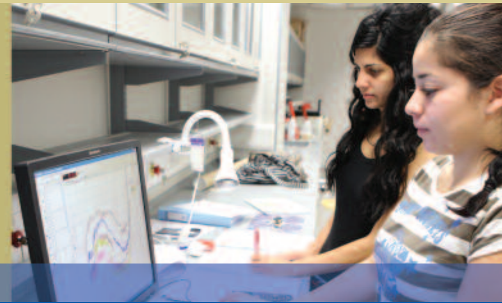
FACULTY OF PURE AND APPLIED SCIENCES







Department of Mathematics and Statistics

The Department offers postgraduate programmes which lead to the following degrees:

- *Master in Pure Mathematics*
- *Ph.D in Mathematics - Pure Mathematics*
- *Master in Applied Mathematics*
- *Ph.D in Mathematics - Applied Mathematics*
- *Master in Applied Statistics*
- *Ph.D in Statistics*
- *Mathematics Education*

Postgraduate Studies Programme

The programmes are supervised by the Postgraduate Programmes Coordinator who can be either the chairperson of the Department or a faculty member appointed by the Departmental Board. The Coordinator is the chairperson of the Postgraduate Studies Committee. The other members are also appointed by the Departmental Board. An interdepartmental committee coordinates the interdepartmental postgraduate programme.

Admission to Postgraduate Programmes

The number of postgraduate students to be admitted is announced separately for each specific programme at the Master or Doctorate level.

The criteria for evaluation and ranking of the candidates are the following:

- Prior university training in an appropriate field of study and a transcript of the degree. Appropriate fields of study are Mathematics, Statistics or other related subjects such as Computer Science, Physics, Engineering, etc.
- Recommendation letters (at least two) from university professors
- Personal interview (if necessary)
- Other qualifications, such as exams, awards, distinctions, etc.
- Sufficient knowledge of the English language (recommended)
- Candidates with insufficient knowledge of mathematics will be required to attend a number of undergraduate courses, in addition to those required by the regulations of the Department.

For more information on the Admission and Attendance Regulations – Application Requirements consult the Office of Postgraduate Studies, Academic Affairs and Student Welfare Services (tel. 22894021/61) or the Department's Secretariat.

MASTER IN APPLIED MATHEMATICS

Regulations

To obtain a Master degree in Applied Mathematics successful completion of a minimum of 90 ECTS is required.

Each course corresponds to 10 ECTS, the Master thesis to 15 ECTS and Seminars to 5 ECTS.

A postgraduate student may attend at most two Seminars.

Indicative Programme of Studies

Options	ECTS/Course	Total ECTS
6 Compulsory Courses	10	60
3 Elective Courses	10	30
TOTAL		90
or		
6 Compulsory Courses	10	60
2 Elective Courses	10	20
2 Seminars	5	10
TOTAL		90
or		
6 Compulsory Courses	10	60
1 Elective Course	10	10
1 Seminar	5	5
Master Thesis	15	15
TOTAL		90

List of Courses

Compulsory Courses

Category I

Two of the following:

MAS 601 Measure and Integration
MAS 604 Functional Analysis
MAS 606 Function Theory of One Complex Variable

Category II

Two of the following:

MAS 603 Partial Differential Equations
MAS 621 Numerical Linear Algebra
MAS 671 Numerical Solution of Ordinary Differential Equations
MAS 673 Finite Element Methods

Category III

Two of the following:

MAS 613 Ordinary Differential Equations
MAS 672 Numerical Solution of Partial Differential Equations
MAS 677 Topics in Numerical Analysis I
MAS 678 Topics in Numerical Analysis II
MAS 679 Topics in Numerical Analysis III
MAS 680 Seminar in Applied Mathematics I
MAS 681 Seminar in Applied Mathematics II
MAS 682 Classical Mechanics
MAS 683 Fluid Dynamics
MAS 684 Topics in Applied Mathematics I
MAS 685 Topics in Applied Mathematics II
MAS 686 Topics in Applied Mathematics III
MAS 687 Topics in Differential Equations
MAS 688 Topics in Differential Equations
MAS 689 Topics in Differential Equations

Note: Category III also includes all the courses offered under the Categories I and II.

Elective Courses

MAS 602 Fourier Analysis
MAS 605 Elliptic Partial Differential Equations of Second Order
MAS 608 Evolution Differential Equations with Partial Derivatives of Second Order
MAS 611 Harmonic Analysis
MAS 617 Topics in Mathematical Analysis I
MAS 618 Topics in Mathematical Analysis II
MAS 619 Topics in Mathematical Analysis III
MAS 620 Approximation Theory
MAS 633 General Relativity

PH.D. IN MATHEMATICS – Applied Mathematics

For the fulfillment of a Doctor of Philosophy Degree the requirements are:

1. Successful completion of 120 ECTS

at the postgraduate level in accordance with the provisions of the programme of studies of the Department. Students with a Master degree are partially or fully exempted from this requirement.

