

# Department of Chemistry

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Professors:	Haddadin, Makhlof J.; Sultan, Rabieh F.
Associate Professors:	Al-Ghoul, Mazen H.; Halaoui, Lara I.
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Lecturer:	<sup>P</sup> Fares, Fares A.
Instructors:	Deeb, Hana H.; Abi Rafii, Randa R.; Sadek, Samar A.

## Undergraduate Program

Students are accepted as provisional majors in the sophomore year. In order to be accepted as a regular major in the junior year a student must have passed CHEM 201 with a minimum grade of 70, must obtain a 70 average in all other chemistry courses taken, a minimum average of 70 in all mathematics and physics courses taken, and CMPS 209/200. As a major, the student must complete the following minimum requirements: CHEM 201, CHEM 211, CHEM 212, CHEM 215, CHEM 216, CHEM 217, CHEM 218, CHEM 220, CHEM 225, CHEM 228, CHEM 229, and CHEM 230; at least two elective courses of the following four courses: CHEM 231, CHEM 232, CHEM 233, and BIOL 220; in addition to MATH 201, MATH 202, and CMPS 209 or CMPS 200; PHYS 211 and PHYS 211L or PHYS 228 and PHYS 228L.

Freshman students who intend to major in chemistry should complete the following minimum requirements: CHEM 101 and CHEM 102, MATH 101 and MATH 102. PHYS 101 and PHYS 101L are useful science electives.

Students who intend to minor in chemistry should complete the following requirements: CHEM 201, one course from CHEM 206 or CHEM 215, CHEM 211, CHEM 212, CHEM 228, and one course from CHEM 217 or CHEM 218, for a total of 18 or 19 credits. MATH 201 is a prerequisite for a minor in chemistry.

For a premedical chemistry student the core premedical chemistry courses are CHEM 201, CHEM 211, CHEM 212, CHEM 216, and CHEM 225 for a total of 15 credits. The biology premedical courses are BIOL 201 and BIOL 202 (8 credits).

The physics requirements for a premedical chemistry student are any one of the following six combinations<sup>1</sup>:

- A. PHYS 211, PHYS 211L, PHYS 228, PHYS 228L (8 cr.)
- B. PHYS 211, PHYS 211L, PHYS 210, PHYS 210L (8 cr.)
- C. PHYS 210, PHYS 210L, PHYS 228, PHYS 228L (8 cr.)
- D. PHYS 211, PHYS 210, PHYS 221L (8 cr.)
- E. PHYS 228, PHYS 228L, PHYS 210, PHYS 221L (9 cr.)
- F. PHYS 228, PHYS 228L, PHYS 211, PHYS 221L (9 cr.)

The chemistry core courses for non-chemistry major premedical students are CHEM 201, CHEM 206, CHEM 210, CHEM 211, and CHEM 212, for a total of 15 credits.

\* On leave 2005-2006

<sup>P</sup> Part-time

<sup>1</sup> These requirements apply to students entering as of the summer 2004

**CHEM 101**                      **General Chemistry I**                      **3.3; 4 cr.**  
An introductory course that covers atomic structure, chemical bonding, gas laws, stoichiometry, solutions, chemical equilibrium, and other basic concepts. Includes laboratory practice. *Each semester.*

**CHEM 102**                      **General Chemistry II**                      **3.3; 4 cr.**  
A course that covers acid-base and solubility equilibria and introductory thermodynamics; surveys common groups in the periodic table; provides an introduction to organic chemistry, nuclear chemistry, and electrochemistry. Includes laboratory practice. *Prerequisite: CHEM 101. Each semester.*

**CHEM 200**                      **Basic Chemistry**                      **3.0; 3 cr.**  
A course that stresses the fundamental chemical principles, such as stoichiometry, acids and bases, the phases of matter, basic thermodynamics, and solutions. Designed for students majoring in agriculture, nursing, public health, and medical laboratory technology. *Students cannot receive credit for both CHEM 200 and CHEM 201. Each semester.*

**CHEM 201**                      **Chemical Principles**                      **3.0; 3 cr.**  
A theoretical introduction to chemical principles, stressing atomic structure, bonding, stoichiometry, gases, solutions, acids and bases, solution equilibria. Designed for students with a background in chemistry equivalent to CHEM 101. *Students cannot receive credit for both CHEM 200 and CHEM 201. Each semester.*

