Computational Mathematical and Statistical Sciences, PHD

Chairperson: Anne Clough, Ph.D.
Program Director: Mehdi Maadooliat, Ph.D.
Computational Sciences website (https://www.marquette.edu/grad/programs-computational-sciences.php)

Degree Offered

Doctor of Philosophy

Program Description

Computational mathematical and statistical sciences (CMPS) is a field of study that emphasizes the discovery, implementation and use of computational tools to solve problems in mathematics and statistics that are both applied and pure. The master's degree program accommodates students whose objectives are either the master's degree or the preparation for doctoral study. The doctoral program is designed for individuals of outstanding ability who show promise as researchers in an interdisciplinary environment.

The diverse research opportunities in our graduate program are enhanced by the research faculty around Marquette's campus in the sciences and engineering and by the Milwaukee area research laboratories and clinics. Consult the Department of Mathematical and Statistical Sciences website for the most current information.

Computational Mathematical and Statistical Sciences Doctorate

A doctoral student in computational mathematical and statistical sciences must first complete a plan of study, designed to see the student through completion of the comprehensive examination. This plan of study should be prepared in cooperation with an adviser and approved by the Graduate Committee of the Department of Mathematical and Statistical Sciences.

Upon completion of the comprehensive examination, a doctoral student must then complete a program of study designed to see the student through completion of the program. This program of study should be defined, in cooperation with an adviser, on a Doctoral Program Planning Form and approved by the department's Graduate Committee.

The total 57-credit program includes a minimum of 45 credit hours of approved course work beyond the bachelor's degree plus 12 dissertation credits. Students must complete:

- the 15 credit hour core.
- a 3 credit hour adviser-approved COSC course.
- the 2 credit hours of MSSC 6090 Research Methods/Professional Development.
- at least 25 credit hours of electives. Approved programs of study normally include 6 credits of courses outside the department and no more than 12 credit hours in courses at the 5000 level.
- the 12 credit hours of MSSC 8999 Doctoral Dissertation.

Advancement to candidacy for the doctoral degree is considered after successful completion of the comprehensive examination, completion of all course work specified in the Doctoral Program Planning Form and successful completion of the qualifying examination, conducted by the student's doctoral committee. Typically, the doctoral committee also serves as the dissertation committee.

A full-time doctoral student is expected to complete the core courses within the first two years of study, and to take the comprehensive examination at the first opportunity after their completion. A student who enters the program with the necessary core courses is expected to take the comprehensive exam at the first available time it is offered.

Code	Title	Hours
Required 15 credit hour core:		
MSSC 6000	Scientific Computing	3
MSSC 6010	Computational Probability	3
MSSC 6020	Statistical Simulation	3
MSSC 6030	Applied Mathematical Analysis	3
MSSC 6040	Applied Linear Algebra	3
Choose an adviser-approved COSC 6000-6899 course		3
MSSC 6090	Research Methods/Professional Development (1 credit, taken at least twice)	2
Elective courses (no more than 12 credits at the 5000 level)		25

