

The background of the cover is an aerial view of a modern building with a grid-like facade. A circular inset in the lower-left corner shows a wavy mosaic pattern in shades of brown and black. A teal horizontal band is positioned across the middle of the image, containing the main title.

Applied Mathematics and Computational Science

Program Guide
2017-2018

Table of Contents

1. Aims and Scope

The Applied Mathematics and Computational Sciences (AMCS) program educates students to construct and solve Mathematical and Computational models of real-world problems. Two degree programs are offered: the M.S. degree (under either a Thesis or a Non-Thesis option) and the Ph.D. degree. Admission to one degree program does not guarantee transfer to another.

The Applied Math and Computational Science program offers specializations in three distinct directions (called "Tracks"): Applied Mathematics (AM), Computational Science and Engineering (CSE) and Statistics (ST).

The requirements for the different specializations may vary and are outlined below. All students in the M.S. program are guided by a Faculty advisor to develop their program of study.

2. Assessment Test

Students are admitted to KAUST from a wide variety of programs and backgrounds. In order to facilitate the design of an appropriate study plan for each individual student, all admitted students are required to take a written assessment exam when they arrive on Campus. The exam will focus on mathematics and basic sciences. The purpose of the assessment is to determine whether students have mastered the prerequisites for undertaking graduate-level courses taught in the program. The Academic Advisor works with admitted students to develop a study plan if needed. Students are encouraged to prepare for the assessment by refreshing the general knowledge gained from their undergraduate education before arriving at KAUST. The remedial study plan requirements must be satisfactorily completed, in addition to the University degree requirements.

3. Master's Degree Requirements

It is the sole responsibility of the student to plan her/his graduate program in consultation with her/his advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

The Master's Degree (M.S.) is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a 'B-' for course credit. Students are expected to complete the M.S. degree in three semesters and one Summer Session.

3.1 M.S. Course Requirements

- Core Courses
- Elective Courses
- Research/Capstone Experience
- Graduate Seminar 298 (non-credit): All students are required to register and receive a satisfactory grade for every semester the program requires they attend.

3.1.1 Core Courses

AM track: Core Courses (fifteen credits)

- AMCS 231: Applied Partial Differential Equations
- AMCS 243: Probability and Statistics or AMCS 241: Probability and Random Processes
- AMCS 251: Numerical Linear Algebra
- AMCS 252: Numerical Analysis of Differential Equations
- AMCS 235: Real Analysis

CSE track: Core Courses (six credits)

Students must fulfil at least two of the four core courses below:

- AMCS 231: Applied Partial Differential Equations
- AMCS 243: Probability and Statistics or AMCS 241: Probability and Random Processes
- AMCS 251: Numerical Linear Algebra
- AMCS 252: Numerical Analysis of Differential Equations

ST track: Core Courses (twelve credits)

- AMCS 211: Optimization I
- AMCS 241: Probability and Random Processes
- AMCS 243: Probability and Statistics
- AMCS 245: Linear Models

The core courses in the three AMCS tracks are designed to cover the basic skills and competence that are expected off any student holding an advanced degree.

3.1.2 Elective Courses

This portion of the degree is designed to allow each student to tailor his/her educational experience to meet individual research and educational objectives, with the permission of the student's academic advisor.

AM track:

Nine credits of elective courses not necessarily within the AMCS program. Some credits may be taken outside the AMCS program subject to the approval of the Academic Advisor.

CSE track:

Students in the CSE track must take an additional eighteen credits of course work made up of:

Six credits of Computer Science courses.

Six credits in applications of modelling. Eligible application courses include AMCS 332 (mathematical modelling) and courses from other programs. At least one of the modelling courses should be from outside AMCS. In case both courses are from outside AMCS, it is recommended that they be drawn from the same track.

Six credits from AMCS courses.

STAT Track:

Twelve credits of elective courses not necessarily within the AMCS program

3.1.3 Winter Enrichment Program

Students are required to satisfactorily complete at least one full Winter Enrichment Program (WEP).

3.2 M.S. Thesis Option

Students wishing to pursue the thesis option must apply by the ninth week of their second semester for a thesis and must have at least a 3.2 cumulative GPA.

A minimum of twelve credits of Thesis Research (297) is required. 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. The selected thesis advisor must be a fulltime program-affiliated Assistant, Associate or Full Professor at KAUST. This advisor can only become project-affiliated for the specific thesis project upon program level approval. Project-affiliation approval must be completed prior to commencing research.

3.2.1 M.S. Thesis Defense Requirements

An oral defense of the M.S. Thesis is required, although it may be waived by the Dean's Office under exceptional circumstances. A requirement of a public presentation and all other details are left to the discretion of the thesis committee.

A written thesis is required. It is advisable that the student submits a final copy of the thesis to the Thesis Committee Members at least two weeks prior to the defense date.

- Students are required to comply with the university formatting guidelines provided by the library [CLICK HERE](#)
- Students are responsible for scheduling the thesis defense date with his/her thesis committee.
- A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the student fails. The final approval must be submitted at the latest two weeks before the end of the semester.

3.2.2 M.S. Thesis Defense Committee

The M.S. Thesis Defense Committee, which must be approved by the student's Dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be KAUST Faculty. The Chair plus one additional Faculty Member must be affiliated with the student's program. This membership can be summarized as:

Member Role Program Status:

Member	Role	Program Status
1	Chair	Within Program
2	Faculty	Within Program
3	Faculty or Approved Research Scientist	Outside Program
4	Additional Faculty	Inside or Outside KAUST

Notes:

- Members 1-3 are required. Member 4 is optional.
- Co-Chairs may serve as Member 2, 3 or 4, but may not be a Research Scientist.
- Adjunct Professors and Professor Emeriti may retain their roles on current Committees, but may not serve as Chair on any new Committees.
- Professors of Practice and Research Professors may serve as Members 2, 3 or 4 depending upon their affiliation with the student's program. They may also serve as Co-Chairs.
- Visiting Professors may serve as Member 4.

View a list of faculty and their affiliations: [CLICK HERE](#)

3.3 M.S. Non-Thesis Option

Students wishing to pursue the non-thesis option must complete a minimum of six credits of Directed Research (299). Summer internship credits may be used to fulfill the research requirements provided that the Summer internship is research-based. Summer internships are subject to approval by the student's academic advisor.

Students must complete the remaining credits through one or a combination of the options listed below:

- Broadening Experience Courses: Courses that broaden a student's M.S. experience.
- Internship: Research-based Summer Internship (295). Students are only allowed to take one internship.
- PhD Courses : Courses numbered at the 300 level.

It should be noted that a student may also combine courses to satisfy the six credit requirement. For example, a student could take one Ph.D.-level course and one graduate-level course in another program. A student may not enroll in two Summer internships.

4. Doctor of Philosophy

The Doctor of Philosophy (Ph.D.) Degree is designed to prepare students for research careers in academia and industry. It is offered exclusively as a fulltime program.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a B.S. Degree and two and a half years for students entering with a M.S. Degree. A minimum GPA of 3.0 must be achieved on all doctoral coursework. Individual courses require a minimum of a 'B-' to earn course credit.

The Ph.D. Degree includes the following steps:

- Securing a Dissertation Advisor.
- Successful completion of Program Coursework.
- Passing the Qualifying Examination.
- Passing the Dissertation Proposal Defense to obtain candidacy status.
- Preparing, submitting and successfully defending a Doctoral Dissertation

4.1 Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. Degree with a B.S. Degree or a relevant M.S. Degree. Students holding a B.S. Degree must complete all Program Core/Mandatory Courses and Elective Courses outlined in the M.S. Degree section and are also required to complete the Ph.D. courses below. Students entering with a B.S. Degree may also qualify to earn the M.S. Degree by satisfying the M.S. Degree requirements; however, it is the student's responsibility to declare their intentions to graduate with an M.S.

Students entering the Ph.D. Degree with a relevant M.S. Degree must complete the requirements below, though additional courses may be required by the Dissertation Advisor.

Ph.D. Courses

- At least four 300-level courses. (Four electives from AMCS or another program of which at least two at the AMCS 300-level).
- Graduate Seminar 398 (non-credit): All students are required to register and receive a Satisfactory grade for every semester the program requires they attend.
- Winter Enrichment Program: Students are required to satisfactorily complete at least one full Winter Enrichment Program (WEP) as part of the degree requirements. Students who completed WEP requirements while earning the M.S. Degree are not required to enroll in a full WEP for a second time in the Ph.D. Degree.

Students entering the program with an M.S. Degree from KAUST may transfer unused coursework toward the Ph.D. program requirements subject to program level approval. Students transferring from another university's Ph.D. program may receive some Dissertation Research and Coursework credit on a case-by-case basis for related work performed at the original Institution upon approval by the Dean. However, such students must still satisfy the Qualifying Exam and Dissertation Proposal Defense requirements at KAUST.

