

# Department of Chemistry

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| Chairperson:          | Patra, Digambara J.   |
| Professors:           | Al-Ghoul, Mazen H.; Bouhadir, Kamal H.; El-Rassy, Houssam T.; Ghaddar, Tarek H.; Ghauch, Antoine R.; Halaoui, Lara I.; Hasanayn, Faraj A.; Kaafarani, Bilal R.; Patra, Digambara J.; Sultan, Rabih F. |
| Associate Professors: | Karam, Pierre M.; Hmadeh, Mohamad A.  |
| Instructors:          | Abi Rafii, Randa A.; Deeb, Hana H.; Sadek, Samar A.   |

## MS in Chemistry

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 6 credits must be graduate courses in the concentration field of chemistry, and 6 credits must be graduate courses in chemistry outside the student's field of specialization. CHEM 361 is a requirement for all graduate students. A 9-credit thesis, CHEM 399, is required.

The research interests of the chemistry faculty include synthetic heterocyclic chemistry, synthesis of biomaterials for drug delivery and 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; patterns and fractals in precipitate and metal electro-deposition systems; laboratory and field investigations of atmospheric chemistry processes; design and synthesis of dyes for dye sensitized solar cells; 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; 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); organic solar cells; molecular recognition; solid-state stacking of organic materials; biocatalysis; control of inorganic phase growth; developing new probe molecules based on nanocapsules, nanocrystals, curcumin and PAHs for physical and biophysical studies; fluorescence sensing and spectroscopic investigation on multi-component analysis and biosensor development; fluorescence spectroscopy, imaging and applications; hybrid solid materials; luminescence, solid surface room temperature phosphorescence (SS-RTP) and diffuse reflectance spectrometry (DRS); monitoring of organic and inorganic pollutants in industrial effluent under rigorous conditions; nanoscopy and single molecule studies in physical and biophysical chemistry; new methods for depollution of water contaminated by organic pollutants; photophysical and biophysical chemistry; probe chemistry; use of the reductive properties of Zero Valent Iron for the degradation of pesticides and chlorinated organic compounds in water; renewable energy, biosensing and photochemistry at the single molecule level.

# Course Descriptions

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- 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 316      Chemistry of Synthetic Polymers      3.0; 3 cr.**  
**for Biomedical Applications**  
An introduction to the chemistry of synthetic polymers and their applications in the biomedical field; nomenclature, preparations, reactions, synthesis, mechanisms, characterization, biocompatibility and biodegradability. A general presentation of biomedical applications of synthetic polymers in bones, joints, teeth, artificial organs, synthetic skin, contact lenses, time-release drug delivery and gene delivery. *Alternate years.*

- CHEM 317 Synthetic Organic Chemistry 3.0; 3 cr.**  
A survey of new reagents and synthetic procedures used in advanced organic synthesis; oxidation and reduction reagents in organic synthesis; protecting groups; carbon-carbon bond formation; functional groups inter-conversions. *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 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 325 Molecular Spectroscopy 3.0; 3 cr.**  
Review of basic quantum mechanics; fundamental features of spectroscopy and experimental methods; atomic spectra; diatomic molecules; rotational spectroscopy; vibrational spectroscopy; electronic spectroscopy; polyatomic molecules; direct product representations and selection rules; re-emission of energy by excited molecules; fluorescence; fluorescence spectra; molecular beams and lasers. *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 Master's Degree Programs in Environmental Sciences. *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 Master's Degree Programs in Environmental Sciences. *Annually.*

**CHEM 351**      **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 term of graduate studies, but not during a summer session. Students taking CHEM 361 are required to submit written reports to their advisors and to present a seminar to the students and faculty of the department. CHEM 361 is required of all graduate students in the department. *May not be repeated for credit.*

**CHEM 395A**      **Comprehensive Exam**      **0 cr.**  
*Prerequisite: Consent of advisor.*

**CHEM 399**      **Thesis**      **9 cr.**