Applied Statistics (APST)

Chairperson: Rebecca L. Sanders, Ph.D.
Program Director: Daniel Rowe, Ph.D.
Applied Statistics website (https://www.marquette.edu/grad/programs-applied-statistics.php)

Degree Offered

Master of Science, students are admitted under Plan B (non-thesis option) but may request Plan A (thesis option).

Program Description

The master of science program in applied statistics offered by the Department of Mathematical and Statistical Sciences produces graduates who deal with big data, perform statistical analysis to detect hidden patterns in data, perform risk factor analysis and perform predictive analysis. Statistics is the science of data utilizing a principled foundation in mathematics with applications in many fields such as social sciences, engineering, business, biomedical sciences and economics. The master of science in applied statistics is intended for students who have a mathematical background (not necessarily having a degree in mathematics) that want to develop strong data analytic skills to solve complex, real world problems. This program meets the needs for recent graduates who are seeking a master's degree program in applied statistics, and for mid-career workers with a solid mathematics and/or statistics background who are seeking a graduate program in applied statistics either for career advancement or for a career change. Students may select courses from a large number of approved courses offered by the Department of Mathematical and Statistical Sciences and other units on campus.

Students may pursue the degree on a full-time or part-time basis. Most courses are offered in the evenings.

Prerequisites for Admission

Applicants must have completed or are in the process of completing a bachelor's degree from an accredited college or university. Admission to the master of science program in applied statistics is based on a sufficient formal mathematics and/or statistics background and a previous experience with programming. The applied statistics program accommodates students from a wide variety of disciplines.

Application Deadline

The master of science program in applied statistics follows the Graduate School deadlines for the submission of applications: August 1 for fall admission, December 15 for spring admission, and May 1 for summer admission. However, to be considered for financial aid, applications for fall must be submitted by January 15. Decisions about acceptance into the program are made when all required documents for the application are received. Admission decisions are made independently of decisions to offer financial aid.

Application Requirements

Applicants must submit, directly to the Graduate School:

1. A completed application form and fee online (http://marquette.edu/grad/future_apply.shtml).
2. Copies of all college/university transcripts except Marquette.[1]
3. An essay outlining relevant work experience or education, career goals, possible areas of interest and reasons for seeking admission to this program.
4. Three letters of reference from professors or professionals familiar with the applicant's abilities, academic work and/or professional background.
5. (For students applying for merit-based financial aid only) GRE scores (General Test only).
6. (For international applicants who have not attended an English-speaking university only) a TOEFL score or other acceptable proof of English proficiency.

[1] Upon admission, final official transcripts from all previously attended colleges/universities, with certified English translations if original language is not English, must be submitted to the Graduate School within the first five weeks of the term of admission or a hold preventing registration for future terms is placed on the student record.

General Information

Students interested in applying to the program should consult the program website (http://marquette.edu/mscs/grad-applied-statistics.shtml) for additional information, including a list of currently approved courses for the degree.

A complete list and short description of the courses offered by the Department of Mathematical and Statistical Sciences (MSSC) is available on the MSSC department page of the bulletin (http://bulletin.marquette.edu/grad/programs/mathstatsandcomputerscience).

Applied Statistics Master's Requirements

A master's student is admitted to the non-thesis program (Plan B). A formal request to pursue a thesis (Plan A) must be approved by the department's applied statistics program director, the department's Graduate Committee and the Graduate School.

Plan A

All Plan A students must complete a minimum of 30 credit hours (21 credits of program core courses, 3 elective credits and 6 credits of MSSC 6999 Master's Thesis), and submit a thesis that must be an original contribution to the student's field of study. A public defense of the thesis is required.

Required Core courses (21 credits):		
MSSC 5710	Mathematical Statistics	3
MSSC 5780	Regression Analysis	3
MSSC 6010	Computational Probability	3
MSSC 6020	Simulation	3
MSSC 6040	Applied Linear Algebra	3
MSSC 6240	Design of Experiments and Data Analysis	3
MSSC 6250	Statistical Machine Learning	3
Approved Elective course(s)		3
Master's Thesis/Research:		
MSSC 6999	Master's Thesis	6
Total Credit Hours		30

Plan B

All Plan B students complete at least 33 credits (21 credits of program core courses, 9 credits of approved elective courses and a 3 credit statistical consulting practicum). A written report and an oral presentation are required for the statistical consulting practicum.