**CHEM 202**                      **Introduction to Environmental Chemistry**                      **3.0; 3 cr.**  
An introduction to the fundamentals of physical, inorganic, and organic chemistry, with applications to environmental problems. This course surveys atomic and molecular structure, solutions, equilibrium, acids and bases, oxidation-reduction, reaction kinetics with emphasis on mechanisms of organic free radical reactions, and basic radioactivity. *Students can receive credit for CHEM 201 and CHEM 202. Prerequisite: CHEM 101 or equivalent. Each semester.*

**CHEM 203**                      **Introductory Chemical Techniques**                      **1.3; 2 cr.**  
A laboratory course on the methods of quantitative analysis, physical chemistry measurements, and inorganic semi-micro qualitative analysis, with applications to environmental problems. *Not open to chemistry majors. Pre- or corequisite: CHEM 200, 201, or 202. Annually.*

**CHEM 205**                      **Introductory Chemistry Laboratory**                      **1.4; 2 cr.**  
A laboratory course on the methods of quantitative analysis, physical chemistry measurements, and inorganic semi-micro qualitative analysis. *Not open to chemistry majors. Pre- or corequisite: CHEM 200, 201, or 202. Each semester.*

**CHEM 206**                      **Quantitative Analysis**                      **3.4; 4 cr.**  
A course that covers gravimetric and volumetric techniques; acid/base, complex formation, and redox titrations; electrochemistry and an introduction to chromatography and spectrophotometric analysis. This course is designed for biology majors. *Not open to chemistry majors. Students cannot receive credit for both CHEM 206 and CHEM 215–216. Prerequisite: CHEM 201. Each semester.*

**CHEM 208**                      **Brief Survey of Organic Chemistry**                      **3.0; 3 cr.**  
A brief survey designed for students majoring in agriculture or public health that covers the following topics: hydrocarbons, stereoisomerism, organo halogens, oxygen containing groups, carbonyl groups, carboxylic acids and their derivatives, amines, carbohydrates, and amino-acids. *Students cannot receive credit for both CHEM 208 and CHEM 211. Prerequisite: CHEM 102 or equivalent. Each semester.*

**CHEM 209                      Introductory Organic Laboratory                      1.4; 2 cr.**

A course of basic experiments in organic chemistry, including synthesis and techniques of separation and purification of organic compounds. *Students cannot receive credit for more than one course among CHEM 209 and CHEM 210. Pre- or corequisite: CHEM 208. Each semester.*

**CHEM 210                      Organic Laboratory for Non-Majors                      1.4; 2 cr.**

Basic experimental techniques in organic analytical chemistry (melting and boiling point, chromatography, distillation, extraction, recrystallization), performing reactions in synthetic organic chemistry. *Students cannot receive credit for more than one course between CHEM 209 and CHEM 210. Pre- or corequisite: CHEM 212. Each semester.*

**CHEM 211                      Organic Chemistry I                      3.0; 3 cr.**

An introduction to organic chemistry organized according to functional groups. This course covers synthesis, properties, and reactions of aliphatic and aromatic hydrocarbons and alkyl halides, with emphasis on mechanistic and stereochemical aspects of organic reactions. Designed for chemistry majors and premedical study. *Students cannot receive credit for both CHEM 208 and CHEM 211. Prerequisite: CHEM 201. Each semester.*

**CHEM 212                      Organic Chemistry II                      3.0; 3 cr.**

Synthesis, properties, and reactions of organic functional groups, including alcohols and ethers, aldehydes and ketones, carboxylic acids and derivatives, amines, phenols, and aryl halides; chemistry of difunctional compounds and of molecules of biological importance, including carbohydrates, proteins, and nucleic acids; and, organic structure determination by spectroscopic methods. Emphasis is placed on reaction mechanism and stereochemistry, as well as on the design of multi-step syntheses. Designed for chemistry majors and premedical study. *Prerequisite: CHEM 211. Each semester.*

**CHEM 215                      Analytical Chemistry                      3.0; 3 cr.**

A course that covers fundamental analytical processes, including solution equilibria, titrations, electrochemical theory and applications, chromatography and spectrophotometric techniques. *Students cannot receive credit for both CHEM 215 and CHEM 206. Prerequisite: CHEM 201. Annually.*

**CHEM 216                      Analytical Chemistry Laboratory                      1.4; 2 cr.**

Experimental work in related areas of chemical analysis and instrumentation; acid/base titrations, pH measurements, complexometric analysis, electrochemical determination of electrode potentials and ion activities; ion-selective electrodes; spectrophotometric analysis. *Pre- or corequisite: CHEM 215. Annually.*