2. Comprehensive Examination (CE)

Candidates elect two areas from among the four areas included in the Syllabus Content for the Written Comprehensive Examination, on which they will be examined. Students should successfully complete the CE at the latest by the fifth semester of their studies.

3. Oral Examination

The candidate for the Ph.D. must present a research proposal for a Doctoral Thesis before a three-member committee. The presentation takes place at the latest one year after the admission of the student as a doctoral candidate.

4. Doctoral Thesis

A doctoral thesis can be submitted only after the completion of at least four semesters in the postgraduate programme at Ph.D. level, and after the student has successfully completed the comprehensive examination and obtained the required ECTS.

5. Defence of the Thesis

Defence of the thesis takes place before a five-member committee.

For more information on the comprehensive examination, the oral examination, the Doctoral Thesis and the Defence of the Thesis, see the Admission and Attendance Regulations – Application Requirements consult the Office of Postgraduate Studies, Academic Affairs and Student Welfare Services (tel. 22894021/61) or the Department's Secretariat.

The Syllabus for the Written Comprehensive Examination (WCE)

APPLIED MATHEMATICS

Newton equations, central forces, rotating axis systems, particle systems, motion of solids, Euler equations. Generalized coordinate systems, holonomic systems, Lagrange equations. Hamilton equations, equations of normal transformations, symmetries and conservation laws, Hamilton-Jacobi theory. Introduction to special relativity. Theorems of Stokes and Gauss, Calculus of variations, special functions, integral equations, asymptotic analysis.

MATHEMATICAL ANALYSIS (APPLIED)

Basic theory of metric space. σ-algebras, measures, outer measure. Borel measure on the real line. Measurable functions, integration. Convergence. Product measure and n-dimensional Lebesque measure. Polar coordinates and signed measures, the Radon-Nikodym theorem. Basic theory of L_p spaces.

PARTIAL DIFFERENTIAL EQUATIONS

First order quasi – linear equations: the method of characteristics. Existence (Cauchy – Kovalenski) and uniqueness (Holmgren) theorems. Theory of distributions: the dual of a differential operator, weak solutions, fundamental solutions. Construction of fundamental solutions. Second order equations: classification and canonical forms, solution of initial and boundary value problems for elliptic, parabolic and hyperbolic equations. Separation of variables, Fourier series.

NUMERICAL ANALYSIS

Numerical solution of non-linear equations. Matrix and vector norms. Direct and iterative methods for linear systems.

Computation of eigenvalues and eigenvectors. Polynomial interpolation (Lagrange and Hermite). Numerical quadrature (Newton and Gauss rules). Linear multistep methods for initial value problems in ODEs. Initial value and finite difference methods for boundary value problems in ODEs. Numerical solution for first and second order hyperbolic PDEs (method of characteristics, finite differences techniques). Numerical solution of parabolic PDEs. Numerical solution of the one and two-dimensional heat equation. Finite differences methods for Laplacian and Poisson problems.

Metric spaces, normed linear spaces and inner product spaces. Banach fixed point theorem and applications. Best approximation in normed linear spaces and inner product spaces. Finite difference element methods for elliptic problems. Variatonal, Ritz and Galerkin method. Error analysis.

MASTER IN PURE MATHEMATICS

Regulations

To obtain a Master degree in Pure Mathematics successful completion of a minimum of 90 ECTS is required.

Each course corresponds to 10 ECTS, the Master thesis to 15 ECTS and seminars to 5 ECTS.

A postgraduate student may attend at most two seminars.

Regular meetings of the teaching staff will take place for the programme of Pure Mathematics (Undergraduate and Postgraduate) where it will be decided which courses will be offered and by whom they will be taught.

Indicative Programme of Studies

Options	ECTS/Course	Total ECTS
4 Compulsory Courses	10	40
5 Elective Courses	10	50
TOTAL		90
or		
4 Compulsory Courses	10	40
4 Elective Courses	10	40
2 Seminars	5	10
TOTAL		90
or		
4 Compulsory Courses	10	40
3 Elective Courses	10	30
1 Seminar	5	5
Master Thesis	15	15
TOTAL		90

List of Courses

Compulsory Courses

MAS 601 Measure and Integration
MAS 606 Function Theory of one Complex Variable
MAS 632 Riemannian Geometry
MAS 627 Group Representation Theory I or MAS 624 Introduction to Commutative Algebra

