

Chemical Science Program

Aims and Scope of the Graduate Program

The chemical science program at King Abdullah University of Science and Technology is an interdisciplinary program that covers all basic areas of chemistry and promotes cross-program collaboration by offering a wide range of electives. Our program specifically focuses on research on catalysis and functional material chemistry. It offers Master of Science and doctoral degrees.

Students with B.S. degrees in relevant fields are allowed to enroll directly in the Ph.D. program without earning an M.S. degree. However, at the discretion of the admissions committee, such students may be required to obtain an M.S. degree before enrolling in the Ph.D. program.

Upon successful completion of the M.S. degree, students will have acquired a sound foundation that enables them to pursue a successful career in chemical research or to proceed further for advanced graduate studies. The Ph.D. program emphasizes a student's ability to undertake independent and original research projects. The program leading to the Ph.D. degree requires the development of broad knowledge through additional coursework beyond that required for a M.S. degree. Upon completion of the Ph.D. degree, the student is expected to be capable of designing and executing independent research projects and have profound chemical knowledge.

Master's Degree

To earn an M.S. degree in chemical science, which requires a minimum of 36 credits, students are required to fulfill the following requirements:

1. Core Curriculum: (12 credits) Select three from the core curriculum listed below (9 credits). Enroll in the Chemical Science Program Rotation (see below, 3 credits).
Core Curriculum List: ChemS 320 - Advanced Organic Chemistry I: Named Organic Reaction and Synthetic Techniques; ChemS 340 - Advanced Organic Chemistry II: Physical Organic Chemistry Fundamentals; ChemS 330 - Advanced Inorganic Chemistry I: Fundamentals and Techniques of Inorganic Functional Material; ChemS 350 - Advanced Inorganic Chemistry II: Homogenous and Heterogeneous Catalysis; ChemS 360 - Advanced Physical Chemistry I: Theoretical Chemistry Applications; ChemS 370 - Advanced Physical Chemistry II: Thermodynamics and Kinetics
2. Elective Curriculum: (12 credits) Enroll in a combination of courses, directed research or thesis hours with the approval of the student's advisor.
3. Research/Capstone Experience: (12 credits) Enroll in at least 12 credits of thesis research (ChemS 297).

Students are permitted to register for more than 12 credits of M.S. thesis research as necessary and with the permission of the thesis advisor.

Evaluation of satisfactory completion of M.S. thesis work is performed by a committee comprising the M.S. thesis advisor and two other faculty members. Students are expected to choose their thesis committees by the beginning of their second semester. The chair of the committee must be a faculty member within the Chemical Science program. The evaluation of M.S. thesis credits is through a pass or a fail grade. The requirement of a public seminar based on the student's work is left to the discretion of the MS thesis advisor. For additional details on thesis requirements and committee formation, see General Degree Program Guidelines.

The student is responsible for scheduling the thesis defense date with his/her supervisor and committee members. The defense of the M.S. thesis should be scheduled by the end of the third semester. Candidates should give a copy of their thesis to the research committee 2 weeks before the final date of defense.

Chemical Science Program Rotation: Students admitted to the Chemical Science MS Program participate in a rotation course their first semester in the program. The goal of this course is to provide students with exposure to multiple research groups in the program and aid in the selection of a research advisor. Rotation assignments will be made by the program committee with mutual approval of the concerned parties (designated faculty and the student). Students with a preapproved advisor may spend the whole rotation period in that lab with the approval of the advisor Program Chair and Dean.

Degree of Doctor of Philosophy

In accordance with KAUST regulations, the Ph.D. program in Chemical Science includes the following requirements:

1. Successful completion of Ph.D. coursework;
2. Designating a research advisor;
3. Passing a subject-comprehensive examination;
4. Obtaining candidacy status;
5. Preparing and submitting a doctoral dissertation and successfully defending it.

Coursework requirements

Students who enter the program with a B.S. degree are required to complete the following:

1. A minimum of 10 semesters including summers (102 credits).
2. Coursework and research work requirements for the M.S. program (30 credits).

3. Passing the research presentation exam the end of their first year (end of summer beginning of Fall). At this stage candidate will be switched officially to Ph.D. track or he/she will spend one more semester to graduate with an M.S. thesis.