**CHEM 217                      Thermodynamics and Chemical Dynamics                      3.0; 3 cr.**

A course that covers the basic principles of chemical thermodynamics and chemical dynamics; mathematical machinery of the laws of thermodynamics; heat, work, and energy; first, second, and third laws of thermodynamics; thermodynamics of chemical reactions; thermodynamics of solutions; transport properties: diffusion, viscosity, ion transport, thermal conductivity; chemical kinetics; collision theory; activated complex theory. *Prerequisites: CHEM 201 and MATH 201. Annually.*

**CHEM 218                      Molecular Structure                      3.0; 3 cr.**

Failures of classical physics, quantum theory, Schrödinger equation, particle in a box, harmonic oscillator, rotational motion, hydrogen atom, atomic orbitals, spin, Pauli exclusion principle, complex atoms, term symbols, molecular structure, hybridization, Hückel theory, rotation, vibration, and electronic spectra. *Students cannot receive credit for both PHYS 212 and CHEM 218<sup>2</sup>. Prerequisites: CHEM 201 and MATH 201. Annually.*

- CHEM 220                      Physical Chemistry Laboratory                      1.6; 3 cr.**  
Experiments in thermodynamics, kinetics, electrochemistry, spectroscopy, and exercise in computational chemistry. *Prerequisite: CHEM 217, pre- or corequisite: CHEM 218. Annually.*
- CHEM 225                      Organic Structure Determination                      1.6, 4 cr.**  
Experiments in the techniques of purification, separation, and synthesis of derivatives of organic compounds; theory and practice in the analysis of organic compounds by infrared, ultraviolet-visible spectrophotometry, mass spectrometry, and nuclear magnetic resonance; identification of pure compounds and of components of mixtures of organic compounds by chemical and spectral methods. *Prerequisite: CHEM 212. Annually.*
- CHEM 227                      Technical Analysis                      1.4, 3 cr.**  
Applications of chemical analysis to the analysis of natural and industrial products such as water, milk, textiles, liquors, oils, petroleum. Industrial techniques such as sample preparation and preconcentration. Separation and identification techniques: extraction, chromatography, and spectroscopy. *Prerequisite: CHEM 215. Alternate years.*
- CHEM 228                      Inorganic Chemistry                      3.0; 3 cr.**  
Atomic structure, molecular structure (VBT, MOT), molecular shape (VSEPR), symmetry and group theory, the structure of solids (metals, ionic), acids and bases (Bronsted, Lewis, HSAB, solvents). *Prerequisite: CHEM 201. Annually.*
- CHEM 229                      Coordination Compounds                      3.0; 3 cr.**  
A course that covers d-metal complexes (structures and symmetries, bonding and electronic structure, reactions of complexes); electronic spectra of complexes; reaction mechanisms of d-block complexes (ligand substitution reactions in square-planar and octahedral complexes, redox reactions, photochemical reactions). *Prerequisite: CHEM 228. Annually.*
- CHEM 230                      Senior Seminar                      1 cr.**  
A literature search of a specific topic in chemistry. A written report and an oral presentation in a seminar form. *Prerequisite: Senior standing. Each semester.*
- CHEM 231                      Organic Synthesis                      1.4; 3 cr.**  
Experiments in multistep synthesis of organic compounds, with an emphasis on methods used for synthesis and isolation, and characterization of intermediates and products. *Pre- or corequisite: CHEM 212. Annually.*
- CHEM 232                      Inorganic Synthesis                      1.4; 3 cr.**  
Experiments in synthesis, separation, purification, and characterization of inorganic main-group and transition metal compounds by IR, UV-Vis, NMR, and ESR spectroscopy. *Prerequisite: CHEM 228. Annually.*
- CHEM 233                      Topics in Physical Chemistry                      3.0; 3 cr.**  
A course that covers a selection of topics in thermodynamics, advanced kinetics, and techniques in physical analysis; thermodynamics of phase transformation; theoretical and experimental aspects of rates of reactions; rate laws of complex reactions, catalysis, adsorption isotherms, spectroscopic techniques (e.g., laser spectroscopy, NMR, EPR); surface analysis and imaging techniques; X-ray crystallography. *Prerequisite: CHEM 217; and pre- or corequisite: CHEM 218. Annually.*

**CHEM 295 Special Topics in Chemistry****3.0; 3 cr.***Prerequisite: senior standing in chemistry.***CHEM 299 Independent Study****3 cr.**

Independent chemical research carried out under the direction of a faculty member, including presentation of the results in the form of a senior thesis. Offered to senior students in good standing, by arrangement with the project director. *Each semester.*

