LEDR 6931. Topics in Leadership Studies 1-3 sem. hrs. Examination of topics related to contemporary issues in leadership studies.
Prereq: LEDR 6000, 6005, and 6010 or 6030. LEDR 6944. Practicum in Leadership Studies 3 sem. hrs. Prereq: LEDR 6000, 6005, and 6010 or 6030.
LEDR 6995. Independent Study in Leadership Studies 1-3 sem. hrs. Prereq: Cons. of dept. ch.; cons. of prog. dir.
LEDR 6998. Professional Project in Leadership Studies 3 sem. hrs. Required course for the integrative learning experience. Must be taken twice, over two terms, for a total of 6 credits. Two options: 1) complete a professional project or 2) complete a research article of publishable quality. S/U grade assessment. Prereq: fifteen core credits and 9 specialization credits completed. For the general track in leadership studies, 24 credits completed.

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

Sports Leadership (SPLE)

SPLE 6001. Introduction to Sports Leadership 3 sem. hrs. Overview of the diverse leadership opportunities within the sports industry. Discussion of current athletic issues and challenges from a leadership and managerial perspective.

SPLE 6100. Legal and Ethical Athletic Leadership 3 sem. hrs. An introduction to the basic legal system's terminology and principles as applied to amateur and professional sports, as well as the ethical and moral issues involved. Examines risk management, legal status and rights, compliance issues, crisis management, liability, gender equity and other current issues.

SPLE 6200. Sports Communication 3 sem. hrs. A study of the various components of communication skills within the industry including: special events, research, corporate sponsorship, media, media events, computer systems and constituent relations through technological and traditional means.

SPLE 6300. Social-Historical Foundations of Sports 3 sem. hrs. Examination of the historical and sociological foundations of athletics in the U.S. Important areas of emphasis include: historical development of athletics, sport as a cultural product, social relations, organizational structures, and contemporary issues.

SPLE 6400. Strategic Governance in the Sports Industry 3 sem. hrs. Analysis of the foundations of the sport industry including amateur and professional organizations. Statistically analyzes and evaluates the multifaceted elements of a successful athletic operation, including: consumer psychology, discretionary-spending patterns, and other contributing critical ingredients.

SPLE 6931. Topics in Athletic Leadership 3 sem. hrs. Examination of topics related to contemporary issues in athletic leadership.

SPLE 6964. Practicum in Sports Leadership 3-6 sem. hrs. Supervised experiences in sports leadership. Each student must negotiate an appropriate practicum plan and location with the graduate sports leadership faculty and the sports leadership practicum coordinator. Prereq: Cons. of dept. ch.; cons. of prog. dir.


MATHEMATICS, STATISTICS AND COMPUTER SCIENCE (MSCS) / BIOINFORMATICS (BIIN) / COMPUTATIONAL SCIENCES (CMPS) / COMPUTING (COMP)

Chairperson and Professor: Krenz
Assistant Chairperson: Manyo
Professor: Bankston, Bansal, Braunschweiger (Emeritus), Clough, Corliss, Hamedani, Hanneken, Harrison, Harris, P. Jones, Lawrence (Emeritus), Merrill, Moyer, Pastijn, Ruitenber
Associate Professor: Ahmed, Brookshear (Emeritus), Byline, Factor, Kaiser, Rowe, Slattery, Struble
Research Associate Professor: Tonelliato
Research Assistant Professor: Feng
Research Associate: Bolte
Assistant Professor: Brylov, Ge, Madiraju, Magiera, Sanders, Scott, Spiller
Note: Faculty members and their ranks are for the 2009–2010 academic year.

DEGREES OFFERED

COMPUTATIONAL SCIENCES

Master of Science, students are admitted under Plan B (non-thesis option) but Plan A (thesis option) is also offered; Doctor of Philosophy

MATHEMATICS, STATISTICS AND COMPUTER SCIENCE

Master of Science, students are admitted under Plan B (non-thesis option) but Plan A (thesis option) is also offered

BIOINFORMATICS

Master of Science, students are admitted under Plan B (non-thesis option) but Plan A (thesis option) is also offered

COMPUTING

Master of Science, students are admitted under Plan B (non-thesis option) but Plan A (thesis option) is also offered

SPECIALIZATION

M.S. (MSCS): Mathematics for Secondary School Teachers

PROGRAM OVERVIEW

The Department of Mathematics, Statistics and Computer Science offers a range of master's and doctoral programs in accord with the breadth of the disciplines it encompasses. Further information on each of the programs described below may be found on the departmental Web site.