Required Core courses (21 credits):		
MSSC 5710	Mathematical Statistics	3
MSSC 5780	Regression Analysis	3
MSSC 6010	Computational Probability	3
MSSC 6020	Simulation	3
MSSC 6040	Applied Linear Algebra	3
MSSC 6240	Design of Experiments and Data Analysis	3
MSSC 6250	Statistical Machine Learning	3
Approved Elective courses		9
Professional Practice/Statistical Consulting:		3
MSSC 6975	Practicum for Statistical Consulting	
Total Credit Hours		33

Plan A and Plan B master's students may select additional approved elective courses from within the department or from outside departments. For a complete list of approved elective courses outside of the department, consult with the applied statistics program director. The following is a list of approved elective courses withing the department:

MSSC 5540	Numerical Analysis	3
MSSC 5630	Mathematical Modeling and Analysis	3
MSSC 5700	Theory of Probability	3
MSSC 5760	Time Series Analysis	3
MSSC 6030	Applied Mathematical Analysis	3

For both Plan A and Plan B:

- Depending on the course topic and approval by program director, MSSC 5931 Topics in Mathematical or Statistical Sciences, MSSC 6931 Topics in Mathematical or Statistical Sciences, MSSC 6995 Independent Study in Mathematical or Statistical Sciences or MSSC 6960 Seminar in Mathematical or Statistical Sciences may also be an approved elective course.

- Up to 6 credit hours total of courses may be taken from the Medical College of Wisconsin and the University of Wisconsin-Milwaukee, as allowed under the reciprocal arrangement between Marquette and these institutions, as long as they are pre-approved by the applied statistics program director and the Graduate School.
- Master's students who come with little background in statistics may be required to complete MSSC 5720 Statistical Methods during their first term or during the summer before their first fall term. This is in addition to the required course work for Plan A or Plan B.

Accelerated Degree Program

The accelerated degree program (ADP) in applied statistics allows students to earn, in five years, a bachelor's degree with an undergraduate major in a variety of fields including, but not limited to: bioinformatics, biomedical engineering, business, chemistry, computational mathematics, computer science, data science, electrical engineering, mathematics, applied mathematical economics, mechanical engineering, physics and psychology and a master of science degree in applied statistics. Students complete 12 credit hours of approved graduate courses during their senior undergraduate year that counts as part of the undergraduate credit hour requirement.

Students may obtain both degrees in five years. Students with a GPA of 3.000 or better in their mathematics, science and engineering courses are eligible to apply in their junior year. Up to 12 graduate credits can count toward both degrees.

The Department of Mathematical and Statistical Sciences offers early admission into the master of science in applied statistics program. Marquette undergraduate students majoring in the above listed majors and others can apply for this program in the second term of their junior year.

Courses

MSSC 5020. The Teaching of Mathematics. 3 cr. hrs.
Historical background, problems, curricular materials, and teaching procedures in the various areas of mathematics pertinent to the needs of a secondary school mathematics teacher. In addition, a three-hour time block on one day each week between 8 a.m. and 3 p.m. must be kept free for clinical experience.

MSSC 5030. Concepts in Geometry and Calculus from an Advanced Standpoint. 3 cr. hrs.
Topics chosen primarily from geometry and calculus, taught from an advanced standpoint to enrich and deepen the student's understanding. Emphasis on alternative approaches, generalizations, historical contexts and connections with prior mathematical studies.

MSSC 5040. Concepts in High School Algebra and Number Theory from an Advanced Standpoint. 3 cr. hrs.
Topics closely related to the high school mathematics curriculum, chosen primarily from algebra and number theory, taught from an advanced standpoint to enrich and deepen the student's understanding. Emphasis on alternative approaches, generalizations, historical contexts and connections with prior mathematical studies.

MSSC 5120. Abstract Algebra 1. 3 cr. hrs.
Sets, mappings, operations on sets, relations and partitions. A postulational approach to algebraic systems including semigroups, groups, rings and fields. Homomorphisms of groups and rings, number systems, polynomial rings.

MSSC 5121. Abstract Algebra 2. 3 cr. hrs.
A continuation of MSSC 5120 with emphasis on groups, rings, fields and modules.

MSSC 5200. Intermediate Analysis 1. 3 cr. hrs.
Limits and continuity, differentiability, Riemann integration. Topology of N-dimensional spaces.

MSSC 5201. Intermediate Analysis 2. 3 cr. hrs.
Transformations of N-spaces, line and surface integrals, sequences and series, uniform convergence.

MSSC 5210. Complex Variables. 3 cr. hrs.
Complex numbers, analytic functions, differentiation, series expansion, line integrals, singularities and residues.