MSSC 5020	The Teaching of Mathematics	
MSSC 5030	Concepts in Geometry and Calculus from an Advanced Standpoint	
MSSC 5040	Concepts in High School Algebra and Number Theory from an Advanced Standpoint	
MSSC 5120	Abstract Algebra 1	
MSSC 5121	Abstract Algebra 2	
MSSC 5200	Intermediate Analysis 1	
MSSC 5201	Intermediate Analysis 2	
MSSC 5210	Complex Variables	
MSSC 5310	History of Mathematical Ideas	
MSSC 5320	Theory of Numbers	
MSSC 5420	Foundations of Geometry	
MSSC 5450	Topology	
MSSC 5500	Theory of Differential Equations	
MSSC 5510	Elementary Partial Differential Equations	
MSSC 5540	Numerical Analysis	
MSSC 5630	Mathematical Modeling and Analysis	
MSSC 5650	Theory of Optimization	
MSSC 5670	Applied Combinatorial Mathematics	
MSSC 5700	Theory of Probability	
MSSC 5710	Mathematical Statistics	
MSSC 5720	Statistical Methods	
MSSC 5730	Introduction to R for Statistics and Data Science	
MSSC 5740	Biostatistical Methods and Models	
MSSC 5750	Computational Statistics	
MSSC 5760	Time Series Analysis	
MSSC 5770	Statistical Machine Vision	
MSSC 5780	Regression Analysis	
MSSC 5790	Bayesian Statistics	
MSSC 5931	Topics in Mathematical or Statistical Sciences	
MSSC 6110	Applied Discrete Mathematics	
MSSC 6120	Optimization	
MSSC 6130	Dynamical Systems	
MSSC 6210	Theory of Statistics	
MSSC 6220	Analysis of Variance and Covariance	
MSSC 6230	Multivariate Statistical Analysis	
MSSC 6240	Design and Analysis of Scientific Experiments	
MSSC 6250	Statistical Machine Learning	
MSSC 6410	Real Analysis	
MSSC 6420	Algebra	
MSSC 6430	Logic and Set Theory	
MSSC 6440	Topology	
MSSC 6770	Innovations in Secondary Mathematics: Meeting the NCTM Standards	
MSSC 6931	Topics in Mathematical or Statistical Sciences	
Specific additional courses as approved by adviser in BIEN, COSC and EECE.		
Doctoral Dissertation/Research		
MSSC 8999	Doctoral Dissertation	12
Total Credit Hours:		**57**

All newly admitted computational mathematical and statistical sciences (CMPS) doctoral students who begin the program without an earned master's degree in an acceptable field are simultaneously enrolled in the CMPS master of science program or the applied statistics (APST) master of science program as a Plan B student. These students concurrently complete both the master's degree of choice and the doctoral degree as part of the doctoral course of study.

University Policies

- Academic Censure - Graduate School (https://bulletin.marquette.edu/policies/academic-censure/graduate/)
- Academic Integrity (https://bulletin.marquette.edu/policies/academic-integrity/)
- Academic Misconduct (https://bulletin.marquette.edu/policies/academic-misconduct-policy/)
- Academic Program Definitions (https://bulletin.marquette.edu/policies/academic-programs-defined/)
- Accelerated Degree Programs (https://bulletin.marquette.edu/policies/accelerated-degree-programs/)
- Attendance - Graduate School (https://bulletin.marquette.edu/policies/attendance/graduate/)
- Awarding Diplomas and Certificates (https://bulletin.marquette.edu/policies/awarding-diplomas-certificates/)
- Background Checks, Drug Testing (https://bulletin.marquette.edu/policies/background-checks-drug-testing/)
- Class Rank (https://bulletin.marquette.edu/policies/class-rank/)
- Commencement (https://bulletin.marquette.edu/policies/commencement/)
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- Grade Appeals (https://bulletin.marquette.edu/policies/grade-appeals/)
- Grading System - Graduate School and Graduate School of Management (https://bulletin.marquette.edu/policies/grading-system/graduate-management/)
- Graduation - Graduate School (https://bulletin.marquette.edu/policies/graduation/graduate/)
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- Last Date of Attendance/Activity (https://bulletin.marquette.edu/policies/last-dateof-attendance-activity/)
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- Registration - Graduate School (https://bulletin.marquette.edu/policies/registration/graduate/)
- Repeated Courses - Graduate School (https://bulletin.marquette.edu/policies/repeated-courses/graduate/)
- Student Data Use and Privacy (https://bulletin.marquette.edu/policies/student-data-use-privacy/)
- Transcripts-Official (https://bulletin.marquette.edu/policies/transcripts-official/)
- Transfer Course Credit - Graduate School (https://bulletin.marquette.edu/policies/transfer-course-credit-policy/graduate/)
- Withdrawal - Graduate School (https://bulletin.marquette.edu/policies/withdrawals/graduate/)

Graduate School Policies

- Academic Performance (https://bulletin.marquette.edu/graduate/policies/academic-performance/)
- Academic Programs Overview (https://bulletin.marquette.edu/graduate/policies/academic-programs-overview/)
- Advising (https://bulletin.marquette.edu/graduate/policies/advising/)
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- Time Limitations (https://bulletin.marquette.edu/graduate/policies/time-limitations/)
- Working with Minors (https://bulletin.marquette.edu/graduate/policies/working-minors/)