COMPUTATIONAL SCIENCES (CMPS)

Computational science is the discovery, implementation, simulation, and application of models to solve scientific and engineering problems. The master's degree program accommodates students whose objectives are either the master's degree or preparation for doctoral study in some aspect of the computational sciences. 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 naturally interdisciplinary department are enhanced by the research programs of associated faculty on the Marquette campus in the sciences and engineering and Milwaukee area research laboratories and clinics. Consult the department Web site for the most current information.

**PREREQUISITES FOR ADMISSION**

Admission to the master’s program in computational sciences requires an undergraduate degree in mathematics, statistics, computer science, or a related field such as engineering or an area of science, with at least a minor (3 courses beyond calculus) in mathematics, and proficiency in a high-level computer language.

Admission to the doctoral program in computational sciences requires (in addition to the prerequisites for master’s admission) demonstrated promise for original research.

**APPLICATION DEADLINE**

To be considered for admission, all application requirements must be completed and received in the Graduate School by January 15 for both the master’s and doctoral programs.

**APPLICATION REQUIREMENTS**

Applicants must submit, directly to the Graduate School:

1. A completed online application form and fee.
2. Official transcripts from all current and previous colleges/universities except Marquette.
3. Three letters of recommendation addressing the applicant’s academic qualifications for graduate study in the intended program.
4. (For doctoral and all international applicants) GRE scores (General Test only).
5. (For international applicants only) a TOEFL score or other acceptable proof of English proficiency.
6. (For doctoral applicants only) English-language publications authored by the applicant, including a master's thesis or essay, if applicable (optional, but strongly recommended).

**MASTER’S REQUIREMENTS**

A master’s student must complete a plan of study prepared in cooperation with an adviser and approved by the Graduate Committee of the Department of Mathematics, Statistics, and Computer Science.

A master's student is admitted to the non-thesis program (Plan B) which requires at least 30 credit hours of course work and a non-credit essay that reflects the student's ability to synthesize source materials related to a particular area of research or professional practice. An oral presentation of the essay is required.

A formal request to pursue a thesis (Plan A) must be approved by the department's Graduate Committee and the Graduate School. The Plan A student must complete a minimum of 30 credit hours, including six hours of thesis credits, and submit a thesis that must be approved by the department's Graduate Committee. The total program, exclusive of dissertation, will contain a minimum of 45 credit hours of approved course work beyond the bachelor's degree, including the 18-credit computational sciences core, which consists of MScS 6010-MScS 6060, and at least 2 credits of MScS 6900 (research methods/professional development). Twelve hours of dissertation credits are also required. Approved programs of study will normally include 6 credits of courses outside the department and no more than 12 credits in undergraduate courses.

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 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. No foreign language is required.

**MATHEMATICS, STATISTICS, AND COMPUTER SCIENCE (MScS)**

The mathematics for secondary school teachers (MSST) specialization is designed for teachers who wish to do graduate work in the mathematical sciences but do not anticipate graduate study in mathematics beyond the master’s level.

**PREREQUISITES FOR ADMISSION**

Mathematics for secondary school teachers (MSST) applicants should hold, or be eligible to hold, a teaching certificate for secondary school mathematics.

**APPLICATION DEADLINE**

To be considered for admission, all application requirements must be completed and received in the Graduate School by January 15.

**APPLICATION REQUIREMENTS**

Applicants must submit, directly to the Graduate School:

1. A completed online application form and fee.
2. Official transcripts from all current and previous colleges/universities except Marquette.
3. Three letters of recommendation addressing the applicant's academic qualifications for graduate study in the intended program.
4. (For international applicants only) GRE scores (General Test only).
5. (For international applicants only) a TOEFL score or other acceptable proof of English proficiency.

**MASTER’S REQUIREMENTS**

A master’s student must complete a plan of study prepared in cooperation with an adviser and approved by the Graduate Committee of the Department of Mathematics, Statistics, and Computer Science.

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 program, exclusive of dissertation, will contain a minimum of 45 credit hours of approved course work beyond the bachelor’s degree, including the 18-credit computational sciences core, which consists of MScS 6010-MScS 6060, and at least 2 credits of MScS 6900 (research methods/professional development). Twelve hours of dissertation credits are also required. Approved programs of study will normally include 6 credits of courses outside the department and no more than 12 credits in undergraduate courses.

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 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. No foreign language is required.

**MATHEMATICS, STATISTICS, AND COMPUTER SCIENCE (MScS)**

The mathematics for secondary school teachers (MSST) specialization is designed for teachers who wish to do graduate work in the mathematical sciences but do not anticipate graduate study in mathematics beyond the master’s level.