**34 + 6 credits in Chemistry**

<b>Modes of Analysis</b>	<b>English and Arabic (9)</b>	<b>Humanities (12)</b>	<b>Social Sciences</b>	<b>Sciences, Math, and Technology (53–56)</b>
Lecture courses (57–63)	<ol style="list-style-type: none"> <li>Required Arabic course: 201A or B, or any upper level course (3)</li> <li>Required English courses: 203(3), 204(3)</li> </ol>	Required credits in the humanities: 12 credits including 6 credits from CVSP (see pp. 163–65)	Electives <sup>1</sup> (unspecified): highly recommended is an introductory course in economics (e.g., ECON 203, 211, 212)	<ol style="list-style-type: none"> <li>Chemistry courses (24–30) Core: CHEM 201(3), 211(3), 212(3), 215(3), 217(3), 218(3), 228(3), 229(3) Electives<sup>2</sup>: CHEM 233(3), BIOL 220(3)</li> <li>Science courses (12 cr.): PHYS 211(3) or PHYS 228(3), MATH 201(3), MATH 202(3), CMPS 209 or 200(3)</li> </ol>
Seminar (1)				CHEM 230(1)
Laboratory (13–19)				<ol style="list-style-type: none"> <li>Chemistry courses (9–15) Core: CHEM 216(2), 220(3), 225(4) Electives<sup>2</sup>: CHEM 231(3), 232(3)</li> <li>Science courses (1): PHYS 211L or 228L(1) + CMPS 209 or 200(3)<sup>3</sup></li> </ol>
Research project (0 or 3)				CHEM 299(3) <sup>4</sup>

1 The number of free elective credits total 16. Students can fulfill the economics and social sciences requirements in the various modes of analysis from these credits.

2 Students take, in addition to the 33 credits of core chemistry courses and the seminar course (230), 6 credits of the following elective courses of chemistry or biochemistry: CHEM 231, CHEM 232, CHEM 233, BIOL 220.

3 CMPS 209 is counted only once in the science credits above (53–56). It is, however, included and counted in both lecture and lab modes of analysis.

4 Not a requirement; could be taken as part of the 16 credits.

**THE REQUIREMENTS LISTED ABOVE APPLY TO STUDENTS WHO JOINED THEIR MAJOR AS OF OCTOBER 1, 2001–02. STUDENTS WHO JOINED A MAJOR PRIOR TO THAT DATE SHOULD CONSULT THE 2000–01 CATALOGUE**

# Graduate Program

The department offers the MS degree in chemistry. Graduate students may specialize in analytical, inorganic, organic, or physical chemistry. Of the minimum 21 graduate course credits required for the MS degree, a minimum of six credits must be graduate courses in the special field of chemistry in which the student concentrates. At least six additional credits must be graduate courses in chemistry outside the student's field of specialization. CHEM 361 is a requirement for all graduate students.

The research interests of the chemistry faculty include the following: synthetic heterocyclic chemistry; synthesis of biomaterials for drug delivery; synthesis of carbocyclic DNA analogs; reactive intermediates; cage compounds; coordination and organometallic chemistry; supramolecular chemistry; photocatalysis; photoelectrochemistry of semiconductors; synthesis, assembly, and physical properties of nanostructured materials; surface chemistry; irreversible nonequilibrium thermodynamics and statistical mechanics; nonlinear dynamics in chemistry; generalized hydrodynamics; chemical waves; precipitate patterns; laboratory and field investigations of atmospheric chemistry processes; design and synthesis of novel photoactive dendrimers; self-assembled mono-layers (SAMs) of bioactive material and poly-peptides on metal surfaces; study of electronic structure of unsaturated transition metal complexes and their reactions; analytical monitoring of priority pollutants in soil and water; process analytical chemistry applied in waste treatment and recycling technologies; natural compounds for metal sequestration; calorimetric methods in life sciences; discotic liquid crystals; synthesis of electron-deficient materials for organic electronics and opto-electronics applications; organic light emitting diodes (OLEDs), organic field effect transistors (OFETs), and organic solar cells; molecular recognition; and, solid-state stacking of organic materials.