Computational Mathematical and Statistical Sciences

- Computational Mathematical and Statistical Sciences, MS (https://bulletin.marquette.edu/graduate/computational-mathematical-statistical-sciences-ms/)
- Computational Mathematical and Statistical Sciences, PHD (p. 1)

MSSC 5020 The Teaching of Mathematics (3 credits)
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.
Level of Study: Graduate
Last four terms offered: 2022 Fall Term, 2020 Fall Term, 2018 Fall Term, 2017 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205020)

MSSC 5030 Concepts in Geometry and Calculus from an Advanced Standpoint (3 credits)
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.
Level of Study: Graduate
Last four terms offered: 2022 Spring Term, 2021 Spring Term, 2019 Spring Term, 2017 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205030)

MSSC 5040 Concepts in High School Algebra and Number Theory from an Advanced Standpoint (3 credits)
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.
Level of Study: Graduate
Last four terms offered: 2016 Spring Term, 2014 Spring Term, 2012 Spring Term, 2010 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205040)

MSSC 5120 Abstract Algebra 1 (3 credits)
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.
Level of Study: Graduate
Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205120)

MSSC 5121 Abstract Algebra 2 (3 credits)
A continuation of MSSC 5120 with emphasis on groups, rings, fields and modules.
Level of Study: Graduate
Last four terms offered: 2021 Spring Term, 2019 Spring Term, 2017 Spring Term, 2014 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205121)

MSSC 5200 Intermediate Analysis 1 (3 credits)
Limits and continuity, differentiability, Riemann integration. Topology of N-dimensional spaces.
Level of Study: Graduate
Last four terms offered: 2021 Fall Term, 2019 Fall Term, 2017 Fall Term, 2015 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205200)

MSSC 5201 Intermediate Analysis 2 (3 credits)
Transformations of N-spaces, line and surface integrals, sequences and series, uniform convergence.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205201)

MSSC 5210 Complex Variables (3 credits)
Complex numbers, analytic functions, differentiation, series expansion, line integrals, singularities and residues.
Level of Study: Graduate
Last four terms offered: 2022 Spring Term, 2020 Spring Term, 2016 Spring Term, 2015 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205210)

MSSC 5310 History of Mathematical Ideas (3 credits)
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.
Level of Study: Graduate
Last four terms offered: 2022 Fall Term, 2021 Spring Term, 2019 Spring Term, 2017 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205310)

MSSC 5320 Theory of Numbers (3 credits)
Integers, unique factorization theorems, arithmetic functions, theory of congruences, quadratic residues, partition theory.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2020 Spring Term, 2018 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205320)

MSSC 5420 Foundations of Geometry (3 credits)
Modern postulational development of Euclidean and non-Euclidean geometries.
Level of Study: Graduate
Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205420)

MSSC 5450 Topology (3 credits)
Topological spaces, mappings, metric spaces, product and quotient spaces. Separation axioms, compactness, local compactness and connectedness.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2021 Spring Term, 2019 Spring Term, 2015 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205450)

MSSC 5500 Theory of Differential Equations (3 credits)
Existence and uniqueness theorems, linear and non-linear systems, numerical techniques, stability.
Level of Study: Graduate
Last four terms offered: 2020 Fall Term, 2016 Fall Term, 2014 Fall Term, 2012 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205500)

MSSC 5510 Elementary Partial Differential Equations (3 credits)
Fourier series, method of separation of variables, eigenfunction expansions, application of eigenfunctions to partial differential equations, Green's functions and transform methods.
Level of Study: Graduate
Last four terms offered: 2021 Spring Term, 2019 Spring Term, 2017 Spring Term, 2015 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205510)

MSSC 5540 Numerical Analysis (3 credits)
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.
Level of Study: Graduate
Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205540)

MSSC 5630 Mathematical Modeling and Analysis (3 credits)
Construction and analysis of mathematical models from biological, behavioral and physical sciences.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Fall Term, 2021 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205630)

MSSC 5650 Theory of Optimization (3 credits)
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.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2021 Spring Term, 2019 Spring Term, 2017 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205650)

