DEPARTMENT OF CHEMISTRY

Chairman

Dr. Khalid R. Alhooshani

Faculty

Al-Arfaj	Al-Betar	Al-Hamouz
Al-Harbi	Alhooshani	Ali
Al-Muallem	Al-Saadi	Al-Thagfi
Chanbasha	El Ali	Fettouhi
Ganyiu	Garrison	Isab
Jalilov	Janjua	Joya
Kandial	Kawde	Khaled
Khan	Mazumder	Morsy
Musa	Oladepo	Peedikakal
Rehman	Rinaldi	Saleh
Shaikh	Sharif	Siddiqui
Tahir	Ullah	Wibowo

The Department of Chemistry offers degrees of Master of Science (MS), and Doctor of Philosophy (PhD). The research activities of the Department of Chemistry are exceptionally diverse and broad. Graduate courses and research projects are available in the major branches of chemistry that include analytical, industrial, inorganic, organic and physical chemistry. The ongoing research programs cover most areas of study in modern chemistry and also involve collaborative programs with other departments. Current areas of research include: organic synthesis, physical organic chemistry, coordination chemistry, X-ray structure determination, chromatography, thermodynamics of solutions, molecular dynamics by ESR, NMR, and laser techniques, polymer synthesis and characterization, electroanalytical methods, fuels chemistry research, energy production research and solid state reactions.

The Chemistry Department is well equipped for advanced research leading to higher degrees in chemistry. Research supporting facilities such as mechanical and electronic workshops are available in the Chemistry Department. The Department maintains a glass blowing shop for the repair or design of glass equipment. In addition to the University central chemical store, the departmental chemical store stocks almost all commonly used chemicals, glassware, etc. for teaching and research. General instruments aiding students and faculty in their teaching and research include various spectrophotometers, atomic absorption spectrometers, gas chromatographs and a high performance liquid chromatography unit.

Admission Requirements

All applicants for admission to the department must satisfy the general Graduate School admission requirements. In particular, an applicant must hold a B.S. degree in chemistry from a university of recognized standing when applying for the master's degree. Applicants for the Ph.D. must hold a master's degree in chemistry from a university of recognized standing.

MASTER OF SCIENCE IN CHEMISTRY

Degree Requirements

(a) Core Courses (18 credit hours)		Credit Hours
Physical Chemistry: A Molecular Approach	CHEM 501	3
Chemistry of Coordination Compounds	CHEM 502	3
Organic Reactions: Mechanism & Reactivity	CHEM 503	3
Advanced Analytical Chemistry	CHEM 504	3
Seminar	CHEM 599	0
Thesis	CHEM 610	6

(b) Elective Courses (12 credit hours)		Credit Hours
Two CHEM Courses	CHEM 5xx/6xx	6
Two Free Elective Courses	XXX 5xx/6xx or CHEM 5xx/6xx	6

Degree Plan

COURSE	TITLE	LT	LB	CR	COURSE	TITLE	LT	LB	CR
First Year									
CHEM 501	Physical Chemistry: A Molecular Approach	3	0	3	CHEM 502	Chemistry of Coordination Compounds	3	0	3
CHEM 504	Advanced Analytical Chemistry	3	0	3	CHEM 503	Organic Reactions: Mechanism&Reactivity	3	0	3
CHEM xxx	Elective I	3	0	3	CHEM xxx	Elective II	3	0	3
					CHEM 599	Seminar	1	0	0
		9	**0**	**9**			**10**	**0**	**9**
Second Year									
XXX xxx	Free Elective I	3	0	3	CHEM 610	Thesis	0	0	6
XXX xxx	Free Elective II	3	0	3					
CHEM 610	Thesis	0	0	IP					
		6	**0**	**6**			**0**	**0**	**6**
Total credit hours required in Degree Program : 30									

PHD IN CHEMISTRY

Degree Requirements

(a) Core Courses (12 credit hours)		Credit Hours
Seminar	CHEM 699	0
PhD Pre-Dissertation	CHEM 711	3
PhD Dissertation	CHEM 712	9