4.2 Ph.D. Designation of Dissertation Advisor

The selected Dissertation Advisor must be a full time program-affiliated Assistant, Associate or Full

Professor at KAUST. The student may also select an advisor from another program at KAUST. This advisor can only become project-affiliated for the specific thesis project with program level approval. Project-affiliation approval must be completed prior to commencing research. View a list of faculty and their affiliations: [CLICK HERE](#)

4.3 Ph.D. Candidacy

In addition to the coursework requirements, the student must successfully complete the required Ph.D. qualification milestones to progress towards Ph.D. candidacy status. These milestones consist of the subject-based qualifying examination and Ph.D. Proposal Defense.

4.3.1 Subject-Based Qualifying Exam

The purpose of the subject-based Qualifying Exam is to test the student's knowledge of the subject matter within the field of study. All students entering the Ph.D. program with a B.S. Degree must take this examination within two years of their admission. Students admitted to the program with an M.S. Degree must take this exam within one year. Students who fail the subject-based Qualifying Exam with no retake or fail the retake will be dismissed from the University.

4.3.2 Ph.D. Dissertation Proposal Defense Committee

Formation of a Dissertation Proposal Defense Committee must include the following members:

- First Member: Dissertation Advisor who acts as Committee Chair.
- Second Member: Program or Program-affiliated Faculty Member.
- Third Member: KAUST Faculty Member from another Program.

The Proposal Dissertation Committee must be approved by the Dean. Once constituted, the composition of the Proposal Committee can only be changed with the approval of both the Dissertation Advisor and the Dean.

View a list of faculty and their affiliations: [CLICK HERE](#)

4.3.3 Ph.D. Dissertation Proposal Defense

The purpose of the Dissertation Proposal Defense is to demonstrate that the student has the ability and is adequately prepared to undertake Ph.D.- level research in the proposed area. This preparation includes necessary knowledge of the chosen subject, a review of the literature and preparatory theory or experiment as applicable.

The Dissertation Proposal Defense is the second part of the qualification milestones that must be completed to become a Ph.D. Candidate. Ph.D. students are required to complete the Dissertation Proposal Defense within one year after passing the qualifying exam. The Dissertation Proposal Defense includes two aspects: a written Research Proposal and an oral Research Proposal Defense. Ph.D. students must request to present the Dissertation Proposal Defense to the Proposal Dissertation Committee at the beginning of the Semester they will defend their proposal.

There are four possible outcomes from this Dissertation Proposal Defense:

- Pass
- Pass with conditions
- Fail with retake
- Fail without retake

A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the students fails.

In the instance of a Pass with Conditions, the entire committee must agree on the required conditions and if they cannot, the Dean decides. The deadline to complete the conditions is one month after the defense date, unless the committee unanimously agrees to change it.

In the instance of a Fail without Retake, the decision of the committee must be unanimous. The deadline to complete the retake is six months after the defense date, unless the committee unanimously agrees to reduce it. Students who fail the Dissertation Proposal Defense, or who fail the Retake will be dismissed from the University.

A student who successfully passes the Dissertation Proposal Defense is deemed a Ph.D. Candidate.

4.4 Ph.D. Defense

To graduate, a Ph.D. candidate has to form a Ph.D. Dissertation Defense Committee, finalize the Ph.D. dissertation and successfully defend his/her Ph.D. dissertation.

4.4.1 Ph.D. Dissertation Defense Committee

The Ph.D. Dissertation Defense Committee, which must be approved by the student's Dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST Faculty and one must be an Examiner who is external to KAUST. The Chair, plus one additional Faculty Member must be affiliated with the student's Program. The External Examiner is not required to attend the Defense, but must write a report on the dissertation and may attend the Dissertation Defense at the discretion of the Program.

Member Role Program Status:

Member	Role	Program Status
1	Chair	Within Program
2	Faculty	Within Program
3	Faculty	Outside Program
4	External Examiner	Outside KAUST
5	Approved Research Scientist	Inside KAUST
6	Additional Faculty	Inside or outside KAUST

Notes:

- Members 1-4 are required. Members 5 and 6 are optional.
- Co-Chairs may serve as either member 2, 3 or 6.
- Adjunct Professors and Professor Emeriti may retain their roles on current Committees, but may not serve as Chair on any new Committees.
- Professors of Practice and Research Professors may serve as members 2, 3 or 6 depending upon their affiliation with the student's Program. They may also serve as Co-Chairs.
- Visiting Professors may serve as member 6, but not as the External Examiner.

The only requirement with commonality with the Proposal Committee is the Supervisor, although it is expected that other members will carry forward to this committee.

If the student has a co-supervisor, this person can be considered one of the above four members required, provided they come under the categories listed. (i.e. meets the requirements of the position).

It is the responsibility of the student to inform the Dissertation Defense Committee of his/her progress, meet deadlines for submitting Graduation Forms, the defense date, etc. It is expected that the student submits his/her dissertation at least six weeks prior to the defense date in order to receive

feedback from the committee members in a timely manner.

4.4.2 Ph.D. Dissertation Defense

The Ph.D. Degree requires the passing of the defense and acceptance of the dissertation. The final defense is a public presentation that consists of an oral defense followed by questions and may last a maximum of three hours.

The student must determine the defense date with agreement of all the members of the Dissertation Committee. It is the responsibility of the student to submit the required documents to the Graduate Program Coordinator at the beginning of the semester they intend to defend. It is also expected that the student submits their written dissertation to the committee nine weeks prior to the defense date in order to receive feedback .

The written dissertation is required to comply with the University Formatting Guidelines which are on the library website: [CLICK HERE](#)

There are four possible outcomes from this Dissertation Final Defense:

- Pass
- Pass with conditions
- Fail with retake
- Fail without retake

A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the student fails. If more than one member casts a negative vote, one retake of the oral defense is permitted if the entire committee agrees. In the instance of a 'Pass with Conditions', the entire committee must agree on the required conditions and if they cannot, the Dean decides. The deadline to complete the revisions is one month after the defense date, unless the committee unanimously agrees to reduce it. The deadline to complete the retake is one month after the defense date, unless the committee unanimously agrees to reduce it. Students who fail the Dissertation Defense or who fail the retake will be dismissed from the University.

Evaluation of the Ph.D. Dissertation Defense is recorded by submitting the Result of Ph.D. Dissertation Defense Examination form within three days after the Defense to the Registrar's Office,

5. Program Courses and Descriptions

AMCS 101: Engineering Mathematics (3-0-0)

Coordinates, Lines, Circles, Functions and their graphs, Polynomials, trigonometric functions, limits, derivatives, numerical approximation of derivatives, indefinite integrals, the definite integral, the fundamental theorem of calculus, applications of the integral: areas, volumes, numerical integration, transcendental functions, techniques of integration: integration by parts; partial fraction decomposition, substitutions, differential equations of first order, separable equations, numerical integration of differential equations, Euler method, solution of linear differential equations of second order with constant coefficients, Infinite sequences and series, geometric series, convergence tests for series, power series and radius of convergence, Taylor series, approximation of functions by polynomials, exponential, cosine and sine expansions, error bounds. The plane and three-dimensional space, vectors, parametric equations for curves, lines, planes, dot and cross product, functions of several variables, partial derivatives, tangent planes and normals, linear approximation, gradient and the differential

AMCS 102: Vector Calculus (3-0-0)

This course covers differential, integral and vector calculus for functions of more than one variable. These mathematical tools and methods are used extensively in the physical sciences, engineering, economics and

computer graphics. The course covers triple integrals, cylindrical and spherical polar coordinates. Line and surface integrals. Divergence and curl applications, conservative vector fields. Green's, Gauss' and Stokes' theorems applications.

AMCS 107: Introduction to Programming with Matlab and Mathematica (3-0-0)

This course gives an introduction to MATLAB® and Mathematica. It is designed to give students fluency in these two mathematical software. The course consists of interactive lectures with students doing sample programming problems in real time.

AMCS 131: Vector Calculus and Ordinary Differential Equations (3-0-0)

The course is concentrated mostly on Multivariate Calculus and basic ODEs and contains some necessary preliminaries from Single Variable Calculus and Complex Analysis.

AMCS 143: Introduction to Probability and Statistics (3-0-0)

This course provides an elementary introduction to probability and statistics with applications. Topics include: basic probability models; combinatorics; random variables; discrete and continuous probability distributions; statistical estimation and testing; confidence intervals and an introduction to linear regression.

AMCS 151: Linear Algebra (3-0-0)

This is a basic subject on matrix theory and linear algebra. Emphasis is given to topics that will be useful in other disciplines, including systems of equations, introduction to vector spaces, basis and dimension, rank of a matrix, determinants, eigenvalues and diagonalization, similarity, and positive definite matrices. Applications. Orthogonal and unitary matrices and transformations. Orthogonal projections, Gram-Schmidt procedure.

AMCS 162: Discrete Mathematics (3-0-0)

This course covers elementary discrete mathematics for computer science and engineering. It emphasizes mathematical definitions and proofs as well as applicable methods. Topics include formal logic notation, proof methods; induction, well-ordering; sets, relations; elementary graph theory; integer congruence's; asymptotic notation and growth of functions; permutations and combinations, and counting principles.