**CHEM 301                      Structure of Inorganic Compounds                      3.0; 3 cr.**  
Electronic absorption spectra of complex inorganic molecules; vibrational, NMR, NQR, EPR, and Mössbauer spectroscopy; physical methods of determination of the structure of inorganic molecules. *Annually.*

**CHEM 303                      Chemistry of the Coordination Compounds                      3.0; 3 cr.**  
Applications of Orgel and Tanabe-Sugano diagrams; factors affecting stability of coordination compounds; stereochemistry; trans-effect; stabilization of oxidation states; mechanisms of the reactions of coordination compounds; catalysis by coordination compounds. *Annually.*

**CHEM 304                      Mechanisms of Inorganic Reactions                      3.0; 3 cr.**  
Mechanisms of substitution reactions in octahedral and square planar metal complexes; mechanisms of oxidation-reduction, metal ion catalysis and photochemistry; application of symmetry rules to inorganic reactions; fluxional molecules. *Alternate years.*

**CHEM 311                      Advanced Organic Chemistry                      3.0; 3 cr.**  
Electronic interpretation of organic reactions; correlation of inductive, resonance, and steric effects with reactivity of molecules; chemistry of carbocations, carbanions, carbenes, carbenoids, and radicals as intermediates in characteristic organic reaction mechanisms. *Annually.*

**CHEM 313                      Physical Organic Chemistry                      3.0; 3 cr.**  
Organic reactions mechanisms, linear free energy relationships, solvent and reagent correlations, isotope effects, catalysis in weak and strong acid and base medium, organic photochemistry and pericyclic reactions. *Alternate years.*

**CHEM 314 Heterocyclic Chemistry 3.0; 3 cr.**

A general survey of the synthesis and reactions of selected classes of heterocyclic compounds; spectroscopic properties and structural relationships. *Alternate years.*

**CHEM 315 Chemistry and Technology of High Polymers 3.0; 3 cr.**

An introduction to the chemistry of high polymers; types, mechanisms, and kinetics of polymerization; structure, characterization, and properties of macromolecules; preparation, processing, and uses of the more common condensation and addition polymers used in plastics, elastomers, and fibers. *Alternate years.*

**CHEM 321 Quantum Chemistry 3.0; 3 cr.**

Wave mechanics, solutions of time-independent Schrödinger equation, particle in a box, harmonic oscillator, angular momentum, H-atom, atomic orbitals, variational theorem, perturbation theory, polyelectronic atoms, Slater determinants, term symbols, Hückel MO theory, electronic wave functions, SCF and CI calculations. *Alternate years.*

**CHEM 322 Statistical Thermodynamics 3.0; 3 cr.**

General statistical mechanics of independent particles; partition functions for atoms and molecules, and simple chemical equilibria; heat capacities of solids, configuration of polymers, ensembles, theory of imperfect gases and of mixtures, lattice statistics, irreversible processes. *Alternate years.*

**CHEM 323 Chemical Kinetics 3.0; 3 cr.**

Rate analysis, modern experimental techniques, theories of chemical kinetics, selected topics in gas phase and solution kinetics, characterization of transition states by ab-initio methods. *Alternate years.*

**CHEM 324 Electrochemistry 3.0; 3 cr.**

Fundamentals and applications of electrochemistry. Overview of electrode processes, potentials and thermodynamics of cells; kinetics of electrode reactions; Marcus microscopic theory for charge transfer; treatment of mass transfer by migration and diffusion; electrochemical techniques including potential step methods, potential sweep methods, and hydrodynamic methods; electrode reactions with coupled homogeneous chemical reactions; instrumentation. *Alternate years.*

**CHEM 331 Chemical Instrumentation for Environmental Analysis 3.0; 3 cr.**

Qualitative and quantitative analytical methods; ultraviolet (UV) and infrared (IR) spectroscopy; atomic absorption (AA) and emission spectroscopy; introduction to chromatographic separations. Designed for the Interfaculty Graduate Environmental Sciences Program (IGESP). *Annually.*

**CHEM 332 Chemical Separations in Environmental Analysis 3.0; 3 cr.**

Fundamentals of analytical separations; distribution methods in discrete stages; methods in continuous stages; chromatographic methods: GC, HPLC, SFC; non-chromatographic methods: electrophoresis, field-flow fractionation, size exclusion; recent innovations. Designed for the Interfaculty Graduate Environmental Sciences Program (IGESP). *Annually.*

**CHEM 351/352 Special Topics 3 cr.**

May be repeated for credit with consent of the department.

**CHEM 361 Tutorial 3 cr.**

A tutorial that should be taken during a student's second or third semester of graduate studies, but not during a summer session. Students taking CHEM 361 are required to submit written reports to their advisers and to present a seminar to the students and faculty of the department. CHEM 361 is required of all graduate students in the department.

**CHEM 399 MS Thesis 9 cr.**