Students who enter the program with an M.S. degree are required to complete the following:

1. A minimum of 8 semesters including summer (72 credits).
2. A minimum of 6 credit hours of coursework at the 300-level or above and 54 credit hours of Ph.D. dissertation research work. In special cases, these minimum requirements may be reduced with the approval of the dean.

Designation of a Research Advisor

To be successfully enrolled in the Chemical Science Ph.D. program, prospective candidates should identify a faculty member to sponsor them prior to arrival at KAUST. Phone and personal interviews will be conducted to identify candidates for this program. In the rare cases where the advisor or student decide to change their agreement after the candidate has commenced his/her PhD work at KAUST, the student must find another sponsor to be allowed to continue in the program.

Research proposal defense

A Ph.D. candidate student must submit a written research proposal to the dissertation committee two weeks prior to an oral defense of the proposal. The oral defense consists of an oral presentation of original work (close to the candidate's area of research but not the exact work done in the lab) followed by a question and answer session. The oral defense must be attended by a minimum of three members of the dissertation committee. The committee will determine if the proposal is novel and the possibility of funding from major funding agencies. The committee's decision can take the form of pass, conditional pass, fail with retake, or fail. In the case of fail with retake, the committee will provide feedback to the student, who must prepare and pass a repeat examination within one semester.

Dissertation committee

The dissertation committee is formed by the student under the guidance of the advisor. The committee is chaired by the advisor and includes at least three other faculty members, one of whom will be external to the program. The committee may additionally include one or more members external to KAUST. Students are required to maintain active contacts with their committee members to discuss the student's progress. All committee members must be designated as dissertation readers.

Research Data Presentation and Dissertation

By the end of the third year, a research data presentation must be made to the dissertation committee and the committee will then formally advise the candidate on research milestones that need to be met before permission to write the dissertation is granted.

A peer-reviewed publication based upon the dissertation research is required to obtain the degree of Ph.D. This requirement could be waived under extenuating circumstances and at the discretion of the student's dissertation committee.

Dissertation Defense

The student must schedule a dissertation defense after the doctoral research project and dissertation are completed. The dissertation defense will include a defense of the doctoral dissertation and a test of the candidate's knowledge in the specialized field of research. The format of the dissertation defense will be a public seminar presented by the candidate, with an open question period, followed by a private examination by the dissertation committee. The possible outcomes of the exam are pass, conditional pass, or fail. After a successful defense, the final written dissertation approved by the committee must be submitted within two months and must be signed by the supervisor and all dissertation committee members.

Chemical Science Program (ChemS) Course Descriptions

ChemS 210 Material Chemistry I (3-0-3)

Prerequisite: An understanding of the material covered in basic inorganic and organic chemistry. This course is designed to present students with a descriptive overview of Materials Chemistry with particular emphasis on the correlation between materials structures and their properties. This course will cover the following topics: molecular symmetry; basic crystallography; band theory; porous materials; nano-structured materials and some material characterization techniques including powder X-ray diffraction and physical adsorption.

ChemS 212 Spectroscopy Analysis (3-0-3)

This course covers surface tension and surface free energy (theory and measurement methods), surface films on liquid substrates (surface potential, monomolecular films, Langmuir-Blodgett layers), electrical aspects of surface chemistry (electrical double layer, zeta potential, DLVO theory), solid-liquid interface, stability of dispersions, stabilization of suspensions, Contact angle (theory and measurement methods) Emulsions, foams and aerosols, wetting of surfaces by liquids, Lotus effect, Flotation, aggregation and flocculation, Detergency, surfactants, self-assembly, micelles and Vesicles, Friction, lubrication, and Characterization of colloidal particles Applications of colloid and surface science in petroleum recovery, coating and painting, food, pharmaceutical and cosmetic industry

ChemS 215 Polymers and Polymerization Processes (3-0-3)

Prerequisite: Basic training in chemistry, physics, or engineering. The preparation, reactions and properties of high-molecular-weight polymeric materials of both natural and synthetic origin. The course is a survey of preparative methods of polymers; step growth polymerization, radical polymerization, ionic polymerization, ring-opening polymerization, polymerization by transition metal catalysts; and methods of characterization (nuclear magnetic resonance, Raman, infrared, intrinsic viscosity, differential scanning, calorimetry, gel permeation chromatography) and scattering (light, x-rays).