AMCS199: Directed Study (variable credit up to a maximum of 12 credits)

Provides an individualized course of study that meets specific needs in a particular topic as outlined and directed by the instructor. A student may take this course based on the approval of the instructor and the student's home Division.

AMCS 201: Applied Mathematics I (3-0-3) (Equivalent to AMCS 132)

Prerequisites: Advanced and multivariate calculus and elementary complex variables. AMCS 201 and 202 may be taken separately or in either order. No degree credit for AMCS majors

Part of a fast-paced two-course sequence in graduate applied mathematics for engineers and scientists, with an emphasis on analytical technique. A review of practical aspects of linear operators (superposition, Green's functions and Eigen analysis) in the context of ordinary differential equations, followed by extension to linear partial differential equations (PDEs) of parabolic, hyperbolic and elliptic type through separation of variables and special functions. Integral transforms of Laplace and Fourier type. Self-similarity. Method of characteristics for first-order PDEs. Introduction to perturbation methods for nonlinear PDEs, asymptotic analysis, and singular perturbations.

AMCS 202: Applied Mathematics II (3-0-3) (Equivalent to AMCS 153)

Prerequisites: Advanced and multivariate calculus and elementary complex variables. AMCS 201 and 202 may be taken separately or in either order. No degree credit for AMCS majors.

Part of a fast-paced two-course sequence in graduate applied mathematics for engineers and scientists, with an emphasis on analytical technique. A review of linear spaces (basis, independence, null space and rank, condition number, inner product, norm and Gram-Schmidt orthogonalization) in the context of direct

and iterative methods for the solution of linear systems of equations arising in engineering applications. Projections and least squares. Eigen analysis, diagonalization and functions of matrices. Complex analysis, Cauchy-Riemann conditions, Cauchy integral theorem, residue theorem, Taylor and Laurent series, contour integration and conformal mapping.

AMCS 206: Applied Numerical Methods (3-0-3) (Equivalent to AMCS 152)

Prerequisites: Advanced and multivariate calculus. No degree credit for AMCS majors.

A fast-paced one-semester survey of numerical methods for engineers and scientists, with an emphasis on technique and software. Computer representation of numbers and floating point errors. Numerical solution of systems of linear and nonlinear algebraic equations, interpolation, least squares, quadrature, optimization, nonlinear equations, approximation of solutions of ordinary and partial differential equations. Truncation error, numerical stability, stiffness, and operation and storage complexity of numerical algorithms.

AMCS 210: Applied Statistics and Data Analysis (3-0-3) (Equivalent to AMCS 110)

Prerequisites: Advanced and multivariate calculus. For students outside AMCS wishing to obtain an introduction to statistical method. No degree credits for AMCS majors.

Provides fundamentals of probability and statistics for data analysis in research. Topics include data collection, exploratory data analysis, random variables, common discrete and continuous distributions, sampling distributions, estimation, confidence intervals, hypothesis tests, linear regression, analysis of variance, two-way tables and data analysis using statistical software.

AMCS 211: Numerical Optimization (3-0-3)

Prerequisites: Advanced and multivariate calculus and elementary real analysis.

Solution of nonlinear equations. Optimality conditions for smooth optimization problems. Theory and algorithms to solve unconstrained optimization; linear programming; quadratic programming; global optimization; general linearly and non-linearly constrained optimization problems.

AMCS 212: Linear and Nonlinear Optimization (3-0-3)

Prerequisites: Advanced and multivariate calculus.

The role of duality, optimality conditions and algorithms in finding and recognizing solutions. Perspectives: problem formulation, analytical theory, computational methods and recent applications in engineering, finance and economics. Theories: finite dimensional derivatives, convexity, optimality, duality and sensitivity. Methods: simplex and interior-point, gradient, Newton and barrier.

AMCS 231: Applied Partial Differential Equations I (3-0-3)

Prerequisites: Advanced and multivariate calculus and elementary complex variables.

First part of a sequence of courses on partial differential equations (PDE) emphasizing theory and solution techniques for linear equations. Origin of PDE in science and engineering. Equations of diffusion, heat conduction and wave propagation. The method of characteristics. Classification of PDE. Separation of variables, theory of the Fourier series and Fourier transform. The method of Green's functions. Sturm-Liouville problem, special functions, Eigen function expansions. Higher dimensional PDE and their solution by separation of variables, transform methods and Green's functions. Introduction to quasi-linear PDE and shock waves.

AMCS 232: Weak Solutions of Partial Differential Equations (3-0-3)

Prerequisite: AMCS 231 or 201.

This is a first course on weak solutions of partial differential equations. The course begins with a brief introduction to distributions and weak derivatives. Next we consider Sobolev spaces and fundamental results: extension and trace theorems, Sobolev and Morrey theorem, Poincaré's inequality and Rellich-Kondrachov theorem. Then we examine weak solutions of elliptic equations through Lax-Milgram theorem. The course ends with a discussions of weak solutions of linear evolution equations - second-order linear parabolic equations, linear hyperbolic systems and semigroup methods.

AMCS 235: Real Analysis (3-0-3)

Prerequisite: Advanced and multi-variable calculus.

This course is an introduction to measure and integration, the theory of metric spaces and their applications to the approximation of real valued functions. It starts with notions of convergence from sequences of continuous functions, the Ascoli- Arzela compactness theorem and the Weierstrass approximation theorem. The main body of the course deals with the theory of measure and integration and limiting processes for the Lebesgue integral. The last part covers the topics of differentiation, functions of bounded variation and Fourier series. The course provides the main background needed in modern Advanced Mathematics related to Real Analysis.

AMCS 241: Probability and Random Processes (3-0-3)

Prerequisites: Advanced and multivariate calculus.

Introduction to probability and random processes. Topics include probability axioms, sigma algebras, random vectors, expectation, probability distributions and densities, Poisson and Wiener processes, stationary processes, autocorrelation, spectral density, effects of filtering, linear least-squares estimation and convergence of random sequences.

AMCS 243: Probability and Statistics (3-0-3)

Prerequisites: Advanced and multivariable calculus.

This course is an introduction to probability and statistic for students in statistics, applied mathematics, electrical engineering and computer science. This core course is intended to provide a solid general background in probability and statistics that will form the basis of more advanced courses in statistics. Content: – Probability: Axioms of probability, Conditional probability and independence, Random variables, expectation, and moments, discrete random variables, Continuous random variables, Pairs of random variables, Limit theorems. – Theory of Statistics: Estimators and properties, Optimality, Maximum likelihood, hypothesis tests, Confidence intervals, Bayesian statistics. Methods of Statistics: Graphics and exploratory data analysis, Robust and nonparametric statistics.

AMCS 245: Linear Models (3-0-3)

Prerequisites: Advanced and multivariable calculus, linear algebra.

This course is an introduction to the formulation and use of the general linear model, including parameter estimation, inference and the use of such models in a variety of settings. Emphasis will be split between understanding the theoretical formulation of the models and the ability to apply the models to answer scientific questions.

AMCS 251: Numerical Linear Algebra (3-0-3)

Prerequisites: Programming skills (MATLAB preferred) and linear algebra.

Linear algebra from a numerical solution perspective. Singular Value Decomposition, matrix factorizations, linear least squares, Gram-Schmidt orthogonalization, conditioning and stability, Eigen analysis, Krylov subspace methods and preconditioning and optimization and conjugate gradient methods.

AMCS 252: Numerical Analysis of Differential Equations (3-0-3)

Prerequisites: Familiarity with Taylor series, norms, orthogonal polynomials, matrix analysis, linear systems of equations, eigenvalues, differential equations, and programming in MATLAB or a similar language.

The course covers theory and algorithms for the numerical solution of ODEs and of PDEs of parabolic, hyperbolic and elliptic type. Theoretical concepts include: accuracy, zero-stability, absolute stability, convergence, order of accuracy, stiffness, conservation and the CFL condition. Algorithms covered include: finite differences, steady and unsteady discretization in one and two dimensions, Newton methods, Runge-Kutta methods, linear multistep methods, multigrid, implicit methods for stiff problems, centered and upwind methods for wave equations, dimensional splitting and operator splitting.

AMCS 253: Iterative Methods of Linear and Nonlinear Algebra (3-0-3)

Prerequisites: Programming skills (MATLAB preferred) and linear algebra.

Classical stationary iterative methods of linear algebra, Chebyshev, multilevel and Krylov subspace iterative

methods, preconditioners from approximate factorizations, hierarchical solvers and domain decomposition; Classical nonlinear iterative methods, fixed-point, Newton and its variants, nonlinear Schwarz methods.

AMCS 255: Advanced Computational Physics (3-0-3)

This course covers a selection of advanced topics related to computational physics. Based on prior knowledge in calculus and linear algebra, the following topics are considered: Lagrangian formalism, symmetries and conservation laws, stability and bifurcation, multi-body problems and rigid bodies, linear and nonlinear oscillations, Hamiltonian formalism, canonical transformations and invariances, Liouville's theorem, discrete Lagrangian and Hamiltonian formalisms, Hamilton Jacobi theory, transition to quantum mechanics and relativity fields.