(b) Elective Courses (30 credit hours)		Credit Hours
Eight CHEM Courses *A student who obtained his MS from another department/university must take CHEM 501, 502, 503, 504 to replace four of the elective courses. Students with a clear evidence of satisfying any of the core courses may replace it with an elective course.*	CHEM 5xx/6xx	24
Two Free Elective Courses	XXX 5xx/6xx	6

Degree Plan

COURSE	TITLE	LT	LB	CR	COURSE	TITLE	LT	LB	CR
First Year									
CHEM xxx	Elective I	3	0	3	CHEM xxx	Elective IV	3	0	3
CHEM xxx	Elective II	3	0	3	CHEM xxx	Elective V	3	0	3
CHEM xxx	Elective III	3	0	3	CHEM xxx	Elective VI	3	0	3
		9	**0**	**9**			**9**	**0**	**9**
Second Year									
CHEM xxx	Elective VII	3	0	3	XXX xxx	Free Elective II	3	0	3
CHEM xxx	Elective VIII	3	0	3	CHEM 711	PhD Pre-Dissertation	0	0	3
XXX xxx	Free Elective I	3	0	3					
CHEM 699	Seminar	1	0	0					
		10	**0**	**9**			**3**	**0**	**6**
Third Year									
CHEM 712	PhD Dissertation	0	0	IP	CHEM 712	PhD Dissertation	0	0	9
		0	**0**	**0**			**0**	**0**	**9**
Total credit hours required in Degree Program : 42									

CHEMISTRY

CHEM 501 Physical Chemistry: A Molecular Approach (3-0-3)
Quantum theory and spectroscopy. The origins of Quantum mechanics and the need for quantization. The development of Schrodinger wave equation and its properties. The application of Schrödinger equation to the particle in a box. The structure and spectra of hydrogenic atoms. Molecular structure and the Huckel approximation. Molecular spectroscopy and the rotational vibrational spectra. Statistical thermodynamics and applications. Reaction dynamics and surface catalysis.
Prerequisite: Graduate Standing

CHEM 502 Chemistry of Coordination Compounds (3-0-3)
Theories of bonding in coordination compounds. Structure, reactions and mechanisms. New trends in coordination chemistry, modern synthetic methods and applications.
Prerequisite: Graduate Standing

CHEM 503 Organic Reactions: Mechanism and Reactivity (3-0-3)
Reaction mechanisms. Conformations and structure reactivity relationships. Aromaticity. Carbanions and carbocations. Organic reaction types including substituent effects and stereochemistry: substitution, addition, elimination, hydrolysis, electrophilic and nucleophilic aromatic substitution. Pericyclic reactions.
Prerequisite: Graduate Standing

CHEM 504 Advanced Analytical Chemistry (3-0-3)
Fundamentals and Methods of Analytical Chemistry. The principles of classical and modern analytical methods. Theory and practice of spectroscopy, electrochemistry, and analytical separation.
Prerequisite: Graduate Standing

CHEM 511 Chemical Kinetics (3-0-3)
Empirical rate law. Order of reactions. Elementary reactions. Complex reactions. Reaction mechanisms. Steady-state approximation theory. Transition state theory. Thermodynamic formulation of the rate constant. Homogeneous reactions. Heterogeneous reactions. Catalysis. Enzyme kinetics. Flash photolysis. Relaxation methods.
Prerequisite: Graduate Standing

CHEM 512 Chemical Thermodynamics (3-0-3)
Principles of thermodynamics. Exact differentials and line integrals. Homogeneous functions. Equations of state of real gases; fugacity. Thermochemistry. Mixtures and solutions. Chemical and phase equilibria. Electrolytic solutions and electrochemical cells. Systematic methods of deriving thermodynamic equations. Statistical thermodynamics. Lagrange's method of undetermined multipliers. The Boltzmann H-theorem. The Einstein crystal model and the Debye crystal model.
Prerequisite: Graduate Standing