Elective Courses

MAS 602 Fourier Analysis
MAS 604 Functional Analysis
MAS 605 Elliptic Partial Differential Equations with Partial Derivatives of Second Order
MAS 607 Function Theory of Several Complex Variables
MAS 608 Evolution Differential Equations with Partial Derivatives of Second Order
MAS 611 Harmonic Analysis
MAS 612 Measure and Probability
MAS 617 Topics in Mathematical Analysis I
MAS 618 Topics in Mathematical Analysis II
MAS 619 Topics in Mathematical Analysis III
MAS 620 Approximation Theory
MAS 622 Algebraic Coding Theory
MAS 623 Number Theory
MAS 624 Introduction to Commutative Algebra
MAS 625 Theory of Groups
MAS 626 Field and Galois Theory
MAS 627 Group Representation Theory I
MAS 628 Group Representation Theory II
MAS 629 Topics in Algebra I
MAS 630 Topics in Algebra II
MAS 631 Differential Topology
MAS 633 General Relativity
MAS 634 Algebraic Topology I
MAS 635 Lie groups and Lie Algebras
MAS 636 Algebraic Topology II
MAS 637 Spectral Geometry
MAS 638 Spin Geometry
MAS 639 Algebraic Geometry
MAS 640 Topics in Geometry I
MAS 641 Topics in Geometry II
MAS 642 Topics in Geometry III
MAS 643 Seminar in Pure Mathematics – Analysis I
MAS 644 Seminar in Pure Mathematics – Analysis II
MAS 645 Seminar in Pure Mathematics – Algebra I
MAS 646 Seminar in Pure Mathematics – Algebra II
MAS 647 Seminar in Pure Mathematics – Geometry I
MAS 648 Seminar in Pure Mathematics – Geometry II
MAS 682 Classical Mechanics

Ph.D. IN MATHEMATICS – Pure Mathematics

For the fulfillment of a Doctor of Philosophy Degree the requirements are:

1. Successful completion of 120 ECTS

at the postgraduate level in accordance with the provisions of the programme of studies of the Department. Students with a Master degree are partially or fully exempted from this requirement.

2. Comprehensive Examination (CE)

The Comprehensive Examination comprises two sections:

A. Written Comprehensive Examination (WCE): the written examination consists of an exam essay divided in four parts.

B. Oral Comprehensive Examination (OCE): on two subjects designated by the Research Advisor of the student. The student is examined orally before a three-member committee appointed by the Postgraduate Studies Committee of the Department after recommendation by the Research Advisor.

3. Oral Exam

The requirements are the same as for the Ph.D. in Applied Mathematics (see relevant paragraph).

4. Doctoral Thesis

The requirements are the same as for the Ph.D. in Applied Mathematics (see relevant paragraph).

5. Defence of the Thesis

The requirements are the same as for the Ph.D. in Applied Mathematics (see relevant paragraph).

The Syllabus for the Written Comprehensive Examination (WCE)

PART ONE

The system of real numbers. Continuity and differentiation of univariate real – valued functions. Riemann integration. Metric spaces, compactness and connectedness. Theorems of Bolzano – Wierstrass, Heine – Borel and Baire category. Convergence of sequences of functions, uniform continuity. σ-algebras outer measures, Borel and Lebesque measures. Measurable functions. Fatou’s Lemma, Monotone Convergence Theorem and Dominated Convergence Theorem. Signed measures and Radon – Nikodym Theorem. Product measures and Fubini, Tonelli Theorems. Basic Theory of L_p spaces and Radon measures. Applications to Probability Theory (Random variables, Law of Large Numbers, conditional expectations, Central Limit Theory).

PART TWO

Complex plane and stereographic projection. Mobius Transformations.

Cauchy-Riemann equations, harmonic functions.

Elementary analytic functions. Complex Integration and Cauchy Integral Representation Theorem. Essential Theorems (Morera, Liouville, Fundamental Theorem of Algebra). Taylor and Laurent series. Residues.
Maximum Principle, Schwarz Lemma, Argument Principle, Rouche Theorem. Conformal mappings and Riemann Mapping Theorem. Infinite series and infinite products. Theorems of Weierstrass and Mittag-Leffler for entire analytic functions.

PART THREE

Groups and homomorphisms. Free groups, generators and relations. Finitely generated abelian groups. Group actions. Sylow theorems and p-groups. Simple groups. Normal series. Extensions. Rings and homomorphisms. Ideals. Factorization in commutative rings. Modules and exact sequences. Free modules. Tensor product of modules. Modules over principal ideal domains. Jordan canonical form. Representations. Semisimple rings. Fields, field extensions. Separable and normal extensions. The fundamental theorem of Galois theory. Solvability by radicals.

PART FOUR

Topological and differentiable manifolds, basic examples and properties. Fundamental group. Tangent spaces. Partition of unity. Regular (non-singular) Values. Sard's Theorem. Vector fields, flows. Frobenius's Theorem. Differential forms. Stoke's Theorem. Riemannian manifolds. Connections and geodesics. Exponential map and regular coordinates. Gauss Lemma and Hopf-Rinow Theorem. Curvature. Gauss-Bonnet Theorem and the Theorem of Hadamard-Cartan.

MASTER IN APPLIED STATISTICS

To obtain a Master degree in Applied Statistics successful completion of a minimum of 93 ECTS is required.