ChemS 218 Photo and Electro Catalysis (3-0-3)

Fundamentals of Photo and Electro catalysis presented with a novel approach for industrial applications

ChemS 220 Organometallic Chemistry (3-0-3)

Systematic consideration of modern aspects of organometallic chemistry including main group and transition metal complexes. The structure and binding in organometallic compounds are covered. Particular emphasis is placed on applications of homogenous organometallic catalysis in polymer synthesis, industrial processes and synthetic organic chemistry.

ChemS 226 Biocatalysis (3-0-3)

This course aims to provide an understanding of fundamental aspects of biocatalysis, while the general focus is set on current applications of biocatalytic systems. It targets students enrolled in chemical sciences, chemical engineering and biological engineering.

ChemS 230 Physical Chemistry of Macromolecules (3-0-3)

Prerequisite: ChemS 215 or consent of instructor. Physical chemistry of macromolecules, including the theory for the experimental methods used for the study of macromolecular solutions.

ChemS 250 Material Chemistry II (3-0-3)

Prerequisite: ChemS 210 or consent of instructor. This course will introduce electron microscopy based techniques: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Electron diffraction (ED), Scanning transmission electron microscopy (STEM), Energy-filtered TEM (EFTEM), Energy dispersive X-ray analysis (EDX), and Electron energy loss spectroscopy (EELS). On-site demonstration of the electron microscope will be given.

ChemS 298 Tools Of Research

Master's-level seminar focusing on special topics within the field.

ChemS 299 M.S. Thesis Research Variable Credit, Pass/Fail

Prerequisite: Approval of Advisor Master-level Thesis Research.

ChemS 319 Bioinorganic Chemistry (3-0-3)

This course will introduce the principles of bioinorganic chemistry and its vast applications in industry and catalytical processes.

ChemS 320 Advanced Organic Chemistry I (3-0-3)

Prerequisite: Adequate knowledge in general chemistry rules and concepts. This course covers reactivity and reactions of organic moieties including enolates, carbenes, radicals, carbonyl compounds, and transition metal organometallics; mechanisms of named reactions; multistep total synthesis techniques and reactions; advanced NMR and mass spectrometric techniques as applied to research efforts in organic chemistry and related fields, such as pharmaceuticals, materials science, supramolecular synthesis, and crystal engineering.

ChemS 330 Advanced Inorganic Chemistry I (3-0-3)

Prerequisite: Adequate knowledge in general chemistry rules and concepts. Generalizations of the periodic table and their relationship to classical and modern concepts of atomic and molecular structure. Inorganic stereochemistry including concepts of crystal chemistry, silicate chemistry, coordination theory, ligand field theory, catalysis, acid-base theory, reaction mechanisms, organometallic chemistry and a detailed consideration of selected groups of the periodic table.

ChemS 340 Advanced Organic Chemistry II (3-0-3)

Prerequisite: ChemS 320 or consent of instructor. This course will focus on a deeper understanding of the structure and reactivity of organic molecules with an emphasis on reaction mechanisms. It is a review of aspects of physical organic chemistry, covering structure and bonding, stereochemistry, and kinetics and thermodynamics, as well as molecular orbital theory with an introduction to the use of computational tools, such as Gaussian 09.

ChemS 350 Advanced Inorganic Chemistry II (3-0-3)

Prerequisite: ChemS 330 or consent of instructor. Emphasis on concepts and applications of homogenous and heterogeneous catalysis and the impact of such processes on the advancement of different industries.

ChemS 360 Theoretical Chemistry (3-0-3)

Prerequisite: Adequate knowledge in general chemistry rules and concepts. Review of quantum mechanics from a postulational viewpoint; variational and matrix methods; time independent and time-dependent perturbation theory; applications to molecular systems including potential energy surfaces and reaction pathways.

ChemS 370 Thermodynamics and Kinetics (3-0-3)

Prerequisite: ChemS 360 or consent of instructor. A discussion of chemical phase equilibria, the treatment of solutions and chemical reactions by classical thermodynamics, the applications of electrochemical cells in studying chemical reactivities, utilization of molecular and atomic spectra in statistical-mechanical calculations.

ChemS 399 Directed Research for Ph.D. Students Variable Credit, Pass/Fail
Prerequisite: Approval of Advisor. Doctoral-level supervised research.