CHEM 513 Principles and Applications of Quantum Chemistry (3-0-3)
Postulates of quantum mechanics. Schrödinger equation, simple quantum mechanical systems, atomic wave functions, angular momentum, orbital, molecular orbital theory, variation, perturbation theory. Application of quantum theory to bonding, and atomic and molecular spectroscopy.
Prerequisite: CHEM 501

CHEM 514 Electrochemical Corrosion (3-0-3)
Fundamentals of electron transfer at the metal-solution interface, advances in electrochemical corrosion techniques, types of corrosion: galvanic, pitting, crevice, bacterial, etc. Corrosion inhibitors and coating, materials properties and selection in different corrosive environments. Advances in monitoring techniques.
Prerequisite: Graduate Standing

CHEM 515 Spectroscopy (3-0-3)
An introduction to modern molecular spectroscopy with emphasis on the concepts and methods needed to understand the interaction of radiation with matter. Topics include atomic, rotational, vibrational and electronic spectra of molecules, and radio frequency spectroscopy.
Prerequisite: CHEM 501

CHEM 517 Computational Chemistry (3-0-3)
Implementation of the different theoretical models: Force field, semi-empirical, abolition, calculations to chemically related problems using latest PC-software packages. Emphasis will be placed on molecular modeling, simulations, and spectral properties of matter in its isolated or solvated form.
Prerequisite: CHEM 501

CHEM 520 Physical Methods in Inorganic Chemistry (3-0-3)
Theory and applications of physical methods used for characterization of inorganic and organometallic compounds including selected topics from modern aspects of theoretical methods, magnetic resonance methods, vibrational, rotational, electronic and Mössbauer spectroscopy, magnetism, ionization methods and X-ray diffraction.
Prerequisite: Graduate Standing

CHEM 522 Organometallic Chemistry (3-0-3)
General properties of organometallic compounds, metal-carbon and metal-hydrogen bonds. Ligand substitution reactions, complexes of π-bond ligands, oxidative addition and reductive elimination, insertion and elimination, nucleophilic and electrophilic addition and abstraction. Homogeneous catalysis. Characterization of organometallic compounds, carbenes, metathesis and polymerization, activation of small molecules, and applications to organic synthesis.
Prerequisite: Graduate Standing

CHEM 523 Chemical Crystallography (3-0-3)
Theory and hands on experience on single crystal and powder X-ray diffractometry. Crystal symmetry and lattices, X-ray diffraction, diffraction data from single crystals, reciprocal space, structure factors, data collection, structure solution and refinement,

diffraction data from powders, indexing powder patterns, phase identification, structure determination from powders, Rietveld refinement, interpretation and presentation of results.
Prerequisite: Graduate Standing

CHEM 526 Solid State Chemistry (3-0-3)
Crystal structures, crystal defects and non-stoichiometry. Solid solutions. Phase diagrams. Bonding in Solids. Synthesis, processing and fabrication methods. Modern characterization techniques. Electrical, magnetic and optical properties. Structure-properties correlation.
Prerequisite: Graduate Standing

CHEM 528 Mechanisms of Inorganic Reactions (3-0-3)
Review of fundamental concepts of chemical kinetics. Physical methods for the determination of reaction rates in inorganic systems. Ligand substitution reactions, Associative and dissociative mechanisms. Stereochemical change, racemization, isomerization. Reaction mechanism of organometallic systems, oxidation-reduction, and photochemical reactions.
Prerequisite: CHEM 502

CHEM 532 Synthetic Organic Chemistry (3-0-3)
Multi-step organic syntheses. Retrosynthetic analysis. New reagents and concepts. Stereospecificity, Stereoselectivity and regioselectivity. Chiral reagents. Protecting groups. Selected examples of total synthesis of natural products.
Prerequisite: Graduate Standing