AMCS 271: Applied Geometry (3-0-3)

Differential Geometry: selected topics from the classical theory of curves and surfaces, geometric variational problems, robust computation of differential invariants, discrete differential geometry. Projective Geometry: computing with homogeneous coordinates, projective maps, quadrics and polarity. Algebraic Geometry: algebraic curves and surfaces, rational parameterizations, basic elimination theory. Kinematical Geometry: geometry of motions, kinematic mappings. The practical use of these topics is illustrated at hand of sample problems from Geometric Modelling, Computer Vision, Robotics and related areas of Geometric Computing.

AMCS 272: Geometric Modelling (3-0-3)

Prerequisites: Advanced and multivariate calculus and linear algebra, computer graphics, and programming experience. Terminology, coordinate systems, and implicit forms. Parametric and spline representations of curves and surfaces and their uses. Basic differential geometry of curves and surfaces. Subdivision surfaces. Solid modelling paradigms and operations. Robustness and accuracy in geometric computations. Applications.

AMCS 297: MS Thesis (variable credit)

AMCS 298: Graduate Seminar

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

AMCS 299: Directed Research (variable credit)

Prerequisite: Sponsorship of advisor and approved prospectus.
Master-level supervised research.

AMCS 303: Numerical Methods of Geophysics (3-0-3)

Prerequisite: ErSE 203 or consent of instructor.

Built on the modelling and simulation foundation developed in ErSE203, this specialized course will discuss advanced ideas of multi-scale modelling, linear and non-linear finite element methods, investigate modern approaches to numerical simulations of hydrodynamic and geophysical turbulence, problems of theoretical glaciology and material science of ice for the prediction of ice sheet evolution and wave propagation in linear and non-linear media.

AMCS 307: Advanced Statistical Inference (3-0-3)

Prerequisite: AMCS 241, 243, 245.

Statistical inference in a wide range of problems at an advanced level. It covers the general theory of estimation, tests and confidence intervals by deriving in particular the asymptotic properties of the maximum likelihood estimator and the likelihood ratio, Wald and scores tests (and their generalizations) and the calculus of M-estimation. Selected modern topics such as Bayesian and permutation inference, rank tests, the jackknife and the bootstrap.

AMCS 308: Stochastic Methods in Engineering (3-0-3)

Prerequisites: Basic probability, numerical analysis, and programming.

Review of basic probability; Monte Carlo simulation; state space models and time series; parameter estimation, prediction and filtering; Markov chains and processes; stochastic control; Markov chain Monte Carlo. Examples from various engineering disciplines.

AMCS 309: Computational Multivariate Statistics (3-0-3)

Prerequisite: AMCS 245.

An introduction to multivariate statistical models, well balancing three equally important elements: the mathematical theory, applications to real data, and computational techniques. Traditional multivariate models and their recent generalizations to tackle regression, data reduction and dimensionality reduction, classification, predictor and classifier instability problems. Tools for analyzing unstructured multivariate data.

AMCS 310: Environmental Statistics (3-0-3)

Prerequisites: AMCS 210 and 243.

This course is an introduction to statistical methods for environmental data, with a focus on applications. Learn, discuss and apply statistical methods to important problems in environmental sciences. Topics include sampling, capture-recapture methods, regression, toxicology, risk analysis, time series, spatial statistics and environmental extremes

AMCS 312: High Performance Computing (3-0-3)

Prerequisites: Experience with Linux and C/C++ and familiarity with basic discrete and numerical algorithms. High performance computing algorithms and software technology, with an emphasis on using distributed memory systems for scientific computing. Theoretical and practically achievable performance for processors memory system, and network, for large-scale scientific applications. The state-of-the-art and promise of predictive computational science and engineering. Algorithmic kernels common to linear and nonlinear algebraic systems, partial differential equations, integral equations, particle methods, optimization and statistics. Computer architecture and the stresses put on scientific applications and their underlying mathematical algorithms by emerging architecture. State-of-the-art discretization techniques, solve libraries and execution frameworks.

AMCS 313: Spatial Statistics (3-0-3)

Prerequisite: AMCS 241, 243, 245. Recommended optional prerequisites: AMCS 307.

This course is an introduction to the concepts and applications of spatial statistics. It covers the following topics. Geostatistical data: Random Fields; Variograms; Covariances; Stationarity; Non-stationarity; Kriging; Simulations. Lattice data: Spatial regression; SAR, CAR, QAR, MA models; Geary/Moran indices. Point patterns: Point processes; K-function; complete spatial randomness; Homogeneous/inhomogeneous processes and Marked point processes.

AMCS 315: Statistics of Extremes (3-0-3)

Prerequisites: AMCS 241, 243, 245 (Mandatory); AMCS 307, 313 (Recommended). The advanced statistics course aims at providing a rather deep understanding of Extreme-Value Theory results, models, and methods, as well as some experience in the practical application of these tools to real data using the statistical software R. Theoretical and practical aspects will be covered.

AMCS 329: Finite Element Methods (3-0-3)

An introduction to the mathematical theory of finite element methods and their applications to the solution of initial and boundary-value problems. A major component of the course will focus on the development of FE applications using the commercial software COMSOL Multiphysics to illustrate the fundamental features of the method. Topics of interest will cover classical problems in engineering and science.

AMCS 330: Computational Science and Engineering (3-0-3)

Prerequisites: Programming experience and familiarity with basic discrete and numerical algorithms and experience with one or more computational applications.

Case studies of representative and prototype applications in partial differential equations and mesh-based methods, particle methods, ray-tracing methods and transactional methods.

AMCS 331: Applied Partial Differential Equations II (3-0-3)

Prerequisites: Multivariate calculus, elementary complex variables, ordinary differential equations.

Recommended: AMCS 231 or AMCS 201.

Second part of a sequence of courses on partial differential equations (PDE) emphasizing theory and solution techniques for nonlinear equations. Quasi-linear and nonlinear PDE in applications. Conservation laws, first-order equations, the method of characteristics. Burgers' equation and wave breaking. Weak solutions, shocks, jump conditions and entropy conditions. Hyperbolic systems of gas dynamics, shallow-water flow, traffic flow and bio-fluid flow. Variational principles, dispersive waves, solitons. Nonlinear diffusion and reaction-diffusion equations in combustion and biology. Traveling waves and their stability. Dimensional analysis and similarity solutions. Perturbation methods. Turing instability and pattern formation. Eigenvalue problems. Stability and bifurcation.

AMCS 332: Introduction to Mathematical Modelling (3-0-3)

An introduction to mathematical modelling through a combination of practical problem-solving experience and applied mathematics techniques, including dimensional analysis, non-dimensionalization, asymptotic expansions, perturbation analysis, boundary layers, computing and other topics.

AMCS 333: Hyperbolic Conservation Laws and Godunov-type Methods (3-0-3)

Prerequisites: Analysis of PDEs (AMCS 231) and Numerical analysis of PDEs (AMCS 252).

The course covers theory and algorithms for the numerical solution of linear and nonlinear hyperbolic PDEs, with applications including fluid dynamics, elasticity, acoustics, electromagnetics, shallow water waves and traffic flow. The main concepts include: characteristics; shock and rarefaction waves; weak solutions; entropy; the Riemann problem; finite volume methods; Godunov's method; TVD methods and high order methods; stability, accuracy and convergence of numerical solutions.

AMCS 334: Mathematical Fluid Dynamics (3-0-3)

Prerequisites: AMCS 231 or AMCS 201. Recommended: AMCS 331.

Equations of fluid dynamics; inviscid flow and Euler equations; vorticity dynamics; viscous incompressible flow and Navier-Stokes equations; existence, uniqueness and regularity of solutions of Navier-Stokes equations; Stokes flow; free-surface flows; linear and nonlinear instability and transition to turbulence; rotating flows; compressible flow and shock dynamics; detonation waves.

AMCS 335: Multiscale Modelling and Simulation for PDEs (3-0-3)

The course will cover some basic multiscale methods as well as some advanced methods for solving partial differential equations with multiple scales. The topics will include: Background, Problems with multiple scales; Difficulties in solving multiscale problems; Homogenization techniques for partial differential equations (PDEs) (with periodic micro-structure); Formal asymptotic analysis; Homogenized media properties. Applications to various PDEs: Effective medium theory (based on homogenization); Simplified theories; Bounds for homogenized coefficients; Numerical homogenization (upscaling) techniques; Slowly varying and non-periodic microstructures; Estimating errors of numerical homogenization: Homogenization for nonlinear operators; Numerical homogenization for nonlinear operators; Multiscale finite element methods; Differences from homogenization/numerical homogenization; Simplified multiscale basis functions.

AMCS 336: Numerical Methods for Stochastic Differential Equations (3-0-3)

Prerequisites: knowledge of basic probability, numerical analysis, and programming.