Indicative Programme of Studies

	ECTS
1st Semester	
MAS 650 Mathematical Statistics	10
MAS 655 Survey Sampling	10
MAS 658 Simulation and Data Analysis	10
MAS 850 Seminar in Applied Statistics I **	1
2nd Semester	
MAS 653 General Linear Models*	10
MAS 659 Multivariate Analysis*	10
MAS Elective Course I+	10
MAS 851 Seminar in Applied Statistics II **	1
3rd Semester	
MAS 657 Analysis of Discrete Data*	10
MAS Elective Course II+	10
MAS Elective Course III+	10
MAS 852 Seminar in Applied Statistics III **	1
TOTAL	93
Options	
MAS 654 Nonparametric Statistics*	10
MAS 656 Time Series Analysis*	10
MAS 660 Probability Theory	10
MAS 661 Topics in Statistics I	10
MAS 662 Topics in Statistics II	10
MAS 663 Topics in Statistics III	10
MAS 664 Bayesian Statistics*	10
MAS 665 Computational Statistics*	10

MAS 666	Biostatistics*	10
MAS 670	Theory of Statistics	10

Notes:

* *In these courses, the use of statistical software is an integral part.*

** *A mandatory course. Students will attend colloqium lectures. A pass/fail course. Students must enroll in the course every semester.*

+ *(a) Two classes from Options I, II and III can be replaced by a Master thesis. The subject of the thesis should be related to Statistical Science. The thesis is carried out under the supervision of a faculty member of the Department.*

  (b) If a student does not choose the thesis option, then option III can be replaced by either Independent Study (MAS 667) or by practical training in the private or public sector (MAS 668).

Ph.D. IN STATISTICS

For the fulfilment of a Doctoral degree in statistics, the following are required :

1. Successful completion of 60 ECTS

at postgraduate level, in accordance with the provisions of the programme of studies of the Department. Students with a Master degree are partially or fully exempted from this requirement.

The 60 ECTS should be completed as follows:

- At least 10 ECTS in Probability Theory (MAS 660)
- At least 10 ECTS in Statistical Theory(MAS 670)
- At least 10 ECTS in Simulation and Data Analysis (MAS 658)

The remaining 30 ECTS may be completed with any postgraduate courses offered by the Department, including reading courses.

2. Comprehensive Examination (CE)

Successful completion of the following CEs with a grade of 7.5 or better:

- CE in Probability Theory (MAS 760) – 0 ECTS
- CE in Statistical Theory (MAS 770) – 0 ECTS
- CE in Simulation and Data Analysis (MAS 758) – 0 ECTS

The CE in Probability Theory (MAS 760) and Statistical Theory (MAS 770) correspond to the final exams for MAS 660 and MAS 670. The CE in Simulation and Data Analysis (MAS 758) is comprised of an open lecture on a project involving data analysis and computations.

3. Seminar

All doctoral students must enrol in the Seminar of Applied Statistics for at least 6 semesters.

4. Doctoral Thesis

The requirements are the same as for the Ph.D. in Applied Mathematics (see relevant paragraph).

5. Defence of the Thesis

The requirements are the same as for the Ph.D. in Applied Mathematics (see relevant paragraph).

The Syllabus Content for the Comprehensive Examination

PROBABILITY THEORY

Axiomatic Foundation

Measure theoretic probability, measure theory and integration, σ-algebras, monotone classes, events, probability spaces, stochastic independence, 0-1 laws, the Borel-Cantelli lemmas.

Random Variables

Random variables, distribution of a random variable, continuous and discrete random variables, distribution of a function of a random variable, random vectors.

Expectation

Expectation of a random variable, expected value and independence, expected value as the integral with respect to a probability measure, properties of integration, moments, probability inequalities, conditional expectation.

Limit Theorems

Modes of convergence of a sequence of random variables, uniform integrability, convergence of moments, moment generating functions, characteristic functions, theorems of continuity and inversion, infinite divisibility laws and stable laws, central limit theorem, weak and strong laws of large numbers.

Martingales and Random Walks

Properties of random walk, limit theorems, definition and properties of martingales, martingale inequalities, convergence criteria, weak and strong laws for martingales, central limit theorem for martingales.

STATISTICAL THEORY

Estimation Theory

Random sample, statistic, families of distributions, exponential families. Estimators (maximum likelihood, least squares, moment estimators, Bayes estimators). Properties of estimators, unbiasedness, sufficiency, consistency. Unbiased estimators of uniformly minimal variance, Fisher information, Cramer – Rao inequality. Rao – Blackwell Theorem and Theorem of Lehmann – Scheffe.

Theory of testing statistical hypothesis

Decision theory, simple and composite hypothesis, test statistics, properties of tests. Neyman – Pearson lemma, uniformly most powerful tests. Likelihood ratio tests. Hypothesis testing and confidence intervals. Goodness-of-fit tests, tests of independence, rank tests.