CHEM 533 Nuclear Magnetic Resonance Spectroscopy (3-0-3)
Physical basis of the nuclear magnetic resonance spectroscopy (NMR). NMR spectra of organic molecules. Experimental aspects of NMR spectroscopy. Chemical shift and spin-spin coupling as a function of structure. The analysis of high-resolution NMR spectra. Two-dimensional NMR spectroscopy. Dynamic effects on NMR. Selected experimental techniques of NMR, carbon-13 NMR spectroscopy and solid state NMR.
Prerequisite: Graduate Standing

CHEM 535 Petrochemicals (3-0-3)
Raw Materials – natural and associated gas and crude oil, – their composition and processing. Thermal, catalytic cracking, catalytic reforming. Hydroprocessing, catalysts, operation variables and reaction mechanisms. Catalysis by transition metal complexes.
Prerequisite: Graduate Standing

CHEM 536 Spectroscopic Identification of Organic Compounds (3-0-3)
Identification and structural analysis of organic compounds by nuclear magnetic resonance, infrared, ultraviolet and mass spectroscopy. Discussion of instrumentation, sample handling and basic theory of each technique with emphasis on their practical applications for structure determination.
Prerequisite: Graduate Standing

CHEM 537 Polymer Synthesis (3-0-3)
Types of polymerization reactions. Kinetic and mechanistic studies of addition and condensation polymerization by ionic, free radical and coordination initiators and catalysts. Ring opening polymerization, stereochemistry of polymerization.
Prerequisite: Graduate Standing

CHEM 538 Natural Products Chemistry (3-0-3)
Classification of natural products. Physico-chemical data, structural determination, syntheses, biosynthesis and physiological activity of several classes of natural products including terpenoids, steroids, carbohydrates, aromatic, aliphatic, alkaloids and non-alkaloid nitrogen compounds.
Prerequisite: Graduate Standing

CHEM 542 Electroanalytical Chemistry (3-0-3)
Advanced treatment of the electroanalytical techniques and methodology with emphasis on the modern techniques. Basic principles, kinetics, and mechanisms of electrode reactions and surface phenomena. Potentiometry, ion-selective electrodes and voltammetry.
Prerequisite: CHEM 504

CHEM 543 Separation Methods (3-0-3)
Theory and practice of modern separation methods with emphasis on gas and liquid chromatographic techniques, and electrophoretic methods.
Prerequisite: CHEM 504

CHEM 560 Energy: Materials and Processes (3-0-3)
Fundamentals of renewable energy harvesting systems, advanced multifunctional semiconductor materials for various types of photovoltaic devices, photocatalytic and photo-electrochemical Hydrogen and Oxygen production. Electro-catalysts for Oxygen and Hydrogen generations reactions. Functional materials for photo, electro, and catalytic CO_2 conversion into value added products. Nanostructured catalytic materials for fuel cells applications. Porous and high-performance nanomaterials for energy storage batteries and supercapacitors. Nanopiezoelectric materials. Nanocatalysts for biofuel production.
Prerequisite: Graduate Standing

CHEM 590 Special Topics in Physical Chemistry (3-0-3)
Topics of current interest in Physical Chemistry.
Prerequisite: Graduate Standing

CHEM 591 Special Topics in Inorganic Chemistry (3-0-3)
Topics of current interest in Inorganic Chemistry.
Prerequisite: Graduate Standing

CHEM 592 Special Topics in Organic Chemistry (3-0-3)
Topics of current interest in Organic Chemistry.
Prerequisite: Graduate Standing

CHEM 593 Special Topics in Analytical Chemistry (3-0-3)
Topics of current interest in Analytical Chemistry.
Prerequisite: Graduate Standing

CHEM 599 Seminar (1-0-0)
Attendance of all departmental seminars and delivering a seminar on a timely research topic. This course gives the student an overview of recent research topics, familiarity with the research methodology, journals and professional societies.
Prerequisite: Graduate Standing

