

**CHEMISTRY (CHE)**

214 Julian Hall, (309) 438-7661

Chemistry.IllinoisState.edu

Chairperson: Craig McLauchlan

**Programs Offered**

Master of Science in Chemistry (M.S.), Master of Science in Chemistry Education (M.S.C.E.), and Master of Chemistry Education (M.C.E.).

**Master of Science in Chemistry Program Requirements**

The program is broad-based, and allows students to specialize in any of the sub-disciplines (physical, organic, inorganic, analytical, biochemistry, or chemical education), although coursework is required in at least four sub-disciplines. The Master of Science in Chemistry (M.S.) is a thesis-based M.S. degree requiring 31 credit hours including: Four hours each in CHE 490 (Research) and CHE 499 (Master's Thesis) are required as part of the 31-hour program, although most students will register for more than the total of eight required hours while pursuing the degree. Students select a research advisor and work closely with that faculty member to complete a thesis based upon original research. Upon completion of a written thesis, a final oral examination/thesis defense is required.

In general, students admitted to the Master of Science in Chemistry program should have completed coursework in science and math equivalent to that required for a B.S. degree in Chemistry at Illinois State University or have received an American Chemical Society-certified B.S. degree from another school. If a student will be admitted to the Master's degree program with deficiencies (though no student will be admitted with 12 or more credit hours of deficiencies in Chemistry coursework), the deficiencies will be identified as specific courses and students will have to complete those courses as early as possible in order to bring their background coursework to the required level. All deficiencies should be completed by the end of the third semester in the program. In general, credit earned for completion of deficiencies does not apply toward M.S. degree requirements unless the student petitions the Department and receives approval to count specific courses (up to a maximum of six credit hours) for graduate credit in the student's plan of study, and only those courses listed in the Graduate Catalog may be counted for graduate credit.

This 31 hour degree requires:

- 21 hours of 400 and/or 300-level courses including a minimum of 12 credit hours of courses at the 400 level in 3 sub-disciplines (analytical, inorganic, organic, physical, biochemistry, and chemical education)
- 2 hours: 1 hour each CHE 492 and CHE 494
- 8 hours: 4 hours each in CHE 490 and CHE 499
- Successful completion of a thesis based upon original research and oral examination/thesis defense

Graduate coursework in related disciplines may be substituted with consent of the Chemistry Department.

All master's degree programs require a minimum of 50 percent of the non-thesis credit hours applied to the degree to be 400-level courses or above.

**Master of Science in Chemistry Education Program Requirements**

The Master of Science in Chemistry Education (M.S.C.E.) is a professional degree designed to improve the content and pedagogical knowledge of teachers of chemistry who already possess a bachelor's degree in Chemistry. The 33 credit hour degree requires coursework in three areas: Chemistry Content, Chemistry Education, and Foundational Science Education. It also requires a continuing and capstone classroom project. By the time of final degree awarding, a candidate must have completed three years of full-time teaching.

**Chemistry Content:**

- 12 credit hours from the following: CHE 315, 344, 350, 380A11, 380A41, 380A52, 380A54, or any 380 or 400-level course in Inorganic, Organic, Analytical, Physical, or Biochemistry for which the student has appropriate prerequisites. No credit will be granted for an Illinois State University course if a student has already taken an equivalent course elsewhere

**Chemistry Education and Science Education:**

- 15 credit hours from the following: CHE 401, 402, 403; TCH 401, 450, 451, 453

**Capstone Project:**

- 6 credit hour sequence: TCH 481 and 482 or TCH 402 and 493, or SED 406 and 407; or CHE 490 and/or 498

**Master of Chemistry Education Program Requirements**

The Master of Chemistry Education (M.C.E.) is a professional degree designed to improve the content and pedagogical knowledge of teachers of chemistry who do not possess a bachelor's degree in Chemistry. The degree requires 33 credit hours of coursework in three areas: Chemistry Content, Chemistry Education, and Foundational Science Education. It also requires a continuing and capstone project. By the time of final degree awarding, a candidate must have completed three years of full-time teaching.

**Chemistry Content:**

- 9 credit hours from the following: CHE 315, 344, 350, 380A11, 380A41, 380A52, 380A54, or any 380 or 400 level course in Inorganic, Organic, Analytical, Physical, or Biochemistry for which the student has appropriate prerequisites. No credit will be granted for an Illinois State University course if a student has already taken an equivalent course elsewhere.

