHM 4490 PROBLEMS IN CHEMISTRY 1 - 3 cr. [0, 0, variable]**

Involves the student in study projects under the direct supervision of an instructor.

Library and laboratory research in selected problems. Prerequisite: Permission of instructor. May be taken for one through three credits.

**\*PHY 1191 PHYSICS I 4 cr. [3, 1, 2]**

A one-year sequential calculus physics course discussing classical mechanics, fluids, thermodynamics, classical electricity and magnetism, optics and waves, modern physics. Application of physics to life science is made in problem selection and laboratory experimentation. Corequisite: MA 2231.

**\*PHY 1192 PHYSICS II 4 cr. [3, 1, 2]**

Continuation of PHY 1191. Prerequisite: PHY 1191.

**\*PHY 2210 GENERAL PHYSICS I 4 cr. [3, 1, 2]**

A calculus based, introductory physics course emphasizing classical concepts. Selected topics include: motion, work and energy, gravitation, electricity and magnetism, and electromagnetic waves. Prerequisite: MA 2231. Co-requisite: MA 2232.

**\*PHY 2211 GENERAL PHYSICS II 4 cr. [3, 1, 2]**

Continuation of PHY 1191 or 2210. Corequisite MA 2233.

**PHY 3264 PHYSICAL METHODS IN FORENSIC SCIENCE 3 cr. [2, 0, 2]**

An advanced treatment of the physical methods used in the investigation of criminal activities. Topics covered include: statistical treatment of data, material properties of matter, ballistics, hair and fiber identification, physical markings, and spectral analysis. Prerequisites: CHM 1110, SCI 1104, SCI 1107