Department of Mathematics

Chairperson: Raji, Wissam V.
Professors Emeriti: Muwafi, Amin; Yff, Peter
Associate Professors: Alhakim, Abbas M.; El Khoury, Sabine S.; Raji, Wissam V.; Tlas, Tamer M.
Assistant Professors: Azar, Monique E.; Bertrand, Florian J.; Della Sala Giuseppe, A.; El Smaily, Mohammad I.; Monni, Stefano
Lecturers: *Fayyad, Dolly J.; Yamani, Hossam A.

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

MA or MS in Mathematics

Students must complete the university requirements for graduate study in the Faculty of Arts and Sciences, and at least 24 credits at the graduate level and a thesis. These 24 credits must include MATH 303, MATH 304, MATH 314, and MATH 341.

MA or MS in Statistics

Students must complete the university requirements for graduate study in the Faculty of Arts and Sciences, and 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. It is expected to be available in the near future.

* part time
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 R^n, 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. Annually.

MATH 306  Calculus on Manifolds  3.0; 3 cr.
Prerequisite: MATH 223 or graduate standing. Occasionally.

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 Sobolev 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.
Closed surfaces, categories and functors, homotopy, the fundamental group functor, and covering spaces. Prerequisites: MATH 214 and MATH 241 or graduate standing. Annually.
MATH 315  Algebraic Topology II  3.0; 3 cr.
Singular homology with applications to Euclidean spaces and an introduction to cohomology theory. 
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. Annually.

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; 3cr.
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 Hasting and Gibbs samplers 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.

MATH 358  Introduction to Symbolic Computing  3.0; 3 cr.
Introductory topics in computer algebra and algorithmic number theory that includes 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. Annually.

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. Annually.

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

MATH 399  MA or MS Thesis  6 cr.
Statistics

The graduate program in statistics is currently frozen. It is expected to be available in the near future.

**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 Hasting and Gibbs samplers and some variants e.g. cluster algorithms and multilevel samplers, as time allows). *Annually.*

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

**STAT 399  MA or MS Thesis  6 cr.**