**Chemistry Education and Science Education:**

- 18 credit hours from the following: CHE 401, 402, 403; TCH 401, 450, 451, 453

**Capstone Project:**

- 6 credit hour sequence: CHE 490 and/or 498; or SED 406 and 407; or TCH 481 and 482

**Chemistry Courses**

The only 300-level chemistry courses available for graduate

credit are those listed in the graduate catalog. Other 300-level chemistry courses are available for undergraduate credit only and may not be used in the degree audit for the graduate degrees in chemistry.

### **315 INSTRUMENTAL ANALYSIS**

**3 sem. hrs.**

Modern instrumental methods of chemical analysis including electroanalytical, spectroscopic, chromatographic, mass spectrometric, surface analytical, and bioanalytical methods. Prerequisites: CHE 215; MAT 146; PHY 109 or 111. Grade of C or better in CHE 215 required for Chemistry and Biochemistry majors.

### **316 INSTRUMENTAL ANALYSIS LABORATORY**

**1 sem. hr.**

Laboratory practice of the principles treated in Instrumental Analysis. Materials charge optional. Prerequisites: CHE 216 and 315 or concurrent registration. Grade of C or better in CHE 216 for Chemistry and Biochemistry majors.

### **318 METHODS OF COMPUTATIONAL SCIENCE**

**3 sem. hrs.**

Introduction to a wide variety of computational techniques and their application to problems in chemistry and physics. Also offered as PHY 318. Prerequisites: CHE 140; IT 165; PHY 109 or 111; CHE 360 or PHY 220 or concurrent registration or consent of the instructor.

### **343 BIOCHEMISTRY LABORATORY**

**2 sem. hrs.**

Application of biochemical principles and methods discussed in Chemistry 342. Lecture and lab. Materials charge optional. Prerequisite: CHE 242 or 342 or concurrent registration.

### **344 GENERAL BIOCHEMISTRY II**

**3 sem. hrs.**

Survey of important aspects of intermediary metabolism, metabolic regulation, membrane transport, and bioenergetics. Topics will include hormonal controls and immunochemical response. Prerequisite: Grade of B or better in CHE 242 or C or better in CHE 342.

### **350 ADVANCED INORGANIC CHEMISTRY**

**3 sem. hrs.**

Advanced inorganic chemistry including modern bonding theories, spectroscopy, structures and reactivity of coordination, main-group and transition-metal compounds; selected special topics. Formerly INORGANIC CHEMISTRY. Prerequisites: MAT 146; PHY 109 or 111; grade of C or better in CHE 232 and 250 required for Chemistry and Biochemistry majors.

### **351 ADVANCED INORGANIC CHEMISTRY LABORATORY**

**1 sem. hr.**

Advanced experiences in the modern synthesis and quantitative characterization of inorganic compounds and materials. Specific experiments and techniques will vary. Materials charge optional. Formerly INORGANIC CHEMISTRY LABORATORY. Prerequisites: CHE 251; CHE 350 or concurrent registration.

### **362 PHYSICAL CHEMISTRY II**

**3 sem. hrs.**

Continuation of CHE 360, including introduction to quantum theory, atomic and molecular applications of quantum mechanics, spectroscopy, and statistical thermodynamics. Prerequisite: CHE 360; grade of C or better in CHE 360 is required for Chemistry and Biochemistry majors.

### **363 PHYSICAL CHEMISTRY LABORATORY II**

**1 sem. hr.**

Laboratory studies related to principles of physical chemistry with emphasis on quantum mechanics and spectroscopy. Materials charge optional. Prerequisites: CHE 361; 362, or concurrent registration. Grade of C or better in CHE 361 is required for Chemistry and Biochemistry majors.

### **380 TOPICS IN CONTEMPORARY CHEMISTRY**

**1-3 sem. hrs.**

New concepts and recent developments in the fields of chemical education, organic, inorganic, analytical, physical, and biochemistry. Multiple enrollments allowed if content differs (see the following topics). Prerequisites: CHE 232. Certain topics may also require CHE 301, 342, 360 or 362. Grade of C or better in CHE 232 (and CHE 360 if prerequisite) is required for Chemistry and Biochemistry majors.

### **380A11 STRUCTURAL DETERMINATION IN CHEMISTRY**

**3 sem. hrs.**

An intermediary level course concerning the application of spectroscopic techniques to the structure determination of organic compounds. Prerequisite: CHE 232, or graduate standing.