For more information on the comprehensive examination, the oral examination, the Doctoral Thesis and the Defence of the Thesis, see Admission and Attendance Regulations – Application Requirements consult the Office of Postgraduate Studies, Academic Affairs and Student Welfare Services (tel. 22894021/61) or the Department's Secretariat.

Course Descriptions

MAS 601 Measure and Integration

Metric spaces. σ- algebras, measures, outer measures. Borel measures on the real line. Measurable functions. Integration. General convergence theorems. Signed measures. Product measures n-dimensional Lebesgue integral. The Radon Nikodym Theorem. L_p spaces.

MAS 602 Fourier Analysis

The Schwarz space. Fourier transform. Plancherel's formula. Convergence of Fourier series and integrals. Applications in partial differential equations. Distributions. Tempered distributions, compactly supported distributions. Sobolev spaces.

MAS 603 Partial Differential Equations

First order quasi-linear equations, the method of characteristics. Classification and normal forms. Existence theorem of Cauchy-Kovalevskaya and uniqueness theorem of Holmgren. Distributions and weak solutions. Hyperbolic theory, characteristics, propagation of singularities. Wave equation in one, two and three space dimensions. Conservation laws and shock waves. Elliptic theory, Laplace and Poisson equations, fundamental solutions, harmonic functions. Variational formulation of elliptic boundary value problems. Parabolic theory, heat equation, parabolic initial/boundary value problems.

MAS 604 Functional Analysis

Compact operators. Spectral theory. Self adjoint operators. Closed and orthonormal operators. Spectral theorem. Semigroups.

MAS 605 Elliptic Partial Differential Equations of Second Order

Laplace equation, fundamental solutions, Green's function, maximum principle, Poisson kernel, Harmonic functions and their properties, Harnack inequalities, equations with variable coefficients, Dirichlet problem, existence and regularity of solutions.

MAS 606 Function Theory of One Complex Variable

Basic facts about complex functions of one complex variable. Differentiation. Cauchy-Riemann equations. Elementary complex functions. Complex integration and the Cauchy Theorem. Applications of Cauchy Theorem. Meromorphic functions. Power series and Laurent series. Residues. Entire functions and Conformal mappings.

MAS 607 Function Theory of Several Complex Variables

Basic facts about holomorphic functions of several complex variables. Integral representations of holomorphic functions of several complex variables.

MAS 608 Evolution Differential Equations with Partial Derivatives of Second Order

Heat equation, fundamental solution, properties of solutions, weak solutions. Maximum principle, wave equations. Solutions with spherical means. Non-homogeneous problem, energy methods, weak solutions, propagation of singularities. Distributions, fundamental solution, L_2 theory, etc.

MAS 609 Stochastic Analysis

Review of the basic notions of probability theory, stochastic integration, Ito's lemma, stochastic differential equations, applications (financial mathematics, formula Black-Scholes, etc.).

MAS 610 Stochastic Processes

Basic notions of stochastic processes, Kolmogorov´s theorem, discrete and continuous time Markov processes, point processes, Brownian motion, random walk.

MAS 611 Harmonic Analysis

Approximation to the identity, weak L_p spaces, interpolation theorems. Maximal functions, harmonic functions, singular integrals, Littlewood-Paley theory. Function spaces.

MAS 612 Measure and Probability

σ- algebras, measures, probability measures, measurable functions. Integration theory. Product measures and Fubini Theorem. Lebesgue-Stieltjes measure, ordinary distributions, characteristic functions. Sequences of measurable functions and different notions of their convergence. Central Limit Theorem and related asymptotic developments. The distribution of the recursive logarithm, Radon-Nicodym Theorem. Conditional mathematical expectation. Martingales.

MAS 613 Ordinary Equations

Existence theorems: Picard-Lindelof and Cauchy-Peano. Uniqueness theorem when Lipschitz condition is satisfied. Smooth dependence of solutions on parameters. Extensibility of solutions. Linear systems, fundamental solution matrix, systems with periodic coefficient. Stability of nonlinear systems. Sturm-Liouville theory.

MAS 617 Topics in Mathematical Analysis I
MAS 618 Topics in Mathematical Analysis II
MAS 619 Topics in Mathematical Analysis III

Topics in real analysis, complex analysis or differential equations.

MAS 621 Numerical Linear Algebra

Elements of matrix analysis, vector and matrix norms. Factorization and least - squares methods. Stability. Direct and iterative methods for the solution of linear systems. Methods for calculating eigenvectors and eigenvalues.

MAS 622 Algebraic Coding Theory

Finite fields. Linear codes, syndrome decoding. Cyclic codes. BCH codes and Reed – Solomon codes. MDS codes. Permutation decoding.

MAS 623 Number Theory

Introduction to algebraic number theory. Quadratic reciprocity, Gauss and Jacobi sums. Field extensions, finite fields, ideal classes. Quadratic and cyclotomic fields. Applications to Diophantine equations.