MSSC 5670 Applied Combinatorial Mathematics (3 credits)
Permutations and combinations, recurrence relations, inclusions and exclusion, Polya's theory of counting, graph theory, transport networks, matching theory.
Level of Study: Graduate
Last four terms offered: 2022 Spring Term, 2020 Spring Term, 2018 Spring Term, 2016 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205670)

MSSC 5700 Theory of Probability (3 credits)
Random variables, distributions, moment generating functions of random variables, various derived probabilistic models and applications.
Level of Study: Graduate
Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205700)

MSSC 5710 Mathematical Statistics (3 credits)
Sampling theory and distributions, estimation and hypothesis testing, regression, correlation, analysis of variance, non-parametric methods, Bayesian statistics.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term, 2020 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205710)

MSSC 5720 Statistical Methods (3 credits)
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.
Level of Study: Graduate
Last four terms offered: 2023 Summer Term, 2023 Spring Term, 2022 Fall Term, 2022 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205720)

MSSC 5730 Introduction to R for Statistics and Data Science (1 credits)
An introductory course to the statistical analysis software R. Topics include basic R programming, importing and cleaning data, data visualization, performing descriptive and inferential statistics, and creating reproducible reports.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205730)

MSSC 5740 Biostatistical Methods and Models (3 credits)
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.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2020 Fall Term, 2019 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205740)

MSSC 5750 Computational Statistics (3 credits)
Explores computational data analysis, an essential part of modern statistics. Introduces statistical computing including statistical programming, Monte Carlo simulation and parallel computing, smoothing and density estimation, implementing numerical methods in R (e.g., Expectation-Maximization algorithm), fitting models to data, statistical prediction and cross-validation.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205750)

MSSC 5760 Time Series Analysis (3 credits)
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.
Level of Study: Graduate
Last four terms offered: 2022 Spring Term, 2020 Spring Term, 2018 Spring Term, 2016 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205760)

MSSC 5770 Statistical Machine Vision (3 credits)
Object recognition and tracking for automatic machine vision systems. Topics include image representation, convolution, filter design, statistical deconvolution, discrete Fourier transform, automated object identification, text analysis, video object tracking and line tracing. Real-world applications such as object tracking within sequence of images, identification of item placement location in industrial settings, and autonomous lane departure identification. Additional topics may include object feature representations and statistical classification of objects. Computational implementation and examples utilize high-level programming language.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205770)

MSSC 5780 Regression Analysis (3 credits)
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.
Level of Study: Graduate
Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205780)

MSSC 5790 Bayesian Statistics (3 credits)
Bivariate, conditional and marginal distributions. The Bayesian philosophy, quantification of a priori information, prior, likelihood and posterior distributions. Bayesian linear models, posterior parameter estimation including maximum posteriori and marginal expectations. Topics may include numerical integration and Markov chain Monte Carlo techniques. Use of a high-level software package.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205790)

MSSC 5931 Topics in Mathematical or Statistical Sciences (1-3 credits)
Topics selected from one of the various branches of mathematics or statistics. Specific topics to be announced in the Schedule of Classes.
Level of Study: Graduate
Last four terms offered: 2023 Summer Term, 2023 Spring Term, 2022 Fall Term, 2022 Summer Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%205931)

MSSC 6000 Scientific Computing (3 credits)
Foundational methods and techniques of scientific computing in the mathematical and statistical sciences. Covers fundamental computational algorithms aimed toward applications in science and engineering. Students implement algorithms, and visualize and validate their outcomes. Further, students are introduced to and implement best programming practices.; introductory statistics course or cons. of instr.; and programming competency in a high-level language.
Prerequisite: Calculus course or cons. of instr.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206000)

MSSC 6010 Computational Probability (3 credits)
A modern course in probability. Foundations of probability for modeling random processes with computational techniques. Topics include 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, transformation of variables, prior and posterior distributions, Law of Large Numbers, Central Limit Theorem, the Bayesian paradigm. Numerical and computational methods will be covered throughout topics.
Prerequisite: Three semesters of mathematics beyond calculus and MATH 4720 or equiv.
Level of Study: Graduate
Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206010)

MSSC 6020 Statistical Simulation (3 credits)
Elements of statistical simulation and modeling with applications. Generation of random variables, simulating statistical models, 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.
Prerequisite: MSSC 6010 and programming competency in a high-level language.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term, 2020 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206020)