### **380A15 MAGNETIC RESONANCE**

**3 sem. hrs.**

This course covers essential concepts and principles in Nuclear Magnetic Resonance (NMR) and Electron Paramagnetic Resonance (EPR) spectroscopies. In EPR, the similarities and differences to NMR will be looked at. Prerequisite: CHE 233. CHE 362 is recommended.

### **380A37 COMPUTATION OF MOLECULAR PROPERTIES**

**3 sem. hrs.**

This course provides an introduction to common techniques employed in computational chemistry. Emphasis is placed on molecular mechanics and molecular dynamics along with methods of molecular orbital theory. Prerequisite: CHE 360.

### **380A45 X-RAY DIFFRACTOMETRY**

**3 sem. hrs.**

Advanced study in the area of X-ray Crystallography. Prerequisite: CHE 362 or concurrent registration.

### **380A52 HOMOGENOUS CATALYSIS**

**3 sem. hrs.**

This course will introduce topics in homogenous catalysis. Students will have the basic knowledge to understand the reactions discussed throughout the semester. the multiple bonds and carbon-carbon bond formation. Prerequisite: CHE 232 or equivalent.

### **380A54 CARBOHYDRATES**

**3 sem. hrs.**

This course is an overview of the physical, chemical, and biochemical aspects of simple and complex carbohydrates. Prerequisite: CHE 342 or equivalent, or graduate standing.

### **380A59 ATMOSPHERIC CHEMISTRY**

**3 sem. hrs.**

New concepts in recent developments in the fields of organic chemical education, inorganic, analytical, physical, and biochemistry. Prerequisites: Grade of C or better in CHE 232.

**380A63 INDUSTRIAL CHEMISTRY****3 sem. hrs.**

Advanced study of physical inorganic chemistry in applied settings. Topics covered include industrial cooling processes, industrial catalysis, manufacturing and purification processes in applied settings. Not for credit if an equivalent course has been taken. Prerequisite: MCE/MSCE degree or non-degree seeking students.

**380A64 BIOCHEMISTRY OF NUTRITION, EXERCISE, AND SPORTS MEDICINE****3 sem. hrs.**

Analysis of the biochemistry of nutrition and exercise and how these can be used to understand their complex interactions. For credit for MSCE/MCE program. Not for credit in the M.S. in Chemistry. Not for credit for CHE, Biochemistry or CTE majors. May be taken for credit in the CHE minor. Prerequisite: CHE 242 or 342 or equivalent or consent of the instructor.

**401 ADVANCED CHEMISTRY DEMONSTRATIONS****1-3 sem. hrs.**

Topical analysis of current best practices in teaching chemistry. Multiple enrollments allowed for credit if content differs (see following topics). Prerequisite: CHE 301 or 401 (any topic) or 402 or 403 or equivalent. Not for credit in the M.S. in Chemistry program.

**401A01 GAS PROPERTIES, LAWS AND REACTIONS****3 sem. hrs.**

Topical analysis of current best practices in teaching gas properties, laws, and reactions. Prerequisite: CHE 301 or 401 (any other topic) or 402 or 403 or equivalent. Not for credit in the M.S. in Chemistry program.

**401A02 CHEMICAL REACTIONS, STOICHIOMETRY AND THE MOLECULE****3 sem. hrs.**

Topical analysis of current best practices in teaching chemical reactions, stoichiometry and the molecule. Prerequisite: CHE 301 or 401 (any other topic) or 402 or 403 or equivalent. Not for credit in the M.S. in Chemistry program.

**401A03 KINETICS, EQUILIBRIUM AND ACIDS AND BASES****3 sem. hrs.**

Topical analysis of current best practices in teaching kinetics, equilibrium and acids and bases in chemistry. Prerequisite: CHE 301 or 401 (any other topic) or 402 or 403 or equivalent. Not for credit in the M.S. in Chemistry program.

**401A04 ATOMIC AND MOLECULAR STRUCTURE****3 sem. hrs.**

Topical analysis of current best practices in teaching atomic and molecular structure. Prerequisite: CHE 301 or 401 (any other topic) or 402 or 403 or equivalent. Not for credit in the M.S. in Chemistry program.

