Department of Mathematics

Chairperson:	Bertrand, Florian J.
Professor Emeritus:	Muwafi, Amin
Professors:	Abi-Khuzam, Faruk F.; Abu-Khuzam, Hazar M.; Khuri-Makdisi, Kamal F.; Nassif, Nabil R.; Shayya, Bassam H.
Associate Professors:	Alhakim, Abbas M.; Bertrand, Florian J.; El Khoury, Sabine S.; Raji, Wissam V.; Tlas, Tamer M.
Assistant Professors:	Andrist, Rafael; Aoun, Richard G.;Della Sala, Giuseppe; Monni, Stefano; Moufawad, Sophie M.; Roy, Tristan Cyrus; Sabra, Ahmad A.; Taati, Siamak; Taghavi-Chabert, Arman
Lecturers:	Fayyad, Dolly J.;Mroue, Fatima K.; Yamani, Hossam A.
Instructors:	Ashkar, Alice N.; Bou Eid, Michella J.; Fleihan, Najwa S.; Itani-Hatab, Maha S.; Khachadourian, Zadour A.; Nassif, Rana G.; Rahhal, Lina A.; Tannous, Joumana A.

The Department of Mathematics offers programs leading to the degree of Master of Science (MS) in Mathematics and Statistics.

Under Mathematics, students may choose between two tracks: a track in Pure Mathematics and a track in Applied Mathematics.[1]

MS in Mathematics

Students who are admitted to one of the two MATH tracks, Pure or Applied, must complete the university requirements for graduate study in the Faculty of Arts and Sciences with at least 24 credits at the graduate level and a thesis. These 24 credits must include the following required core courses for both tracks: MATH 303, MATH 304, MATH 309, and MATH 341.

Students following the Pure Mathematics Track are required to take at least one of MATH 306 or MATH 314 and complete the 24 credits by choosing any 3 elective courses offered in the department, totaling 9 credits, in addition to writing and defending a thesis in an area of Pure Mathematics.

Students following the Applied Mathematics Track are required to take at least one of MATH 350 or MATH/STAT 338 and complete the 24 credits by choosing any 3 elective courses offered in the department, totaling 9 credits, in addition to writing and defending a thesis in an area of Applied Mathematics.

P) Part time

MA or MS in Statistics

Students must complete the university requirements for graduate study in the Faculty of Arts and Sciences, at least 24 credits at the graduate level and a thesis. At least 18 of the 24 credits must be taken in the department and must include MATH 303, STAT 331, STAT 332, STAT 333 and STAT 334. Students interested in taking courses outside the department may do so after obtaining approval from the department. The graduate program in statistics is currently frozen.

Course Descriptions

Mathematics

MATH 301 Graduate Tutorial Courses 1–3 cr.
Prerequisite: Graduate standing or consent of instructor.

MATH 303 Measure and Integration 3.0; 3 cr.
A first course in measure theory, including general properties of measures, construction of Lebesgue measure in Rn, Lebesgue integration and convergence theorems, Lp-spaces, Hardy-Littlewood maximal function, Fubini's theorem and convolutions. *Prerequisite: MATH 223 or graduate standing. Annually.*

MATH 304 Complex Analysis 3.0; 3 cr.
A second course in complex analysis, covering the homotopy version of Cauchy's theorem, the open mapping theorem, maximum principle, Schwarz's lemma, harmonic functions, normal families, Riemann mapping theorem, Riemannian metrics, method of negative curvature, Picard's theorem, analytic continuation, monodromy and modular function. *Prerequisite: MATH 227 or graduate standing. Annually.*

MATH 305 Functional Analysis 3.0; 3 cr.
Vector spaces, Hamel basis, Hahn-Banach theorem, Banach spaces, continuous linear operators and functionals, Hilbert spaces and weak topologies. *Prerequisite: MATH 223 or graduate standing. Occasionally.*

MATH 306 Calculus on Manifolds 3.0; 3 cr.
Manifolds, differentiable structure, vector fields, flows, differential forms, Stokes' theorem, basic Lie group theory. *Prerequisite: MATH 223 or graduate standing. Biennially.*

MATH 307 Topics in Analysis 3.0; 3 cr.

MATH 309 Functional Analysis and Partial Differential Equations 3.0; 3 cr.
The course aims to introduce students to deterministic/analytic tools to study problems which appear in several areas of science. The course introduces mathematical notions and objects such as: Hilbert spaces, weak derivatives, distributions and Soboley spaces, adjoints of linear operators on infinite dimensional spaces, bounded linear operators, fixed point arguments, convolution and Fourier transform. This course connects to partial differential equations where existence of solutions to those elliptic/parabolic/hyperbolic uses the theory introduced in the first part of the course. Applications to

these linear differential equations in diffusion processes and population dynamics will be discussed throughout the course via examples from the literature. This course is self-contained. *Annually*

MATH 314 Algebraic Topology I 3.0; 3 cr.
Homotopy, fundamental group, Seifert-van Kampen theorem, covering spaces, singular homology. *Prerequisites: MATH 214 and MATH 241, or graduate standing. Biennially.*

MATH 315 Algebraic Topology II 3.0; 3 cr.
Singular cohomology, Poincare duality, higher homotopy theory, fiber bundles. *Prerequisite: MATH 314. Occasionally.*

MATH 316 Topics in Topology 3.0; 3 cr.