MSSC 6030 Applied Mathematical Analysis (3 credits)
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.
Prerequisite: Multivariable calculus and linear algebra.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term, 2020 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206030)

MSSC 6040 Applied Linear Algebra (3 credits)
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.
Prerequisite: Multivariable calculus and linear algebra.
Level of Study: Graduate
Last four terms offered: 2022 Fall Term, 2022 Spring Term, 2021 Fall Term, 2020 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206040)

MSSC 6090 Research Methods/Professional Development (1 credits)
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.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term, 2020 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206090)

MSSC 6110 Applied Discrete Mathematics (3 credits)
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.; MATH 1451 and MATH 2100 or equiv.
Prerequisite: COSC 1020 and MATH 1450 or equiv.
Level of Study: Graduate
Last four terms offered: 2008 Fall Term, 2006 Fall Term, 2003 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206110)

MSSC 6120 Optimization (3 credits)
Principles of deterministic model building in operations research. Linear programming and duality. Dynamic and integer programming. Nonlinear optimization and parameter estimation.
Prerequisite: MATH 3100 or equiv.
Level of Study: Graduate
Last four terms offered: 2007 Fall Term, 2005 Fall Term, 2003 Fall Term, 1999 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206120)

MSSC 6130 Dynamical Systems (3 credits)
Theory of discrete and continuous dynamical systems. Periodic solutions, bifurcations, chaotic systems, attractors, fractal dimension and simulation of these systems.
Prerequisite: MATH 4200 or equiv.
Level of Study: Graduate
Last four terms offered: 2007 Spring Term, 2005 Spring Term, 2001 Spring Term, 1998 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206130)

MSSC 6210 Theory of Statistics (3 credits)
Brief review of sampling distributions, convergence, Central Limit Theorem and Law of Large Numbers. Estimation, testing hypotheses, regression and correlation analysis, non-parametric methods.
Prerequisite: MATH 4700 or equiv.
Level of Study: Graduate
Last four terms offered: 2009 Spring Term, 2007 Spring Term, 2005 Spring Term, 2003 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206210)

MSSC 6220 Analysis of Variance and Covariance (3 credits)
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.
Prerequisite: MATH 4710 or equiv.
Level of Study: Graduate
Last four terms offered: 2009 Fall Term, 2007 Fall Term, 2005 Fall Term, 2003 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206220)

MSSC 6230 Multivariate Statistical Analysis (3 credits)
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. A high level programming language may be used.
Prerequisite: MATH 3100 or equiv; MATH 4710 or equiv.
Level of Study: Graduate
Last four terms offered: 2010 Spring Term, 2008 Spring Term, 2006 Spring Term, 2004 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206230)

MSSC 6240 Design and Analysis of Scientific Experiments (3 credits)
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.
Prerequisite: A course in statistical methods, such as MATH 4720 or equiv.
Level of Study: Graduate
Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206240)

MSSC 6250 Statistical Machine Learning (3 credits)
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., cons. of instr.
Prerequisite: A course in statistical methods, such as MATH 4720, and a course in linear algebra, such as MATH 3100, MATH 4780 or equiv.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term, 2020 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206250)

MSSC 6410 Real Analysis (3 credits)
Involves study of algebraic structures of real analysis, function spaces, introduction to linear operators, measure and integration theory, convergence theorems, limits, continuity and derivatives.
Prerequisite: MATH 4200.
Level of Study: Graduate
Last four terms offered: 2007 Fall Term, 2005 Fall Term, 2003 Fall Term, 2001 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206410)

MSSC 6420 Algebra (3 credits)
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.
Prerequisite: MATH 4120 or equiv.
Level of Study: Graduate
Last four terms offered: 2010 Spring Term, 2006 Fall Term, 2004 Fall Term, 2002 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206420)

MSSC 6430 Logic and Set Theory (3 credits)
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.
Prerequisite: MATH 4120 or equiv.
Level of Study: Graduate
Last four terms offered: 2007 Fall Term, 2005 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206430)

MSSC 6440 Topology (3 credits)
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.
Prerequisite: MATH 4200 or equiv.
Level of Study: Graduate
Last four terms offered: 2005 Fall Term, 2000 Fall Term, 1997 Fall Term, 1993 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206440)