MAS 624 Introduction to Commutative Algebra

Prime and maximal ideals. Extension. Finitely generated R – modules. Exact sequences. Tensor product of modules. Algebras. Noetherian rings and Artin rings. Dedekind domains.

MAS 626 Field and Galois Theory

Polynomial rings. Field extensions, splitting fields. Separable extensions, normal extensions. The fundamental theorem of Galois theory. Roots of unity and cyclotomic polynomials. Solution by radicals. Symmetric functions and Abel's theorem.

MAS 627 Group Representation Theory I

Representations. FG-modules, FG-submodules and FG-homomorphisms. Maschke's Theorem and Schur's Lemma. Irreducible module. The group algebra, the centre of the group algebra. Characters, relation between characters and representations. Character tables. Frobenius reciprocity theorem.

MAS 628 Group Representation Theory II

Semi simple rings, construction of irreducible R – modules. Splitting fields. Clifford's theorem. Mackey Decomposition Theorem. Representations of Weyl groups. Representations of compact groups.

MAS 629 Topics in Algebra I
MAS 630 Topics in Algebra II
MAS 631 Differential Topology

Differentiable manifolds. Tangent space. Partition of unity. Regular points. Sard's theorem. Vector fields and flows. Frobenius Theorem. Differential forms. Stokes Theorem. De Rham's Theorem.

MAS 632 Riemannian Geometry

Riemannian manifolds. Geodesics, exponential map, normal coordinates. Gauss lemma. Theorem of Hopf-Rinow. Curvature. Jacobi fields. Theorems of Bonnet-Myers, Synge-Weinstein and Hadamard - Cartan. Homogeneous and symmetric spaces.

MAS 633 General Relativity

Lorentz geometry. Special relativity. Newton spacetime, Minkowski spacetime. Lorentz transformation. Einstein equations. Special solutions (Schwarzschild).

MAS 634 Algebraic Topology I

Homology theory and applications. Cohomology. Universal coefficient theorem. Products. Kuenneth formula. Thom isomorphism. Poincare duality.

MAS 635 Lie Groups and Lie Algebras

Differentiable manifolds. Tangent spaces and vector fields. Lie Groups. Exponential function. Homogeneous spaces. The Campbell-Hausdorf formula. Ado's Theorem. Lie algebras. Ideals and homomorphisms. Solvable and nilpotent Lie algebras. Semisimple Lie algebras. Root systems. Compact Lie groups.

MAS 636 Algebraic Topology II

Obstruction theory. Bundles and K- theory. Bordism. Spectral sequences. Characteristic classes.

MAS 637 Spectral Geometry

Laplace operator. Minimax principle. Isoparametric inequalities. Heat kernel.

MAS 638 Spin Geometry

Clifford algebras. Spin groups and representations. Spin structures. Spin connection. Spin manifolds. Dirac operator. Bochner formula. Lichnerowicz's Theorem.

MAS 639 Algebraic Geometry

Algebraic sets and the Hilbert-Nullstellensatz theorem. Affine, projective and quasi-projective varieties, morphisms, products. Local properties (smooth and singular points), tangent space, dimension. Divisors on algebraic curves, Riemann-Roch theorem. Bezout's theorem and the group structure of an elliptic curve. Blow up and resolution of singularities. Lines on hypersurfaces.

MAS 640 Topics in Geometry I
MAS 641 Topics in Geometry II

Topics from Differential Geometry, Algebraic Geometry and Algebraic Topology.

MAS 650 Mathematical Statistics

Univariate and multivariate random variables, distribution function, joint and conditional distribution, independence, moments. Special parametric families of distributions. Estimation. Methods of finding estimators. Properties of estimators, sufficiency, unbiasedness, consistency. Comparison of estimators. Confidence Intervals. Hypothesis testing. Simple and composite hypothesis, power function. Methods of constructing tests. Properties of tests, unbiasedness, consistency. Comparison of tests. Hypothesis testing and confidence intervals.

MAS 653 General Linear Models

Linear and multiple regression, residuals and model selection procedures, diagnostics. Analysis of variance and non linear regression. Design of experiments, completely randomized designs, designs with two or more factors with interactions. Block designs, split plot and nested designs.

MAS 654 Nonparametric Statistics

Order statistics and their distributions. Tolerance regions. Rank and sign tests for one and two populations. Goodness of fit tests (Kolmogorov – Smirnov, Lilliefors, Shapiro – Wilks). Siegel – Tukey and Kruskal – Wallis tests. Normal and Savage scores. Fisher exact test for 2x2 contingency tables. Mantel – Haenszel test for contingency tables. Kaplan– Meier estimator of the survival function. Jonckheere – Terpstra and page test for ordered alternatives. Nonparametric correlation coefficients (Spearman, Kendall) and measures of agreement.