Brownian motion, stochastic integrals and diffusions as solutions of stochastic differential equations. Functionals of diffusions and their connection with partial differential equations. Weak and strong approximation, efficient numerical methods and error estimates. Jump diffusions.

AMCS 338: Functional Analysis (3-0-3)

This course covers topics in Real Analysis and Functional Analysis and their applications. It starts with a

review of the theory of metric spaces, the L_p spaces, and the approximation of real functions. It proceeds to the theory of Hilbert spaces, Banach spaces and the main theorems of functional analysis, linear operators in Banach and Hilbert spaces, the spectral theory of compact, self-adjoint operators and its application to the theory of boundary value problems and linear elliptic partial differential equation. It concludes with approximation methods in Banach spaces.

AMCS 350: Spectral Methods for Uncertainty Quantification (3-0-3)

This course is an advanced introduction to uncertainty propagation and quantification in model-based simulations. Examples are drawn from a variety of engineering and science applications, emphasizing systems governed by ordinary or partial differential equations. The course will emphasize a probabilistic framework and will survey classical and modern approaches, including sampling methods and techniques based on functional approximations.

AMCS 353: Advanced Topics in Wave Propagation (3-0-3)

This course starts from the basic linearized theory of wave phenomena: examples are chosen from electromagnetics, acoustics, elastics and other subjects and exposes the recent developments in wave propagation. The topics include : basic concepts in wave propagation; waves in layered media; scattering, transmission and reflection; waves in random media, effective medium properties, resolution analysis; applications in wave functional materials and imaging and numerical techniques in techniques in solving wave equations in heterogeneous media. Basic knowledge on eigenvalue problem, fourier transform, linear algebra, vector analysis is desired.

AMCS 354: Asymptotic Methods of Applied Mathematics (3-0-3)

Prerequisite: Basic courses in complex analysis, ODE, and PDE. Asymptotic approximations, regular and singular asymptotics, approximation of integrals (methods of stationary phase and steepest descents), asymptotic analysis of ODE at regular/irregular singular points, parameter asymptotics for initial/boundary value problems, matched asymptotic expansions, the method of multiple scales, WKB method, weakly nonlinear oscillations and waves, bifurcation and stability.

AMCS 370: Inverse Problems (3-0-3)

Prerequisites: Linear algebra, multi-variable calculus.

The aim of the course is to introduce the basic notions and difficulties encountered with ill-posed inverse problems, to present methods for analyzing these problems and to give some tools that enable to solve such problems. The course will show what a regularization method is and introduce different kinds of regularization techniques and the basic properties of these methods for linear ill-posed problems. Non-linear inverse problems are also studied through some examples: inverse spectral problem, inverse problem of electrical impedance tomography and the inverse scattering problem. The course will introduce numerical tools for analyzing inverse problems, with a focus on the adjoint state method. The Bayesian estimation is also considered. Examples of inverse problems are provided especially in medical imaging.

AMCS 390 F: Mathematical Biology (3-0-3)

The course will focus on modeling and analysis of mathematical models for a variety of topics in population biology and in the biomedical sciences including single and competing species ecological models, enzyme reaction kinetics, epidemiology, and infectious diseases. Towards the end, we will study phenotype-structured populations and adaptive evolution.

It is intended as a graduate level course for the Applied Mathematics program and will be also of interest to students from BESE and other programs

AMCS 390G: Advanced Topics in Numerical Integration (3-0-3)

Numerical methods for solving initial value ODE's, especially large problems arising from semi-discretization of PDE's. Review of Runge-Kutta and multistep methods : consistency, stability, convergence, and accuracy. Error estimation and step size control. Stiffness, order reduction, stage order and stiff accuracy. Logarithmic norms and one-sided Lipschitz constants. Symplectic and energy-conserving methods. Monotonicity-, contractivity- and positivity-preserving methods. Methods for multiphysics problems: stabilized methods,

exponential methods and additive methods. Parallel time integration methods: Parareal, deferred corrections and PFASST extrapolation.

AMCS 396: Mathematical Modelling in Computer Vision (3-0-3)

Prerequisites: multivariable calculus and basic probability theory.

A research course that covers topics of interest in computer vision, including image denoising/deblurring, image segmentation/ object detection and image registration / matching. The emphasis will be on creating mathematical models via the framework of Bayesian estimation theory, analyzing these models and constructing computational algorithms to realize these models. Techniques from calculus of variations, differential geometry and partial differential equations will be built up as the need arises.

AMCS 397: Doctoral Dissertation (variable credit)

AMCS 398: Graduate Seminar

Doctoral-level seminar focusing on special topics within the field.

AMCS 399: Directed Research (variable credit)

Prerequisite: Sponsorship of advisor.

Supervised research.

CS 199: Directed Study in CS (3-0-0)

This course is a self-study in a particular topic directed by a faculty. Students do not register for this course. They may be required to enroll in it based on the recommendation of a faculty and approval of the program.

CS 207: Programming Methodology and Abstractions (3-0-3)

Computer programming and the use of abstractions. Object-oriented programming, fundamental data structures (such as stacks, queues, sets) and data-directed design. Recursion and recursive data structures (linked lists, trees, graphs). Introduction to basic time and space complexity analysis. The course teaches the mechanics of the C, C++ or Java language as well as an example of media library.

CS 247: Scientific Visualization (3-0-3)

Prerequisites: Advanced and multivariate calculus and linear algebra, computer graphics, and programming experience. Techniques for generating images of various types of experimentally measured, computer generated or gathered data. Grid structures. Scalar field visualization. Vector field visualization. Particle visualization. Graph visualization. Animation. Applications in science, engineering and medicine.

CS 248: Computer Graphics (3-0-3)

Prerequisites: solid programming skills and linear algebra.

Input and display devices, scan conversion of geometric primitives, 2D and 3D geometric transformations, clipping and windowing, scene modelling and animation, algorithms for visible surface determination, local and global shading models, color and real-time rendering methods.

CS 260: Design and Analysis of Algorithms (3-0-3)

Prerequisite: computer programming skills, probability, basic data structures, basic discrete mathematics.

Review of algorithm analysis (search in ordered array, binary insertion sort, merge sort, 2-3 trees, and asymptotic notation). Divide and conquer algorithms (master theorem, integer multiplication, matrix multiplication, fast Fourier transform). Graphs (breadth-first search, connected components, topological ordering, and depth-first search). Dynamic programming (chain matrix multiplication, shortest paths, edit distance, sequence alignment). Greedy algorithms (binary heaps, Dijkstra's algorithm, minimum spanning tree, Huffman codes). Randomized algorithms (selection, quick sort, global minimum cut, hashing). P and NP (Cook's theorem, examples of NP-complete problems). Approximate algorithms for NP-hard problems (set cover, vertex cover, and maximum independent set). Partial recursive functions (theorem of Post, Diophantine equations). Computations and undecidable problems (undecidability of halting problem, theorem of Rice, semantic and

syntactical properties of programs).

CS 261: Combinatorial Optimization (3-0-3)

Prerequisite: Familiarity with discrete algorithms at the level of AMCS 260.

Topics: algorithms for optimization problems such as matching, maxflow, min-cut and load balancing. Using linear programming, emphasis is on LP duality for design and analysis of approximation algorithms. Approximation algorithms for NP-complete problems such as Steiner trees, traveling salesman and scheduling problems. Randomized algorithms.

CS 291: Scientific Software Engineering (3-0-3)

Prerequisites: Programming experience and familiarity with basic discrete and numerical algorithms.

Practical aspects of application development for high performance computing. Programming language choice; compilers; compiler usage. Build management using make and other tools. Library development and usage. Portability and the GNU autoconf system. Correctness and performance debugging, performance analysis. Group development practices and version control. Use of third-party libraries and software licensing.

CS 292: Parallel Programming Paradigms (3-0-3)

Prerequisites: Programming experience and familiarity with basic discrete and numerical algorithms.

Distributed and shared memory programming models and frameworks. Thread programming and Open MP. Message passing and MPI. Parallel Global Address Space (PGAS) languages. Emerging languages for many-core programming. Elements to be covered will include syntax and semantics, performance issues, thread safety and hybrid programming paradigms.

CS 337: Information Networks (3-0-3)

Prerequisite: probability, stochastic systems, network architecture of the Internet and the systems performance

Modeling, experimental design, performance measurement, model development, analytic modeling, single queue facility, networks of queues, stochastic systems, deterministic systems, birth-death model analysis, closed network model, bottleneck, interactive networks, M/M/m queues, M/G/1 priority queues, Markovian queuing model, random numbers, discrete event simulation, verification and validation of simulation models, workload characterization and benchmarks. Also, advanced research papers on using queuing theory for networking systems. The course consists of a final modeling and simulation project on a novel idea that leads to publication

CS 340: Computational Methods in Data Mining (3-0-3)

Prerequisites: Probability and scientific computing.

Focus is on very-large-scale data mining. Topics include computational methods in supervised and unsupervised learning, association mining and collaborative filtering. Individual or group applications-oriented programming project. 1 credit without project; 3 credits requires final project

CS 361: Combinatorial Machine Learning (3-0-3)

Prerequisites: AMCS/CS 260.