MSSC 5310. History of Mathematical Ideas. 3 cr. hrs.
Topics selected from the following: development of the number system (need for irrational and complex numbers); development of geometry including the effects of the discovery of non-Euclidean geometry; limit concept; need for axiomatic structures; twentieth-century problems. Current mathematics research and place of mathematics in today's world.

MSSC 5320. Theory of Numbers. 3 cr. hrs.
Integers, unique factorization theorems, arithmetic functions, theory of congruences, quadratic residues, partition theory.

MSSC 5420. Foundations of Geometry. 3 cr. hrs.
Modern postulational development of Euclidean and non-Euclidean geometries.

MSSC 5450. Topology. 3 cr. hrs.
Topological spaces, mappings, metric spaces, product and quotient spaces. Separation axioms, compactness, local compactness and connectedness.

MSSC 5500. Theory of Differential Equations. 3 cr. hrs.
Existence and uniqueness theorems, linear and non-linear systems, numerical techniques, stability.

MSSC 5510. Elementary Partial Differential Equations. 3 cr. hrs.
Fourier series, method of separation of variables, eigenfunction expansions, application of eigenfunctions to partial differential equations, Green's functions and transform methods.

MSSC 5540. Numerical Analysis. 3 cr. hrs.
Numerical solution of algebraic and transcendental equations, linear systems and the algebraic eigenvalue problem, interpolation and approximation, numerical integration, difference equations, numerical solution of differential equations and finite difference methods.

MSSC 5630. Mathematical Modeling and Analysis. 3 cr. hrs.
Construction and analysis of mathematical models from biological, behavioral and physical sciences.

MSSC 5650. Theory of Optimization. 3 cr. hrs.
Fundamental theorems describing the solution of linear programs and matrix games. Minimax, duality, saddle point property, simplex and specialized algorithms. Zero sum games, transportation and assignment problems, applications to economics.

MSSC 5670. Applied Combinatorial Mathematics. 3 cr. hrs.
Permutations and combinations, recurrence relations, inclusions and exclusion, Polya's theory of counting, graph theory, transport networks, matching theory.

MSSC 5700. Theory of Probability. 3 cr. hrs.
Random variables, distributions, moment generating functions of random variables, various derived probabilistic models and applications.

MSSC 5710. Mathematical Statistics. 3 cr. hrs.
Sampling theory and distributions, estimation and hypothesis testing, regression, correlation, analysis of variance, non-parametric methods, Bayesian statistics.

MSSC 5720. Statistical Methods. 3 cr. hrs.
Probability, discrete and continuous distributions. Treatment of data, point and interval estimation, hypothesis testing. Large and small sample method, regression, non-parametric methods. An introduction to the basic understanding of statistical methods. Applications-oriented.

MSSC 5740. Biostatistical Methods and Models. 3 cr. hrs.
Introduction to the statistics of life science and the use of mathematical models in biology. Data analysis and presentation, regression, analysis of variance, correlation, parameter estimation and curve fitting. Biological sequence analysis, discrete and continuous mathematical models and simulation.

MSSC 5760. Time Series Analysis. 3 cr. hrs.
Basic concepts of probability. Stationary time series. Autocorrelation and spectrum. Descriptive methods for time series data. ARMA and ARIMA models: estimation and forecasting. Identification and diagnostic techniques. Periodogram and spectral analysis. Use of software for time series analysis.

MSSC 5780. Regression Analysis. 3 cr. hrs.
Basic concepts of statistical inference, simple linear regression, multiple linear regression, diagnostic analysis, selecting the best equation, stepwise methods, nonlinear regression, use of statistical software.

MSSC 5931. Topics in Mathematical or Statistical Sciences. 1-3 cr. hrs.
Topics selected from one of the various branches of mathematics or statistics. Specific topics to be announced in the Schedule of Classes.

MSSC 6010. Computational Probability. 3 cr. hrs.
Foundations of probability for modeling random processes and Bayesian approaches, including: counting techniques, probability of events, random variables, distribution functions, probability functions, probability density functions, expectation, moments, moment generating functions, special discrete and continuous distributions, sampling distributions, prior and posterior distributions, Law of Large Numbers, Central Limit Theorem, Bayesian paradigm. Prereq: Three semesters of mathematics beyond calculus and MATH 4720 or equiv.

MSSC 6020. Simulation. 3 cr. hrs.
Elements of statistical simulation and modeling with applications. Generation of random variables, Monte Carlo method, Markov chains, birth-and-death processes, queues, variance reduction, Markov chain Monte Carlo (MCMC) methods and applications, bootstrapping, validation and analysis of simulated data. Prereq: MSSC 6010 and programming competency in a high-level language.