MSSC 6770 Innovations in Secondary Mathematics: Meeting the NCTM Standards (3 credits)
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.; 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.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206770)

MSSC 6931 Topics in Mathematical or Statistical Sciences (3 credits)
Topics vary. Multiple enrollments allowed under different topics.
Level of Study: Graduate
Last four terms offered: 2021 Spring Term, 2019 Summer Term, 2019 Spring Term, 2018 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206931)

MSSC 6952 Colloquium in Mathematical or Statistical Sciences (0-1 credits)
Research and scholarly presentations on selected topics in the mathematical or statistical sciences by visiting researchers, departmental faculty and graduate students.
Prerequisite: Grad. stndg.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206952)

MSSC 6953 Seminar in Mathematics Curriculum Development and Material 1 (3 credits)
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.
Prerequisite: Admitted to MSST or College of Education.
Level of Study: Graduate
Last four terms offered: 2011 Fall Term, 2008 Fall Term, 2003 Summer Term, 1994 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206953)

MSSC 6954 Seminar in Mathematics Curriculum Development and Material 2 (3 credits)
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.
Prerequisite: MSSC 6953; admitted to MSST or College of Education.
Level of Study: Graduate
Last four terms offered: 1989 Summer Session 2
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206954)

MSSC 6960 Seminar in Mathematical or Statistical Sciences (0-3 credits)
Topics selected from one of the various branches of mathematics or statistics. Specific topics are announced in the Schedule of Classes.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2021 Fall Term, 2021 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206960)

MSSC 6974 Practicum for Research in Mathematical or Statistical Sciences (1-3 credits)
S/U grade assessment.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2019 Summer Term, 2018 Fall Term, 2018 Spring Term, 2017 Summer Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206974)

MSSC 6975 Practicum in Applied Statistics and Data Science (3 credits)
Provides students with the opportunity to explore real-world examples of data analysis as a statistical consultant.
Prerequisite: 3.000 MU GPA; completed at least 12 credit hours; cons. of the applied statistics dir. of graduate studies; or cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2023 Summer Term, 2022 Fall Term, 2022 Summer Term, 2022 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206975)

MSSC 6995 Independent Study in Mathematical or Statistical Sciences (1-5 credits)
Faculty-supervised, independent study/research of a specific area or topic in mathematics or statistics.
Prerequisite: Cons. of instr. and cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2022 Spring Term, 2021 Fall Term, 2021 Spring Term, 2020 Summer Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206995)

MSSC 6998 Professional Project in Mathematical or Statistical Sciences (0 credits)
SNC/UNC grade assessment.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2019 Summer Term, 2019 Spring Term, 2018 Spring Term, 2016 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206998)

MSSC 6999 Master's Thesis (1-6 credits)
S/U grade assessment.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Summer Term, 2022 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%206999)

MSSC 8995 Independent Study in Mathematical or Statistical Sciences (1-3 credits)
In-depth research on a topic or subject matter usually not offered in the established curriculum with faculty and independent of the classroom setting.
Prerequisite: Cons. of instr. and cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Spring Term, 2021 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%208995)

MSSC 8999 Doctoral Dissertation (1-12 credits)
S/U grade assessment.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Spring Term, 2021 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%208999)

MSSC 9970 Graduate Standing Continuation: Less than Half-Time (0 credits)
Fee. SNC/UNC grade assessment. Designated as less than half-time status only, cannot be used in conjunction with other courses, and does not qualify
students for financial aid or loan deferment.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2021 Spring Term, 2020 Fall Term, 2020 Spring Term, 2019 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209970)

MSSC 9974 Graduate Fellowship: Full-Time (0 credits)
Fee. SNC/UNC grade assessment. Designated as full-time status. If a student is already registered in other courses full time, this continuation course is
not needed.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2012 Spring Term, 2010 Summer Term, 2009 Fall Term, 2009 Summer Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209974)

MSSC 9975 Graduate Assistant Teaching: Full-Time (0 credits)
Fee. SNC/UNC grade assessment. Designated as full-time status. If a student is already registered in other courses full time, this continuation course is
not needed.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2021 Spring Term, 2019 Spring Term, 2017 Fall Term, 2016 Summer Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209975)