MATH 338 Introduction to Stochastic Processes 3.0; 3 cr.
This course gives an overview of stochastic processes. Topics will include discrete- and continuous-time Markov chains with discrete and continuous state space; basic martingale theory and Brownian motion. If time permits, integration with respect to Brownian motion will be covered to provide students with a first idea of stochastic integration. *Annually.*

MATH 341 Modules and Rings 3.0; 3 cr.
Fundamental concepts of modules and rings, projective and injective modules, modules over a PID, Artinian and Noetherian modules and rings, semi-simplicity, and tensor products. *Prerequisite: MATH 241 or graduate standing. Annually.*

MATH 342 Modules and Rings II 3.0; 3 cr.
A course covering more advanced topics in modules and rings. *Prerequisite: MATH 341. Occasionally.*

MATH 343 Field Theory 3.0; 3 cr.
Prerequisite: MATH 242. Occasionally.

MATH 344 Commutative Algebra 3.0; 3 cr.
Prerequisites: MATH 242 and MATH 341. Occasionally.

MATH 345 Topics in Algebra 3.0; 3 cr.
Occasionally.

MATH 348 Monte Carlo Methods 3.0; 3 cr.
Common techniques and basic principles of Monte Carlo simulations, including an overview of random number generation, rejection methods, importance sampling and variance reduction techniques, Monte Carlo integration, Markov chain Monte Carlo (Metropolis-Hastings and Gibbs sampler and some variants, e.g., cluster algorithms and multilevel samplers, as time allows). *Annually.*

MATH 350 Discrete Models for Differential Equations 3.1; 3 cr.
A detailed study of methods and tools used in deriving discrete algebraic systems of equations for ordinary and partial differential equations: finite difference and finite element discretization procedures; generation and decomposition of sparse matrices, finite-precision arithmetic, ill-conditioning and pre-conditioning, scalar, vector, and parallelized versions of the algorithms. The course includes tutorial immersion sessions in which students become acquainted with state-of-the-art scientific software tools on standard computational platforms.*Prerequisites: Linear algebra and the equivalent of MATH/CMPS 251 (which can be taken concurrently) or consent of instructor. Same as CMPS 350. Annually.*

MATH 351 Optimization and Nonlinear Problems 3.1; 3 cr.
A study of practical methods for formulating and solving numerical optimization problems that arise in science, engineering and business applications. Newton's method for nonlinear equations and unconstrained optimization. Simplex and interior-point methods for linear programming. Equality and inequality-constrained optimization. sequential quadratic programming. Emphasis is on algorithmic description and analysis. The course includes an implementation component where students develop software and use state-of-the-art numerical libraries. *Prerequisite: Graduate standing. Same as CMPS 351. Occasionally.*

MATH 358 Introduction to Symbolic Computing 3.0; 3 cr.
Introductory topics in computer algebra and algorithmic number theory that include fast multiplication of polynomials and integers, fast Fourier transforms, primality testing and integers factorization. Applications to cryptography and pseudo-random number generation. Linear algebra and polynomial factorization over finite fields. Applications to error-correcting codes. Introduction to Grobner bases. *Prerequisite: Good background in programming, linear algebra, discrete mathematics or consent of instructor. Same as CMPS 358. Occasionally.*

MATH 360 Special Topics in Computational Science 3.0; 3 cr.
A course on selected topics in computational science that changes according to the interests of visiting faculty, instructors and students. Selected topics cover state-of-the-art tools and applications in computational science. *Prerequisite: Consent of instructor. Same as CMPS 360. Occasionally.*

MATH 395A/395B Comprehensive Exam 0 cr.
Prerequisite: Consent of advisor.

MATH 399 MS Thesis 6 cr.

Statistics

The graduate program in statistics is currently frozen.

STAT 331 Advanced Probability Theory 3.0; 3 cr.
Characteristic functions, types of convergence, limiting properties of distribution and characteristic functions, limit theorems, and multivariate functions. *Prerequisites: MATH 227, STAT 238 and MATH 303. Annually.*

STAT 332 Advanced Mathematical Statistics 3.0; 3 cr.
Distribution theory, decision theory, and advanced topics in estimation and inference. *Prerequisites: STAT 235 and STAT 238. Annually.*

STAT 333 Multivariate Analysis 3.0; 3 cr.
Multivariate distributions, correlation coefficients, classification and discrimination, Hotelling's T2, tests of hypotheses for multivariate distributions and canonical variables. *Prerequisite: STAT 238. Annually.*

STAT 334 Advanced Topics in Statistics 3.0; 3 cr.
Annually.

STAT 335 Special Topics from Probability and Statistics 3.0; 3 cr.
May be repeated for credit. Annually.

STAT 338 Introduction to Stochastic Processes 3.0; 3 cr.
This course gives an overview of stochastic processes. Topics will include discrete- and continuous-time Markov chains with discrete and continuous state space; basic martingale theory and Brownian motion. If time permits, integration with respect to Brownian motion will be covered to provide students with a first idea of stochastic integration. *Annually*

STAT 348 Monte Carlo Methods 3.0; 3 cr.
Common techniques and basic principles of Monte Carlo simulations, including an overview of random number generation, rejection methods, importance sampling and variance reduction techniques, Monte Carlo integration, Markov chain Monte Carlo (Metropolis-Hastings and Gibbs sampler and some variants, e.g., cluster algorithms and multilevel samplers, as time allows). *Annually.*

STAT 395A/B Comprehensive Exam 0 cr.
Prerequisite: Consent of advisor.

STAT 399 MA or MS Thesis 6 cr.