MSSC 6030. Applied Mathematical Analysis. 3 cr. hrs.
Foundational topics in analysis considered from a modeling and numerical viewpoint. Emphasizes techniques of proof and approximation, and their role in the solution of problems arising in applications. Prereq: Multivariable calculus and linear algebra.

MSSC 6040. Applied Linear Algebra. 3 cr. hrs.
Foundational linear algebra considered from a numerical viewpoint. Focuses on solutions of linear systems of equations, eigenvalues and eigenvectors, and transformations. Emphasizes and illustrates proof and numerical implementation using problems arising in applications. Prereq: Multivariable calculus and linear algebra.

MSSC 6090. Research Methods/Professional Development. 1 cr. hr.
Designed to introduce the process of research and communication of research in the mathematical and statistical sciences, including presentation and publication of research, preparation of grant proposals, and ethical considerations. May be repeated.

MSSC 6110. Applied Discrete Mathematics. 3 cr. hrs.
Applied discrete mathematics for the mathematics, engineering and computer science graduate student. Emphasis on graph theory and counting problems that serve as a foundation for research areas in the second term. Theory and applications are covered for topics including trees, graph coloring, chromatic polynomials, generating functions, recurrence relations, distinct colorings and Polya's Theorem. Prereq: COSC 1020 and MATH 1450 or equiv.; MATH 1451 and MATH 2100 or equiv.

MSSC 6120. Optimization. 3 cr. hrs.
Principles of deterministic model building in operations research. Linear programming and duality. Dynamic and integer programming. Nonlinear optimization and parameter estimation. Prereq: MATH 3100 or equiv.

MSSC 6130. Dynamical Systems. 3 cr. hrs.
Theory of discrete and continuous dynamical systems. Periodic solutions, bifurcations, chaotic systems, attractors, fractal dimension and simulation of these systems. Prereq: MATH 4200 or equiv.

MSSC 6210. Theory of Statistics. 3 cr. hrs.
Brief review of sampling distributions, Central Limit Theorem and Law of Large Numbers. Estimation, testing hypotheses, regression and correlation analysis, non-parametric methods. Prereq: MATH 4720 or equiv.

MSSC 6220. Analysis of Variance and Covariance. 3 cr. hrs.
Review of statistical inference. One-way layout and multiple comparison. Two-, three- and higher-way layouts. Latin squares, incomplete block and nested design. Analysis of covariance. Prereq: MATH 4710 or equiv.

MSSC 6230. Multivariate Statistical Analysis. 3 cr. hrs.
Basic properties of random vectors, multivariate normal distribution, estimations of mean vector and covariance matrix, Wishart distribution, hypothesis testing, Hotelling's T2, multivariate analysis of variance, principal component analysis, factor analysis, canonical correlation analysis, classification and discriminant analysis. Prereq: MATH 3100 and MATH 4710.

MSSC 6240. Design of Experiments and Data Analysis. 3 cr. hrs.
Single factor, two-factor and multi-factor designs and their analysis, Latin-square design and its analysis; power analysis and sample size selection; 2^k factorial designs; confounding/blocking designs; orthogonality and orthogonal contrasts; 3^k factorial designs; response surface methodology. Prereq: A course in statistical methods, such as MATH 4720 or equiv.

MSSC 6250. Statistical Machine Learning. 3 cr. hrs.
Multivariate data and exploratory analysis, random vector and multivariate normal distribution, multivariate linear regression, principal component and other dimensional reduction techniques, linear discriminant analysis, recursive partition and tree-based methods including classification tree and regression tree, cluster analysis, neural network and support vector machine. Prereq: A course in statistical methods, such as MATH 4720, and a course in linear algebra, such as MATH 3100.

MSSC 6410. Real Analysis. 3 cr. hrs.
Involves study of algebraic structures of real analysis, function spaces, introduction to linear operators, measure and integration theory, convergence theorems, limits, continuity and derivatives. Prereq: MATH 4200.

MSSC 6420. Algebra. 3 cr. hrs.
Studies groups, rings, fields and vector spaces including Sylow's theorems, field of quotients of an integral domain, structure of finitely generated modules over a principal ideal domain, Galois theory of equations, ordered fields and classical groups. Prereq: MATH 4120 or equiv.

MSSC 6430. Logic and Set Theory. 3 cr. hrs.
Naive set theory, first-order logic, elementary model theory, non-standard analysis, Godel's incompleteness theorems for elementary arithmetic, axioms for set theory, ordinal and cardinal arithmetic, the continuum hypothesis, methods of inner models and forcing for proving consistency and independence results. Prereq: MATH 4120 or equiv.