**401A05 REDOX, ELECTROCHEMISTRY AND SOLUTIONS****3 sem. hrs.**

Topical analysis of current best practices in teaching redox, electrochemistry and solutions. Prerequisite: CHE 301 or 401 (any other topic) or 402 or 403 or equivalent. Not for credit in the M.S. in Chemistry program.

**401A06 ADVANCED CHEMISTRY DEMONSTRATIONS: THERMOCHEMICAL ENERGY IN THE CHEMISTRY CURRICULUM****3 sem. hrs.**

Topical analysis of current best practices and difficulties in teaching energy concepts in chemistry as they pertain to secondary school classrooms. A particular emphasis will be to connect content knowledge to modern demonstrations and teaching activities. Not for credit if in the M.S. in Chemistry program. Prerequisite: CHE 301 or 401 (any other topic) or 402 or 403 or equivalent.

**402 TEACHING CHEMISTRY IN THE LABORATORY****1-3 sem. hrs.**

Critical analysis of factors for teaching chemistry in the laboratory. Multiple enrollments allowed for credit (see the following topic). Prerequisites: CHE 301 or 401 or 402 or 403, or equivalent. Not for credit in the M.S. in Chemistry program.

**402A01 AN EXPERIMENTAL SCIENCE****3 sem. hrs.**

Critical analysis of factors for teaching chemistry in the laboratory. Prerequisites: CHE 301 or 401 or 402 (any other topic) or 403, or equivalent. Not for credit in the M.S. in Chemistry program.

**403 TEACHING SCIENCE SAFELY****1-3 sem. hrs.**

Topical analysis of current best practices in teaching science safely. Course multiple enrollments allowed (see the following topics). Prerequisites: CHE 301 or 401 or 402 or 403 or equivalent. Not for credit in the M.S. in Chemistry program.

**403A01 TEACHING CHEMISTRY SAFELY: SECONDARY SCHOOL****3 sem. hrs.**

Topical analysis of current best practices in teaching science safely. Prerequisites: CHE 301 or 401 or 402 or 403 (any other topic) or equivalent. Not for credit in the M.S. in Chemistry program.

**412 ADVANCED TOPICS IN ANALYTICAL CHEMISTRY****1-3 sem. hrs.**

Advanced study in selected areas of modern analytical chemistry. Multiple enrollments allowed (see the following topics). Prerequisite: CHE 315.

**412A05 BIOANALYTICAL CHEMISTRY****3 sem. hrs.**

Advanced study in bioanalytical chemistry. Prerequisite: CHE 315.

**412A07 SURFACE STRUCTURE AND CHEMISTRY****3 sem. hrs.**

Advanced study in surface structure and chemistry. Prerequisite: CHE 315.

**412A09 CHEMICAL INSTRUMENTATION****3 sem. hrs.**

Fundamental theory and practical aspects of analog and digital electronics, computer interfacing, data acquisition, analog and digital signal processing, and S/N enhancement techniques. Prerequisite: CHE 315.

**412A15 PRINCIPLES AND APPLICATIONS OF MASS SPECTROMETRY****3 sem. hrs.**

Advanced study in principles and applications of mass spectrometry. Prerequisite: CHE 315.

**422 MECHANISMS IN ORGANIC CHEMISTRY****3 sem. hrs.**

A critical examination of nucleophilic, electrophilic, and free radical reaction mechanisms including the study of the stability and reactivity of carbanions, carbocations and carbenes.

Prerequisites: CHE 232; 360 or concurrent registration.

**424 ADVANCED TOPICS IN ORGANIC CHEMISTRY****1-3 sem. hrs.**

Lectures in selected topics of modern organic chemistry. Course multiple enrollments allowed. Prerequisite: CHE 232 or equivalent.

**426 ORGANIC SYNTHESIS****3 sem. hrs.**

Survey of stereoselective carbon-carbon single and double bond formation, functional group interconversion, multi-step synthetic strategies and an introduction into enantioselective reactions. Prerequisite: CHE 232 or equivalent.

**428 HETEROCYCLES****3 sem. hrs.**

Advanced study of the major classes of heterocyclic compounds; includes detailed discussion of aromaticity, conformational analysis, ring synthesis, reactions and nomenclature.

**440 ADVANCED TOPICS IN BIOCHEMISTRY****1-3 sem. hrs.**

Advanced study in selected areas of biochemistry.

Prerequisite: One semester of biochemistry. Multiple enrollments allowed if topic differs (see the following topics).