Lower and upper bounds on complexity and algorithms for construction (optimization) of decision trees, decision rules and tests. Decision tables with one-valued decisions and decision tables with many-valued decisions. Approximate decision trees, rules and tests. Global and local approaches to the study of problems over infinite sets of attributes. Applications to discrete optimization, fault diagnosis, pattern recognition, analysis of acyclic programs, data mining and knowledge discovery. Current results of research.

EE 341: Information Theory (3-0-3)

Prerequisite: EE 241 or consent of an instructor.

The concepts of source, channel, rate of transmission of information. Entropy and mutual information. The noiseless coding theorem. Noisy channels, the coding theorem for finite state zero memory channels. Channel capacity. Error bounds. Parity check codes. Source encoding.

CS 380: GPU and GPGPU Programming (3-0-3)

Prerequisite: CS 280. Recommended optional prerequisites: CS 248, CS 292.

Architecture and programming of GPUs (Graphics Processing Units). Covers both the traditional use of GPUs for graphics and visualization, as well as their use for general purpose computations (GPGPU). GPU many-core hardware architecture, shading and compute programming languages and APIs, programming vertex, geometry, and fragment shaders, programming with CUDA, Brook, Open CL, stream computing, approaches to massively parallel computations, memory subsystems and caches, rasterization, texture mapping, linear algebra computations, alternative and future architectures

6. KAUST University Requirements: Office of the Registrar

King Abdullah University of Science and Technology (KAUST) advances Science and Technology through bold and collaborative research. It educates Scientific and Technological leaders, catalyzes the diversification of the Saudi economy and addresses challenges of Regional and Global significance, thereby serving the Kingdom, the Region and the World.

Research and Education, as well as their transformative potential are central to KAUST's mission. KAUST has a three-part mission: Research at KAUST – both basic and goal-oriented is dedicated to advancing Science and Technology of regional and global impact. Research excellence inspires teaching and the training of future leaders in Science and Technology.

Research and Education at KAUST energize innovation and enterprise to support knowledge-based economic diversification.

Through the synergy of Science and Technology, with a focus on innovation and enterprise, KAUST is a catalyst for transforming people's lives.

In support of this mission, King Abdullah University of Science and Technology offers twelve graduate programs leading to M.S. and Ph.D. Degrees.

KAUST offers the following two Degrees:

- The M.S. Degree typically takes three Semesters and a Summer Session to complete (18 months). The Degree allows flexibility for Internships, Research and Academics.
- The Ph.D. Degree is typically a three to four year post-master's Degree. The Ph.D. involves original Research, culminating in a Research Dissertation.

There are three Academic Divisions:

Biological and Environmental Science and Engineering (BESE)

- Bioscience (B)
- Environmental Science and Engineering (EnSE)
- Marine Science (MarS)
- Plant Science (PS)

Computer, Electrical and Mathematical Science and Engineering (CEMSE)

- Applied Mathematics and Computational Science (AMCS)
- Computer Science (CS)
- Electrical Engineering (EE)

Physical Science and Engineering Division (PSE)

- Chemical and Biological Engineering (CBE)
- Chemical Science (ChemS)
- Earth Science and Engineering (ErSE)

- Materials Science and Engineering (MSE)
- Mechanical Engineering (ME)

Each Program is administered by a Graduate Committee and a Graduate Chair. Courses for each program will be listed at the 100 (non-credit), 200 or 300 Level.

7. Master's Program

7.1 Admissions

Admission to the M.S. program requires the satisfactory completion of an undergraduate B.S. Degree in a relevant or related area, such as Engineering, Mathematics or the Physical, Chemical and Biological Sciences.

7.2 Master's Degree Requirements

The M.S. Degree requires successful completion of 36 credits. Students are expected to complete the M.S. Degree in three semesters plus one Summer session. Degree requirements are divided into three sections: Core Curriculum and/or mandatory Courses; Elective Curriculum and Research/Capstone Experience.

- **Core Curriculum (9-15 Credits):** This portion of the degree program is designed to provide a student with the background needed to establish a solid foundation in the program area over and above that obtained through undergraduate studies.
- **Elective Curriculum (9-15 Credits):** This portion of the degree program is designed to allow each student to tailor his/her educational experience to meet individual research and educational objectives. Depending on the program and the objectives, this may be met by added coursework or by additional research experience.
- **Research/Capstone Experience (12 Credits):** The details of this portion of the degree program are uniquely determined by the student and his/her advisor and will involve a combination of research and other capstone experiences that build on the knowledge gained in coursework.
- Satisfactory participation in KAUST's Summer Sessions and Winter Enrichment Program (WEP) is mandatory.
- Summer Session courses are credit bearing and apply towards the degree.
- WEP Courses do not earn credit towards the degree.

At least 36 degree credits must be completed in graduate-level courses and research projects. These courses should be 200-level or above and must be approved by the student's advisor. Additional non-credit bearing activities such as Graduate Seminars may be required by the program.

View a list of Faculty and their affiliations [CLICK HERE](#)

7.2.1 Thesis Requirements

Students wishing to pursue a thesis as part of their M.S. Degree must identify a Research Advisor and must file for thesis status. The application for the thesis option is due to the Registrar's Office by the ninth week of the student's second semester at KAUST.

Criteria for Acceptance into the Master's Degree with Thesis Program:

Students should have a well-constructed Thesis Proposal that includes a time-line for completion. The Thesis Proposal must be approved by the Research Advisor and the Dean of the Division. In the case of an optional thesis program, the student should have a minimum GPA of 3.2 and at least twelve credit hours completed at the conclusion of the first Semester and be registered in at least twelve

credit hours during the second Semester.

The Research Advisor must indicate that he/she endorses the Thesis Topic and Scope of Work and that it could reasonably be completed by the end of the third Semester. Alternatively, the Faculty Member agrees to a longer timeframe, not to exceed the end of the fourth semester and to cover the student and experimental costs that accrue during this period.

The student's program of study should be structured such that the student may change to the M.S. without Thesis option and finish the degree by the end of the student's third semester.

Thesis format requirements are described in the KAUST Thesis and Dissertation Guidelines: [CLICK HERE](#)

Thesis Defense

The evaluation of M.S. Thesis credits comprises of a Satisfactory (S) or Unsatisfactory (U) Grade. The requirement of a Public Seminar based on the student's work is left to the discretion of the M.S. Thesis Advisor. The student is responsible for scheduling the Thesis Defense date with his/her supervisor and committee members. It is advisable that the student submits a written copy of the thesis to the thesis committee members at least two weeks prior to the defense date.

Thesis Defense Committee

Evaluation of satisfactory completion of M.S. Thesis Work is performed by the M.S. Thesis Defense Committee.

The M.S. Thesis Defense Committee, which must be approved by the student's Dean, must consist of at least three members and typically include no more than four members. At least two of the required members must be KAUST Faculty. The Chair plus one additional Faculty Member must be affiliated with the student's program. This membership can be summarized as:

Member Role Program Status:

Member	Role	Program Status
1	Chair	Within Program
2	Faculty	Within Program
3	Faculty or Approved Research Scientist	Outside Program
4	Additional Faculty	Inside or outside KAUST

Notes:

- Members 1-3 are required. Member 4 is optional.
- Co-Chairs may serve as Member 2, 3 or 4, but may not be a Research Scientist.
- Adjunct Professors and Professor Emeriti may retain their roles on current Committees, but may not serve as Chair on any new Committees.
- Professors of Practice and Research Professors may serve as Members 2, 3 or 4 depending upon their affiliation with the student's program. They may also serve as Co-Chairs.
- Visiting Professors may serve as Member 4.

7.2.2 Non-Thesis Option

Students wishing to pursue the non-thesis options must complete a minimum of six credits of

Directed Research (299). Summer internship credits may be used to fulfil the research requirements provided that the Summer internship is research-based. Summer internships are subject to approval by the student's academic advisor.

Students must complete the remaining credits through one or a combination of the options listed below:

- Broadening Experience Courses: Courses that broaden a student's M.S. experience.
- Ph.D. Courses: Courses numbered at the 300 level.

It should be noted that a student may also combine courses to satisfy the six credit requirement. For example, a student could take one Ph.D.-level course and one graduate-level course in another program. A student may not enroll in two Summer internships. Students may select a KAUST Faculty Member from another program to act as a Research Advisor (for either Thesis or Directed Research) but must provide a one-page description of the research and an explanation of how such research would be relevant to the degree program. Upon approval by the Program Chair and the Dean, the Faculty Member would be allowed to act as an affiliated Faculty Member and advisor for the student.

Please note: Degree Programs may have additional requirements to those listed above.

View a list of Faculty and their Affiliations: [CLICK HERE](#)

8. Ph.D. Program

8.1 Admissions

Ph.D. students apply for and enter a specific degree program. A Faculty Advisor is either immediately designated (in the case of a student being recruited by a specific Faculty Member) or temporarily assigned. In the latter case, the student is expected to identify a Research Advisor by, at the latest, the end of the first year.