MAS 655 Survey Sampling

Survey design, sampling and nonsampling errors, simple random sampling, stratified sampling, systematic sampling, cluster sampling, ratio estimators, regression estimators, determination of optimal sample size, bias in survey sampling, modern techniques of survey sampling.

MAS 656 Time Series Analysis

Stochastic processes, weak and strong stationarity. Trend and seasonal behavior of time series. Sample autocorrelation function and sample partial autocorrelation function. Prediction. Parametric families of stochastic processes. ARMA, ARIMA and SARIMA models. Properties, estimation and examples. ARCH and GARCH processes, properties of estimators and examples.

MAS 657 Statistical Analysis of Discrete Data

Types of discrete data. Contingency tables and inference (testing independence and homogeneity). Measures of association. Loglinear models for contingency tables. Logit models. Distribution and Inference for categorical data. Asymptotic theory of goodness-of-fit X_2 tests. Logistic regression.

MAS 658 Simulation and Data Analysis

Introduction to syntax, commands, input/output files. Descriptive statistics, explanatory data analysis, regression analysis and analysis of variance, statistical inference (testing hypotheses, goodness of fit tests). Resampling, Simulation. Importance sampling.

MAS 659 Multivariate Analysis

Random vectors, measures of center and variation in multivariate moments. Multivariate normal distribution. Tests for normality. Estimation of the mean vector and the variance analysis, independence, multivariate – covariance matrix. Wishart and Hotelling distributions. Statistical inference. Union – Intersection Test. Confidence regions.

Multivariate analysis of variance and multivariate regression analysis. Least squares method and Wilks distribution. Analysis of covariance. Principal components, Factor analysis, Discriminant analysis, Cluster analysis.

MAS 660 Probability Theory

Measure spaces and σ-algebras, independence, measurable functions and random variables, distribution functions, Lebesgue integral and expectation, convergence concepts, law of large numbers characteristic functions, central limit theorem, conditional probability, conditional expectation, martingales, central limit theorem for martingales.

MAS 661 Topics in Statistics I
MAS 662 Topics in Statistics II
MAS 663 Topics in StatisticsIII

Topics from probability theory, statistical theory and their applications, such as categorical time-series, non-parametric and semi-parametric statistics, U-statistics, Bootstrap methods, survival analysis, wavelets and their applications in statistics and time-series analysis, analysis of spatial data, analysis of functional data.

MAS 664 Bayesian Statistics

Subjective probability, Bayes rule, prior and posterior distributions, conjugate and non-informative priors, pointwise estimation and credible intervals, hypotheses testing, introduction to Bayesian decision analysis, introduction to empirical Bayes analysis, introduction to Markov chain Monte Carlo techniques.

MAS 665 Computational Statistics

Numerical linear algebra: Multiple regression, Cholesky decomposition, diagnostics and colinearity, principal components and eigenvalue problems.

Nonlinear statistical methods: Maximum likelihood estimation, Newton-Raphson and related methods, multivariate data and the Newton Raphson method, optimization techniques (unconditional and under constraints) EM algorithm.

Numerical Integration and Approximation: Newton-Coates method, spline interpolation, Monte Carlo integration, general approximation methods.

Probability Density Estimation: Histogram, linear and non linear smoothing, splines.

Bootstrap.

MAS 666 Biostatistics

Definition of epidemiology and types of epidemiological studies. Descriptive statistics: graphical and numerical methods for medical data. Measures of association and correlation. Measures of risk and rate. Inference for mean, proportions indicators and coefficients of correlation. Nonparametric tests (Fisher's exact test, McNemar test, etc.). Diagnostic methods, sensitivity and specificity. Numerical methods in clinical epidemiology, ROC curves. Meta - analysis. Censored data. Survival and hazard functions. Nonparametric estimation (Kaplan – Meier and Nelson – Aalén estimators). Methods of comparison of two survival functions (Log – rank, Breslow Peto – Peto tests). Semiparametric estimation (Cox proportional hazards model, partial likelihood). Parametric estimation (exponential, Weibull, log – logistic and lognormal models, proportional odds model). Frailty models.

MAS 667 Statistical Project

This course requires the completion of a project on a specific statistical problem. The course gives students the opportunity to engage in applications of statistical methodology, to develop and cultivate their research ability, to broaden their knowledge of statistical methodology and to become familiar with various scientific areas where the statistical methodology is applied. This aim is achieved either through the research projects of the faculty members or through projects undertaken by the department for collection and analysis of data. Moreover, the students and particularly those wishing to enter the doctoral program, have the opportunity to familiarize themselves with the research interests of their academic advisor and possibly publish original results.

MAS 668 Practical Training

Students are placed in organisations in the private or public sector in order to acquire experience in topics that are closely related to their graduate programme of studies. At the end of the training period, the performance of students is evaluated based on a written report by the management of the host organisation.

MAS 670 Statistical Theory

Stochastic convergence, estimation, asymptotic properties of estimators, efficiency, testing hypotheses, asymptotic properties and efficiency of testing procedures, convergence in metric spaces, stochastic processes.