CHEM 606 Independent Research (3-0-3)
This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.
Prerequisite: Prior arrangement with an instructor

CHEM 610 M.S. Thesis (0-0-6)
Involves individual studies by students in the field of Chemistry. The work should be original and the concept, data and the conclusions should contribute new knowledge to the field of research problem. The quality of the work should reflect the student's proficiency in research and creative thinking. Following preliminary studies and a literature survey on the thesis subject, each student will present his proposed thesis subject orally, and submit a written proposal to the College of Graduate Studies for approval. On satisfactory completion of his thesis work, the student is required to make a formal defense of his research thesis.
Corequisite: CHEM 599

CHEM 615 Statistical Thermodynamics (3-0-3)
The concept of ensemble and types of ensembles, quantum statistical mechanics, the partition function, equilibrium statistical mechanics. Thermodynamic Properties in the dilute limit. Applications of statistical mechanics to ideal gases, crystals and phase transitions.
Prerequisite: CHEM 512

CHEM 617 Chemistry and Physics of Nanomaterials (3-0-3)
Fundamental chemical concepts and basic ideas needed to calculate the difference between the bulk properties of matter and the properties of aggregates. Tools needed to probe matter at the nanoscale level. Examples of nanoscale materials such as monolayers, fullerenes, clusters, biomolecules etc., and their applications.
Prerequisite: Graduate Standing

CHEM 619 Chemistry of Colloids (3-0-3)
Introduction to colloid and surface chemistry, sedimentation and diffusion, rheology of dispersions, adsorption from solution, colloidal structures and surfactant solutions,

electrical double layer, electrophoresis, electrostatic and polymer-induced colloid stability.
Prerequisite: CHEM 501

CHEM 621 Heterogeneous Catalysis (3-0-3)
Fundamentals of adsorption, characterizing catalysts and their surfaces, the significance of pore structure and surface area, solid-state and surface chemistry, poisoning, promotion, deactivation and selectivity of catalysts.
Prerequisite: CHEM 502

CHEM 625 Homogeneous Catalysis (3-0-3)
Transition metal complexes: stability and reactivity, reaction mechanisms, steric and electronic influence of the ligands. Survey of the industrial homogeneous processes including polymerization, hydrogenation, carbonylation, coupling, metathesis, oxidation etc. New developments and new applications.
Prerequisite: Graduate Standing

CHEM 626 Bioinorganic Chemistry (3-0-3)
Bioinorganic chemistry and the biogeochemical cycles, metalloproteins, special cofactors and metal clusters, transport and storage of metal ions in biological systems, hydrolytic chemistry, electron transfer, respiration, and photosynthesis, oxygen, hydrogen, carbon, and sulfur metabolisms, metalloenzymes, metal ion receptors and signaling, biominerals and biomineralization, metals in medicine.
Prerequisite: CHEM 502

CHEM 630 Physical Chemistry and Characterization of Polymers (3-0-3)
Application of physical methods to the determination of the structure of polymers. Physical chemistry of macromolecules. Principles of experimental techniques and application. Correlation between structure and physical macro-properties.
Prerequisite: Graduate Standing

CHEM 633 Polymeric Drug Delivery Systems (3-0-3)
Design and development of natural and synthetic biocompatible polymers for fabricating a drug delivery agent or other medical devices, including hydrogels, drug delivery scaffolds, soluble polymer drug conjugates, polymeric vesicles and micelles, microspheres, and nanoparticles. Explore the use of polymers and factors involving encapsulation of biologics within microspheres for the delivery of gene therapy for incurable diseases.
Prerequisite: Graduate Standing

CHEM 635 Chemistry of Organic Materials (3-0-3)
Fundamentals of organic materials for electronics. Design and development of organic semi-conductors/conductors. Electronic interaction and structure. Organic and polymer nanostructures, nanoparticles, nanowires, nanobelts and nanofibers. Organic functionalization of graphene, carbon nanotubes, graphite and carbon. Applications of organic materials in photovoltaic, bio and chemical sensor devices.
Prerequisite: Graduate Standing