**440A02 NUCLEIC ACIDS****3 sem. hrs.**

Study of structure and function of nucleic acids. Prerequisite: One semester of biochemistry or consent of the instructor.

**440A13 BIOINORGANIC CHEMISTRY****3 sem. hrs.**

The structures, bonding, and experimental methods of study and biological functions of essential/toxic metals and metallodrugs will be considered. Prerequisites: CHE 250 and 342 or equivalent or consent of the instructor.

**442 PROTEINS****3 sem. hrs.**

Chemical forces governing overall protein structure as related to biological function. Methods of protein purification and structural analysis are examined. Prerequisite: CHE 242 or 342 or equivalent.

**444 LIPIDS****3 sem. hrs.**

A survey of lipids: structures, functions, intermediary metabolism, metabolic regulation, and techniques used to isolate, characterize and quantitate lipids. Prerequisite: CHE 242 or 342 required. CHE 344 is recommended.

**454 ADVANCED TOPICS IN INORGANIC CHEMISTRY****1-3 sem. hrs.**

Advanced study in selected areas of modern inorganic chemistry. Multiple enrollments allowed (see the following topics). Prerequisite: CHE 350.

**454A03 ORGANOMETALLIC CHEMISTRY****3 sem. hrs.**

Advanced study in organometallic chemistry. Prerequisite: CHE 350.

**454A06 SOLID STATE AND MATERIALS CHEMISTRY****3 sem. hrs.**

Advanced study in solid state and materials chemistry.

Prerequisite: CHE 350.

**460 QUANTUM CHEMISTRY****3 sem. hrs.**

An introduction to the methods of obtaining exact and approximate solutions to the Schrodinger equation, and the use of these solutions in the description of atomic and molecular systems. Prerequisite: CHE 362. MAT 175 and 340 are recommended.

**464 KINETICS AND DYNAMICS****3 sem. hrs.**

Advanced study of kinetics and dynamics. Topics range from basic kinetics to transition state theory, with an emphasis on modern techniques. Prerequisite: CHE 362.

**466 ADVANCED TOPICS IN PHYSICAL CHEMISTRY****1-3 sem. hrs.**

Advanced study in selected areas of modern physical chemistry. Multiple enrollments allowed (see the following topic).

Prerequisite: CHE 362.

**490 RESEARCH IN CHEMISTRY****Variable credit**

Research involving the gathering of data to form the basis for the thesis. The course can be repeated for credit. No more than four hours may be used on a degree audit to meet degree requirements. Prerequisites: Open only to advanced graduate students. Consent of the Department Chair.

**492 LITERATURE SEMINAR IN CHEMISTRY****1 sem. hr.**

Survey of current techniques for presenting and reviewing chemical literature and presentation of a current topic in the chemical literature. Formerly SEMINAR IN CHEMISTRY.

**494 RESEARCH SEMINAR IN CHEMISTRY****1 sem. hr.**

Survey of current techniques for presentation of chemical information, and presentation of a seminar related to a Master's thesis research topic. Prerequisite: CHE 492 or consent of the instructor.

**498 PROFESSIONAL PRACTICE IN CHEMISTRY****1-9 sem. hrs.**

Refer to General Courses. Provides graduate students with the opportunity to obtain supervised work experience in chemistry. Available as 498A50 Co-op in Chemistry (see below). Graduate students must have completed at least one semester of graduate courses (minimum GPA of 3.0) before the first off-campus assignment is made. If this course is taken as Passing/Not Passing (P/NP) only, it may not be used on a degree audit towards degree requirements. No credit can be awarded toward the 12 hour 400-level course requirement for the degree.

**498A50 PROFESSIONAL PRACTICE: COOP IN CHEMISTRY****1-9 sem. hrs.**

Practical experience by employment in an industrial or government laboratory. Graduate students must have completed at least one semester of graduate courses (minimum GPA of 3.0) before the first off-campus assignment is made. No more than 2 credit hours of 498A50 can be counted towards the 21 hour coursework requirement for the degree. If this course is taken as Passing/Not Passing (P/NP) only, it may not be used on a degree audit towards degree requirements. No credit can be awarded toward the 12 hour 400-level course requirement for the degree.

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**499 MASTER'S THESIS**

**1-6 sem. hrs.**

Refer to General Courses.

**499A90 INDEPENDENT RESEARCH FOR MASTER'S  
THESIS LAST TERM**

**1 sem. hr.**

Refer to General Courses.