MSSC 9976 Graduate Assistant Research: Full-Time (0 credits)
Fee. SNC/UNC grade assessment. Designated as full-time status. If a student is already registered in other courses full time, this continuation course is
not needed.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2020 Fall Term, 2019 Fall Term, 2019 Spring Term, 2018 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209976)

MSSC 9987 Doctoral Qualifying Examination Preparation: Less than Half-Time (0 credits)
Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working
less than 12 hours per week toward their doctoral qualifying exam.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2018 Spring Term, 2017 Fall Term, 2017 Spring Term, 2016 Summer Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209987)

MSSC 9988 Doctoral Qualifying Examination Preparation: Half-Time (0 credits)
Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than
12 to less than 20 hours per week toward their doctoral qualifying exam. May be taken in conjunction with credit-bearing or other non-credit courses to
result in the status indicated, as deemed appropriate by the department.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2016 Spring Term, 2015 Fall Term, 2015 Spring Term, 2012 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209988)

MSSC 9989 Doctoral Qualifying Examination Preparation: Full-Time (0 credits)
Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or
more per week toward their doctoral qualifying exam. May be taken in conjunction with credit-bearing or other non-credit courses to result in the status
indicated, as deemed appropriate by the department.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2018 Spring Term, 2017 Fall Term, 2016 Fall Term, 2016 Summer Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209989)

MSSC 9991 Professional Project Continuation: Less than Half-Time (0 credits)
Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week on their professional project. Any professional project credits required for the degree should be completed before registering for non-credit Professional Project Continuation.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Fall Term, 2021 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209991)

MSSC 9992 Professional Project Continuation: Half-Time (0 credits)
Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week on their professional project. Any project credits required for the degree should be completed before registering for non-credit Professional Project Continuation.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2016 Summer Term, 2016 Spring Term, 2015 Summer Term, 2015 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209992)

MSSC 9993 Professional Project Continuation: Full-Time (0 credits)
Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week on their professional project. Any professional project credits required for the degree should be completed before registering for non-credit Professional Project Continuation.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2018 Fall Term, 2018 Summer Term, 2018 Spring Term, 2016 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209993)

MSSC 9994 Master's Thesis Continuation: Less than Half-Time (0 credits)
Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week on their master's thesis. All six thesis credits required for the degree should be completed before registering for non-credit Master's Thesis Continuation.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2022 Summer Term, 2019 Spring Term, 2018 Fall Term, 2018 Summer Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209994)

MSSC 9995 Master's Thesis Continuation: Half-Time (0 credits)
Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week on their master's thesis. All six thesis credits required for the degree should be completed before registering for non-credit Master's Thesis Continuation.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2021 Spring Term, 2020 Fall Term, 2018 Fall Term, 2018 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209995)

MSSC 9996 Master's Thesis Continuation: Full-Time (0 credits)
Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week on their master's thesis. All six thesis credits required for the degree should be completed before registering for non-credit Master's Thesis Continuation.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2021 Summer Term, 2018 Fall Term, 2018 Spring Term, 2017 Fall Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209996)

MSSC 9997 Doctoral Dissertation Continuation: Less than Half-Time (0 credits)
Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week on their doctoral dissertation. All 12 dissertation credits required for the degree should be completed before registering for non-credit Doctoral Dissertation Continuation.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2021 Spring Term, 2020 Fall Term, 2019 Fall Term, 2018 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209997)

MSSC 9998 Doctoral Dissertation Continuation: Half-Time (0 credits)
Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week on their doctoral dissertation. All 12 dissertation credits required for the degree should be completed before registering for non-credit Doctoral Dissertation Continuation.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2022 Fall Term, 2021 Spring Term, 2020 Fall Term, 2020 Spring Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209998)

MSSC 9999 Doctoral Dissertation Continuation: Full-Time (0 credits)
Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week on their doctoral dissertation. All 12 dissertation credits required for the degree should be completed before registering for non-credit Doctoral Dissertation Continuation.
Prerequisite: Cons. of dept. ch.
Level of Study: Graduate
Last four terms offered: 2023 Summer Term, 2023 Spring Term, 2022 Fall Term, 2022 Summer Term
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=MSSC%209999)