MSSC 6440. Topology. 3 cr. hrs.
Metric spaces, fundamental topology notions, subspace topology, product spaces, quotient spaces, separation axioms, Tietze's theorem, compactness, metrization, uniform spaces, function spaces, homotopy relation, fundamental group, computing manifold groups. Prereq: MATH 4200 or equiv.

MSSC 6770. Innovations in Secondary Mathematics: Meeting the NCTM Standards. 3 cr. hrs.
Online course designed for teachers of secondary mathematics. Emphasizes relevant NCTM standards through discussion, projects, and implementation in a secondary mathematics classroom. Mathematics content amplifies and extends selected topics of secondary mathematics. Topics vary. Credit may be earned multiple times if completed under a different topic. Prereq: Cons. of dept. ch.; one term of calculus and access to an algebra or geometry class of secondary students; or cons. of course coordinator; admitted to MSST or College of Education.

MSSC 6931. Topics in Mathematical or Statistical Sciences. 3 cr. hrs.
Topics vary. Multiple enrollments allowed under different topics.

MSSC 6953. Seminar in Mathematics Curriculum Development and Material 1. 3 cr. hrs.
The historical evolution of mathematics learning theories and research-generated conceptions of mathematics learning; comparisons of various learning theories and their impact on research in mathematics learning; implications of research and learning theories on curriculum development; implications of mathematics learning research/theories on the teaching and learning of mathematics. Prereq: Admitted to MSST or College of Education.

MSSC 6954. Seminar in Mathematics Curriculum Development and Material 2. 3 cr. hrs.
Philosophy of education with particular attention to mathematics education; development by students of useful curricula in the form of teaching units, evaluation materials, and student and teacher bibliographies for specific topics, grade levels, and ability groups; aspects of supervision as related to the role of department chairperson. Prereq: MSSC 6953; admitted to MSST or College of Education.

MSSC 6960. Seminar in Mathematical or Statistical Sciences. 1-3 cr. hrs.
Topics selected from one of the various branches of mathematics or statistics. Specific topics are announced in the Schedule of Classes.

MSSC 6974. Practicum for Research in Mathematical or Statistical Sciences. 1-3 cr. hrs.
S/U grade assessment. Prereq: Cons. of dept. ch.

MSSC 6975. Practicum for Statistical Consulting. 3 cr. hrs.
Provides students with the opportunity to explore real-world examples of data analysis as a statistical consultant. Prereq: 3.00 MU GPA; must be enrolled in the Plan B option of the M.S. program in applied statistics, and have completed at least 18 credit hours; cons. of the applied statistics dir. of graduate studies; or cons. of dept. ch.

MSSC 6995. Independent Study in Mathematical or Statistical Sciences. 1-5 cr. hrs.
Investigations in selected areas of mathematics or statistics. Prereq: Cons. of instr. and cons. of dept. ch.

MSSC 6998. Professional Project in Mathematical or Statistical Sciences. 0 cr. hrs.
SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 6999. Master's Thesis. 1-6 cr. hrs.
S/U grade assessment. Prereq: Cons. of dept. ch.

MSSC 8995. Independent Study in Mathematical or Statistical Sciences. 1-3 cr. hrs.
In-depth research on a topic or subject matter usually not offered in the established curriculum with faculty and independent of the classroom setting. Prereq: Cons. of instr. and cons. of dept. ch.

MSSC 8999. Doctoral Dissertation. 1-12 cr. hrs.
S/U grade assessment. Prereq: Cons. of dept. ch.

MSSC 9970. Graduate Standing Continuation: Less than Half-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9974. Graduate Fellowship: Full-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9975. Graduate Assistant Teaching: Full-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9976. Graduate Assistant Research: Full-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9987. Doctoral Comprehensive Examination Preparation: Less than Half-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9988. Doctoral Comprehensive Examination Preparation: Half-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9989. Doctoral Comprehensive Examination Preparation: Full-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9991. Professional Project Continuation: Less than Half-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9992. Professional Project Continuation: Half-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9993. Professional Project Continuation: Full-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9994. Master's Thesis Continuation: Less than Half-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9995. Master's Thesis Continuation: Half-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9996. Master's Thesis Continuation: Full-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9997. Doctoral Dissertation Continuation: Less than Half-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9998. Doctoral Dissertation Continuation: Half-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

MSSC 9999. Doctoral Dissertation Continuation: Full-Time. 0 cr. hrs.
Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.