There are three phases and associated milestones for Ph.D. students:

- Passing a qualifying exam.
- Passing an oral Defense of the Dissertation Proposal.
- Dissertation phase with a final Defense milestone.

8.2 Ph.D. Degree Requirements

There is a minimum residency requirement (enrolment period at KAUST) of two and a half years for students entering with a M.S. Degree, three and a half years for students entering with a B.S. Degree. Qualification and advancement to candidacy are contingent upon: successfully passing Ph.D. coursework, designating a Research Advisor, successfully passing a Qualifying Exam and writing and orally defending a research proposal. Possible outcomes include Pass, Failure with complete Retake, Failure with Partial Retake and Failure with no Retake.

Students not permitted to retake the exam, or who fail the Retake, will be dismissed from the University. The maximum allotted time for advancement to candidacy for a student entering with a M.S. Degree is one year after passing of qualifying exam; two years for students entering with a B.S. Degree.

Satisfactory participation in KAUST's Summer Session and at least one full Winter Enrichment Program (WEP) is mandatory. Summer Session courses are credit bearing and apply towards the degree. WEP courses do not earn credit towards the degree.

The required coursework is outlined below and refer to Paragraph 5 (Program Courses and Descriptions) for specific program course requirements:

M.S. Degree

- Mandatory and/or Core courses (depending on program).
- Elective courses

Ph.D. Degree

- Two or more courses (six credits of coursework) at 300 level
- Graduate Seminar (if required by the Program)

Students entering the program with a relevant M.S. Degree from another institution may transfer coursework towards the requirements of the M.S. Degree upon approval of the Program Chair.

Students entering the program with a M.S. Degree from KAUST may transfer coursework towards both the M.S. and Ph.D. requirements listed above upon approval of the Program Chair and based on their program of study at KAUST.

Students entering with a B.S. degree from another institution may transfer in up to nine credits of graduate level coursework towards the above requirements upon approval of the Program Chair. In addition, students entering with a B.S. Degree may also qualify to earn a M.S. Degree by satisfying the M.S. Degree requirements as part of the Ph.D. program.

Some degree programs may require a diagnostic entrance exam as a basis for admission and students may be required to complete additional coursework depending on their degree-granting Institution. If the M.S. Degree is from a subject other than the Ph.D. program, there may be additional courses required as specified by the advisor.

8.3 Candidacy

Achieving Ph.D. candidacy is contingent upon successfully passing a qualifying examination, acceptance by the research advisor of a written research proposal and successfully passing an oral examination. Details should be confirmed in the individual degree program material.

For a list of eligible Faculty Advisors for any Degree Program see: [CLICK HERE](#)

Passing the qualification phase is achieved by acceptance by all the committee members of the written proposal and positive vote of all, but, at most, one member of the Oral Exam Committee. If more than one member casts a negative vote, one retake of the oral defense is permitted if the entire committee agrees. A conditional pass involves conditions (e.g. another course in a perceived area of weakness) imposed by the committee, with the conditional status removed when those conditions have been met. Once constituted, the composition of the Qualification Phase Committee can only be changed upon approval by both the Faculty Research Advisor and the Division Dean.

8.4 Dissertation Research Credits

Besides coursework (six or more credit hours), Dissertation Research (Course Number 397) must be earned during the first (Proposal Preparation and Defense) and second phases of the Ph.D. program. A fulltime workload for Ph.D. students is considered to be twelve credit hours per semester (courses and 397) and six credit hours in summer (397 only). There is a minimum residency requirement (enrolment period at KAUST) of two and a half years for students entering with an M.S. Degree and three and a half years for students entering with a B.S. Degree. Ph.D. students typically complete the degree in five years.

8.5 Dissertation and Dissertation Defense

The Dissertation Defense is the final exam of the Ph.D. Degree. It involves a public presentation of the results of the Dissertation Research followed by a question and answer session by the Ph.D. Dissertation

Defense Committee. It is the responsibility of the student to inform the Dissertation Committee of his/her progress and meet deadlines for submitting defense date and graduation forms. It is expected that students will submit their dissertations to their committee six weeks prior to the defense date in order to receive feedback from the committee members in a timely manner. However, the advisor may approve exceptions to this expected timeline.

The Dissertation format requirements are described in the KAUST Thesis and Dissertation Guidelines: [CLICK HERE](#)

The result of the defense will be made based on the recommendation of the committee. There are four possible results:

- **Pass:** The student passes the exam and the dissertation is accepted as submitted.
- **Pass with Conditions:** The student passes the exam but the student is advised of the revisions that must be made to the text of the dissertation.
- **Failure with Retake:** Normally this means the student must do more research to complete the dissertation. The student must revise the dissertation and give another oral examination within one month from the date of the first defense.
- **Failure:** The student does not pass the exam and the dissertation is not accepted therefore the degree is not awarded and the student is dismissed from the University.

8.6 Ph.D. Dissertation Defense Committee

The Ph.D. Dissertation Defense Committee, which must be approved by the student's Dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST Faculty and one must be an examiner who is external to KAUST. The Chair plus one additional Faculty Member must be affiliated with the student's program. The External Examiner is not required to attend the Defense but must write a report on the dissertation and may attend the Dissertation Defense at the discretion of the program.

This Membership can be summarized as:

Member Role Program Status:

Member	Role	Program Status
1	Chair	Within Program
2	Faculty	Within Program
3	Faculty	Outside Program
4	External Examiner	Outside KAUST
5	Approved Research Scientist	Inside KAUST
6	Additional Faculty	Inside or outside KAUST

Notes:

- Members 1-4 are required. Members 5 and 6 are optional.
- Co-Chairs may serve as either member 2, 3 or 6.
- Adjunct Professors and Professor Emeriti may retain their roles on current Committees, but may not serve as Chair on any new Committees.
- Professors of Practice and Research Professors may serve as members 2, 3 or 6 depending upon their affiliation with the student's Program. They may also serve as Co-Chairs.
- Visiting Professors may serve as member 6, but not as the External Examiner.

It is the responsibility of the student to inform the Dissertation Committee of his/her progress and meet deadlines for submitting defense date and graduation forms. It is expected that students will submit their dissertations to their committee six weeks prior to the defense date in order to receive feedback from the committee members in a timely manner. However, the advisor may approve exceptions to this expected timeline.

The Dissertation format requirements are described in the KAUST Thesis and Dissertation Guidelines. [CLICK HERE](#)

9. Program Descriptions

The M.S. and Ph.D. Degree program requirements listed above represent general university-level expectations. The specific details of each degree's requirements are outlined in the descriptions of the individual degree programs.

Course Notation:

Each course is listed prefaced with its unique number and post fixed with (L-C-R) where:

- L = the lecture hours to count towards fulfilling the student workload during the semester.
- C = the recitation or laboratory hours
- R = the credit hours towards fulfilling a degree course requirement.

E.g. CS220 Data Analytics (3-0-3) has a total of three hours of lectures per week, has no labs and earns three credits for the semester.

9.1 University Wide Courses

University Wide Courses are courses in areas not tied to any specific degree program. They are designed to meet institutional requirements, provide broadening experience or to provide supplemental preparation to support students in their degree.

These are listed below:

9.1.1 English as a Second Language

These courses are designed to provide English language training for students who do not fully meet the University's English language entrance requirements. Students will be assigned courses based on their level of English or proficiency.

ESL101 English as a Second Language I (6-0-0):

ESL101 is a foundational English skills course for reading, listening, speaking and writing. The course has a strong focus on teaching students the basics of academic writing and grammar structures in preparation for thesis work. Course materials are typically A2 level to help students acquire basic academic English skills required for graduate coursework.

ESL102 English as a Second Language II (3-0-0):

ESL102 is a pre- English skills course for reading, listening, speaking and writing. The course continues to focus on building academic writing and grammar skills and also have more emphasis on reading for academic purposes. Course materials are typically B1 level to help students further develop pre-intermediate English skills required for graduate coursework.

ESL103 English as a Second Language III (3-0-0)

ESL103 is an upper-intermediate English skills course for reading, listening, speaking and writing. The course helps to further develop academic English skills necessary to successfully complete research and thesis work. Course materials are typically B2 level to help students

refine upper-intermediate English skills required for graduate coursework.

9.1.2 Enrichment Program - WEP Courses

The Winter Enrichment Program (WEP) takes place in January each year and is designed to broaden students' horizon. WEP is an essential and core requirement of the degree programs at KAUST. Satisfactory completion of at least one WEP is required of all M.S. students as part of the completion of the degree requirements. Ph.D. students who did not receive their M.S. Degree at KAUST are also required to satisfactorily complete at least one WEP. To satisfy this mandatory requirement, full participation must occur within a single WEP period.