MAS 671 Numerical Solution of Ordinary Differential Equations

One-step and multistep methods for initial value problems. Runge – Kutta methods. Numerical solution of two-point boundary value problems.

MAS 672 Numerical Solution of Partial Differential Equations

Parabolic equations, the heat equation. Stability. The Crank – Nicolson method, ADI methods. Hyperbolic equations, the Courant – Friedrichs – Lewy condition. Elliptic equations, the Poisson equation. Iterative methods for the solution of linear systems.

MAS 673 Finite Element Methods

Sobolov spaces. Ritz-Galrkin approximation. Variational formulation of elliptic boundary value problems. Finite element spaces. Polynomial approximation in Sobolev spaces. N-dimensional variational problems.

MAS 677 Topics in Numerical Analysis I
MAS 678 Topics in Numerical Analysis II
MAS 679 Topics in Numerical Analysis III

Topics in Computational Mathematics and Approximation Theory.

MAS 682 Classical Mechanics

Lie Groups and Lie Algebras. Equations of motion (Newton, Lagrange). Poisson structures, Integrable systems, Lax pairs, bi – Hamiltonian systems, Todu lattices. Symmetries of Differential Equations, Noether Theorem.

MAS 683 Fluid Dynamics

Equations of motion. Viscous flows. Stokes flows. Non-Newtonian and viscoelastic flows.

MAS 684 Topics in Applied Mathematics I
MAS 685 Topics in Applied Mathematics II
MAS 686 Topics in Applied Mathematics III

Topics from different areas of Applied Mathematics.

MAS 687 Topics in Differential Equations I
MAS 688 Topics in Differential Equations II
MAS 689 Topics in Differential Equations III

Topics from Ordinary Differential Equations and Partial Differential Equations.

Research Interests of Academic Staff

- **Tasos Christofides**

Professor

U-Statistics, Probability Inequalities, Sampling, Stochastic Orders.

- **Cleopatra Christoforou**

Lecturer

Partial Differential Equations, Applied Analysis, Continuum Physics and Hyperbolic Systems of Conservation and Balanced Laws. Zero Viscosity Method and Shock Waves.

- **Pantelis Damianou**

Professor

Lie Groups, Hamiltonian Systems, Differential Geometry, and Number Theory.

- **Konstantinos Fokianos**

Associate Professor

Categorical Time Series, Semiparametric Statistics, Analysis of Spatial Data, Analysis of Large Data Seb, Bioinformatics.

- **Georgios Georgiou**

Professor

Numerical Analysis, Numerical Solution of partial differential equations, Numerical simulation of Newtonian and viscoelastic flow, Hydrodynamic stability, Computational Oceanography.

- **Andreas Karageorghis**

Professor

Numerical Analysis, Computational Mathematics, Boundary and Spectral Methods for the Numerical Solution of Differential Equations.

- **Alexandros Karagrigoriou**

Associate Professor

Statistical Modelling, Model Selection Criteria, Time Series, Bio-Statistics.

- **Stamatis Koumandos**

Professor

Harmonic analysis, Orthogonal polynomials, Special functions, Approximation Theory.

- **George Kyriazis**

Associate Professor

Approximation Theory, Harmonic Analysis.

- **Emmanouel Milakis**

Lecturer

Partial Differential Equations, Free Boundary Problems, Geometric Measure Theory.

- **Christos Pallikaros**

Associate Professor

Group Representation Theory, Representations of Hecke Algebras.

• **Efstathios Paparoditis**

Professor

Time Series Analysis, Bootstrap Methods, Multivariate Analysis, Non-parametric Statistics.

• **Evangelia Samiou**

Associate Professor

Riemannian Geometry.

• **Theofanis Sapatinas**

Associate Professor

Non-parametric Volarity Estimation, Continuous Time Forecasting, Estimation and Inference in Functional Mixed – Effects Models, Theory and Practice of Wavelets in Statistics and Time Series, Non-parametric Regression and Inverse Problems.

• **Yiorgos-Socratis Smyrlis**

Associate Professor

Partial Differential Equations, Numerical Analysis, Fluid Dynamics.

• **Christodoulos Sophocleous**

Associate Professor

Mathematical Physics, Non-Linear Optics and Non-Linear Partial Differential Equations.

• **Nikos Stylianopoulos**

Associate Professor

Numerical Analysis (Numerical Linear Algebra, Numerical Solution of P.D. E's) and Computational Complex Analysis (Conformal Mapping, Approximation in the Complex Plane, Orthogonal Polynomials).

• **Alekos Vidras**

Professor

Complex Analysis (Multidimensional Residues, Mean Periodicity), Carleman Formulas, Bohr phenomena.

• **Christos Xenophontos**

Associate Professor

Numerical Analysis, Computational Mathematics, Numerical Solution of partial differential equations, Finite Element Methods.

Contact

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