CHEM 640 Analytical Spectroscopy (3-0-3)
Principles and theory of atomic and molecular spectroscopic methods in chemical analysis. Atomic Spectroscopy (Absorption, Flame and Plasma Emission, Arc and Spark Emission, and Fluorescence). Molecular Spectroscopy (UV-Vis Absorption, Luminescence "Fluorescence, Phosphorescence, and Chemi- & Bio-luminescence", Infrared Absorption, and Raman Spectroscopy). Recent Spectroscopic Techniques (Photoacoustic Spectroscopy, Laser Spectroscopy, Surface Plasmon Resonance Spectroscopy (SPR), X-Ray Spectroscopy, etc.).
Prerequisite: Graduate Standing

CHEM 642 Chemometrics (3-0-3)
Basic Statistics, Analysis of Variance (ANOVA), Computer Software (Mat Lab for Windows), Principles of Experimental Design, Factorial Designs and Analysis, Fractional Factorials, Response Surface Methodology, Second-order Designs, Application of the chemical Optimization by simplex.
Prerequisite: Graduate Standing

CHEM 643 Environmental Analytical Chemistry (3-0-3)
Analytical aspects of several types of pollutants. Most common and recent analytical techniques used in environmental chemical analysis. Atmosphere, water, oceans, land, biota and environmental monitoring. Instrumental techniques: Chromatography, Spectrometry, Mass spectrometry, X-ray, Radiochemical and Electrochemical methods. Sampling techniques. Environmental data analysis and presentation.
Prerequisite: Graduate Standing

CHEM 644 Electrochemical Biosensors (3-0-3)
The principals and applications of modern electrochemical-based biosensors. Different transduction modes. Various recognition elements. The interface of possible bio-recognition layers with physical transductions. A wide range of practical clinical, environmental and security applications.
Prerequisite: Graduate Standing

CHEM 645 Modern Techniques for Materials Characterization (3-0-3)
Theories behind materials and nanomaterials characterization and analysis. The theories behind advanced microscopic techniques, and optical spectroscopic techniques and other characterization techniques. The components and configuration of these techniques. Advance techniques used for the characterization and surface chemistry of materials and nanomaterials.
Prerequisite: Graduate Standing

CHEM 699 Ph.D. Seminar (1-0-0)
Attendance of all departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D. student should present at least one seminar on a timely research topic. This course gives the student an overview of recent research topics, familiarity with the research methodology, journals and professional societies.
Prerequisite: Graduate Standing

CHEM 701 Directed Research I (0-0-3)
This course is intended to allow the student to conduct research in advanced problems in his Ph. D. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee of the Chemistry Department. The student is expected to deliver a public seminar and a report of his research outcomes at the end of the course.
Prerequisite: Prior arrangement with an instructor

CHEM 702 Directed Research II (0-0-3)
This course is intended to allow the student to conduct research in advanced problems in his Ph. D. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee of the Chemistry Department. The student is expected to deliver a public seminar and a report of his research outcomes at the end of the course.
Prerequisite: Prior arrangement with an instructor

CHEM 711 Ph.D. Pre-Dissertation (0-0-3)
This course enables the student to submit his Ph. D. Dissertation proposal and defend it in public. The student passes the course if the Ph. D. dissertation committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation Proposal Public defense. The course grade can be NP, NF or IC.
Prerequisite: Ph.D. Candidacy, CHEM 699

CHEM 712 Ph.D. Dissertation (0-0-9)
This course enables the students to work on his Ph.D. Dissertation as per the submitted dissertation proposal, submits its final report and defends it in public. The student passes this course if the Ph.D. Dissertation Committee accepts the submitted dissertation report and upon successfully passing the dissertation Public Defense. The course grade can be NP, NF, or IP.
Prerequisite: CHEM 711