9.2 Innovation and Economic Development

9.2.1 IED Technology Innovation and Entrepreneurship (3-0-3)

This course introduces students to using an entrepreneurial and design thinking view to solving real-world challenges including the pathway to commercializing research. It is about changing methods of thinking and equipping graduate students to be able to understand and manage innovation in the corporate world. This course is open to all M.S. students as an elective and to Ph.D. students with permission of their academic advisors.

9.2.2 IED220 – New Venture and Product Innovation Challenge (6-0-6)

This is an experiential, industry mentor-led program: This course will enable students to 'learn-by-doing' through the development of a fully formed business proposition for real intellectual property that has been developed in the Kingdom. The objective is to create a plan for commercialization and launch of a new products and/or new venture. The process will include students learning how to creatively view technology opportunities; the identification and assessment of opportunity and the structuring and packaging of a validated commercial idea. In addition, students will learn key skills including the development of real-world strategy, planning and teambuilding, integrating continuous feedback and communicating key concepts to different audiences.

10. Grading

The KAUST grading system is a 4.0 scale utilizing letter grades and these are the only grades that will be assigned:

A	=	4.00	C	=	2.00
A-	=	3.67	C-	=	1.67
B+	=	3.33	D+	=	1.33
B	=	3.00	D	=	1.00
B-	=	2.67	D-	=	0.67
C+	=	2.33	F	=	0.00
I	=	Incomplete			
IP	=	In-Progress			
W	=	Withdrew			
S	=	Satisfactory			
U	=	Unsatisfactory			
WF	=	Withdrew-Failed			

10.1 Incomplete Grades

Students who complete the majority of the requirements for a course but are unable to finish the course may receive an Incomplete (I) grade. A grade of Incomplete will be assigned only with the consent of the instructor of the course after the instructor and the student have agreed on the academic work that needs to be completed and the date it is due (but no later than the end of the second week of the following semester or session). When the requirements for the course are completed, the instructor will submit a grade that will replace the Incomplete grade on the student's academic record. 'Incompletes' not completed by the end of the second week of the following semester or session will be changed to Failing (F) grades.

Grades for students that are due to Graduate:

Note that any Incomplete grades (as well as Fail grades) will mean a student will not graduate or receive a diploma during the Commencement Ceremony.

Incomplete grades are granted to individual students on a case-by-case basis. Incomplete grades should not be used as a mechanism to extend the course past the end of the Semester. Students are allowed only one Incomplete grade while in a degree program at KAUST.

10.2 In-Progress Grades

Thesis Research (297) or Dissertation Research (397) should be graded as In-Progress (IP) or Unsatisfactory (U) for each semester. These 'IP' Grades will be converted by the Registrar's Office to 'S' Grades for all semesters once the office has been notified that the thesis or dissertation has been submitted to the library.

10.3 Research or Seminar Courses

Use the following grades for these Research or Seminar Courses:

297	=	Thesis Research	-	Either 'IP' or 'U'
397	=	Dissertation Research	-	Either 'IP' or 'U'
295/395	=	Summer Internship	-	Either 'S' or 'U'
298/398	=	Seminar	-	Either 'S' or 'U'
299/399	=	Directed Research	-	Either 'S' or 'U'

Summer Session and Winter Enrichment Program:

Satisfactory participation in KAUST's Summer Session and Winter Enrichment Period (WEP) is mandatory. Summer Session courses are credit bearing and apply towards the degree. WEP Courses do not earn credit towards the degree.

10.4 Cumulative Grade Point Average

- A minimum GPA of 3.0 must be achieved in all coursework.
- Individual courses require a minimum of a B- for Course credit.

11. Academic Standing

A student's academic standing is based on his/her cumulative performance assessment and a semester performance based on the number of credits earned and GPA during the most recently completed semester.

Academic Standing classifications are divided into four categories of decreasing levels of Academic Performance:

- Good Standing
- Academic Notice
- Academic Probation
- Academic Dismissal

Cumulative Assessment:

GPA	Academic Standing
3.00-4.00	Good Standing
2.67-2.99	Academic Notice
2.33-2.66	Academic Probation
Below 2.33	Academic Dismissal

S/U Performance	Academic Standing
0-2 Credits	GPA Standing
3-5 Credits	GPA Standing less one category

6-8 Credits	GPA Standing less two categories
9+ Credits	Academic Dismissal

Semester Assessment (Registered in 12 Credits)

Credits Earned	Academic Standing
12+ Credits	GPA Standing
9-11 Credits	GPA Standing less one category
6-8 Credits	GPA Standing less two categories
0 -4 Credits	Academic Dismissal

Semester Assessment (Registered in 9 Credits)

Credits Earned	Academic Standing
9+ Credits	GPA Standing
6-8 Credits	GPA Standing less one category
3-5 Credits	GPA Standing less two categories
0-2 Credits	Academic Dismissal

Summer Session Assessment

Credits Earned	Academic Standing
6 Credits	GPA Standing
3-5 Credits	GPA Standing less one category
0-2 Credits	GPA Standing less two categories

Definitions:

Good Standing

Student is making satisfactory academic progress towards the degree.

Academic Notice

Student is not making satisfactory progress towards the degree. A student placed on Academic Notice will be monitored in subsequent semesters to ensure satisfactory progress towards the degree (see Good Standing). If the student's performance does not improve in the following semester, the student will be placed on Academic Probation.

Academic Probation

Student is not making satisfactory progress towards the degree. A student placed on Academic Probation will be monitored in subsequent semesters to ensure satisfactory progress towards the degree (see Good Standing). If the student's performance does not improve in the following semester, the student will be academically dismissed.

Academic Dismissal

Student is not making satisfactory progress towards the degree and is unlikely to meet degree requirements. Dismissed students will be required to leave the University. If deemed eligible, dismissed students will have one week from receiving Notice of Dismissal to file an Appeal.

Appeal Process for Students Academically Dismissed

If the student is eligible to appeal, he/she must submit a written explanation why the dismissal should be rescinded along with any supporting documentation. The Committee on Academic Performance will hear the appeal and make a decision to grant or deny the appeal based on the appeal and documentation, the student's past performance and the likelihood that the student is capable of successfully completing his/her academic program. If the appeal is denied, the student will be required to leave the University. The decision of the committee is final – no additional appeals are permitted.

S/U Protection

Due to the significant impact of Unsatisfactory (U) Grades, a Faculty Member giving a 'U' Grade for a course involving six or more credits must obtain concurrency of the Dean prior to submitting the grade. If the grade is given for only a single class (including Research Credit), the number of credits will be capped at six when using the Academic Standing Table displayed above.

Returning to Good Standing

A student not in Good Standing due to a GPA deficiency may return to Good Standing by improving his/her cumulative GPA such that it meets or exceeds 3.0. A student not in Good Standing due to 'U' Grades may return to Good Standing by completing at least twelve credits during the subsequent semester with no 'U' grades and a semester GPA of at least 3.0 in traditionally graded courses.

12. Transferring Credits

A student may petition to transfer graduate credits from another University upon approval of the Program Chair and the Registrar.

Each student's application will be reviewed on a case-by-case basis.

The following rules apply:

- Up to three graduate-level courses not to exceed nine credits may be transferred for credit. Courses already used for another degree cannot be used as transferred credits.
- The course grade for any course to be transferred must be a 'B' or above.
- Courses transferred for degree credit must have been taken within three years prior to admission to KAUST.
- The student must submit a completed KAUST Transfer of Credit Form and include the Course Syllabus and Course Description
- The student is responsible for supplying an official transcript.
- The transcript may be no more than three months old.
- The transcript must be in English or accompanied by a certified English translation.
- The Grading Key must be included with the transcript.
- The Transcript must include the course name, level, grade and credit value.
- The credit value of the course must be equivalent to a minimum of three KAUST credit hours.

Course Transfer and Equivalency:

Graduate credit hours taken from any KAUST program may be applied to other KAUST graduate programs under the guidelines of the degree program to which the student is admitted. Graduate courses taken from another University or KAUST program that are equivalent in level and content to the designated courses in a major track may be counted towards meeting the major track requirement if their equivalence is confirmed by the Program Chair.

Students transferring from other Ph.D. programs may receive some Dissertation Research and Coursework credit units on a case-by-case basis for related work performed at their original Institution. However, such students must satisfy the written and oral requirements for a research proposal (if the proposal had been submitted and approved at the original Institution, the proposal may be the same, if approved by the research advisor). The minimum residency requirement for enrolment of such students at KAUST is two years.

13. Policy for Adding and Dropping Courses

A course may be added during the first week of the semester. Students may add courses after the first week with the permission of the instructor. Instructors have the right to refuse admission to a student if the instructor feels that the student will not have the time to sufficiently master the material due to adding the course late. A course may be dropped without penalty at any time during the first two weeks of the semester. Between the second and ninth week, students can drop a course but the course will appear on

the student's transcript with the grade of Withdraw (W). After the ninth week of a full semester, courses may be dropped only under exceptional circumstances and with the approval of the Course Instructor, the Program Chair and the Registrar.

14. Program Planning

It is the sole responsibility of the student to plan her/his graduate program in consultation with her/his advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