**PREREQUISITES FOR ADMISSION**

Mathematics for secondary school teachers (MSST) applicants should hold, or be eligible to hold, a teaching certificate for secondary school mathematics.

**APPLICATION DEADLINE**

To be considered for admission, all application requirements must be completed and received in the Graduate School by January 15.

**APPLICATION REQUIREMENTS**

Applicants must submit, directly to the Graduate School:

1. A completed online application form and fee.
2. Official transcripts from all current and previous colleges/universities except Marquette.
3. Three letters of recommendation addressing the applicant's academic qualifications for graduate study in the intended program.
4. (For international applicants only) GRE scores (General Test only).
5. (For international applicants only) a TOEFL score or other acceptable proof of English proficiency.
APPLICATION REQUIREMENTS

Applicants must submit, directly to the Marquette University Graduate School:
1. A completed online application form and fee.
2. Official transcripts from all current and previous colleges/universities except Marquette.
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 international applicants only) a TOEFL score or other acceptable proof of English proficiency. A recent GRE score is strongly recommended.

GENERAL INFORMATION

Students interested in applying to the program should consult the program Web site http://bioinformatics.mcw.edu for a list of currently approved courses and scheduled course offerings for the next term.

Special registration for this program is required, as courses are taken at both institutions. Students must register for BIIN 6947 through Marquette University AND for the matching MCW course through Medical College of Wisconsin.

MASTER’S REQUIREMENTS

Students are admitted to the program under Plan B (non-thesis option), although with the co-directors’ approval, students may elect to transfer to Plan A (thesis option). In both options below, courses taken for credit in this program must be from the list of courses approved by the Steering Committee. Exceptions must be approved by the Steering Committee.

Plan B Option (36 credits)

Students must complete 36 credit hours of course work, of which at least 24 hours must be earned in graduate-level courses (6000-level and above).

Plan A Option (30 credits)

Students must complete 24 credit hours of course work, of which at least 18 credit hours must be earned in graduate-level courses (6000-level and above). Students must also complete a master’s thesis for 6 credit hours and pass an oral examination concentrated on the thesis.

For both options, students are required to earn 6 credits for BIIN 6000 and 6005, 3 credits for BIIN 6980 Practicum in Bioinformatics, a minimum of 6 credits of approved computer science courses at the 6000-level, and a minimum of 6 credits of approved biological science courses at the 6000-level.

COMPUTING (COMP)

Program Director and Professor: Harris Professors: Bankston, Corliss, Karshenas, Krenz Associate Professor: Ahamed, Factor, Feng, Johnson, Povinelli, Riedel, Slattery, Struble Assistant Professor: Brylow, Madiraju Note: Faculty members and their ranks are for the 2009-2010 academic year.

The program is designed to meet the educational needs of present and future computing professionals interested in starting a career or updating their skills in areas such as systems analysis, software engineering, database design and administration, network design and administration, systems engineering, and technical support. Students may select courses (including some designated as EECE, MSCS, CSEN, COEN and COSC) from a large number of approved courses offered by the Department of Electrical and Computer Engineering, the Department of Mathematics, Statistics and Computer Science and other units on campus. Students may pursue the degree on a full time or part time basis. Many courses are offered evenings.

PREREQUISITES FOR ADMISSION

Applicants must have completed or be in the process of completing a bachelor’s degree from an accredited college or university. Applicants should also have taken at least two terms of computer programming courses in a modern computer programming language with a knowledge of data structures (or equivalent work experience).

APPLICATION REQUIREMENTS

Applicants must submit, directly to the Graduate School:
1. A completed online application form and fee.
2. Official transcripts from all current and previous colleges/universities except Marquette.
3. 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 international applicants only) a TOEFL score (minimum 600 on the paper-based version, 250 on the computer-based version, 100 on the Internet-based version) or other acceptable proof of English proficiency.

GENERAL INFORMATION

Students interested in applying to the program should consult the program Web site www.mscs.mu.edu/mscs/graduate/comp/ for a list of the currently approved courses for the degree and scheduled course offerings for the next term.

MASTER’S REQUIREMENTS

Students are admitted to the program under Plan B (non-thesis option), although with the co-directors’ approval, students may elect to transfer to Plan A (thesis option) on approval of a thesis outline by their adviser and the Computing Graduate Committee. The course of study is very flexible. Students complete a breadth requirement, primary and secondary concentrations, and additional courses suited to their backgrounds and career goals. The program director and faculty advisers work very closely with students to ensure that they achieve their educational goals through appropriate course selection.

Breadth Requirement (12 credits)

Computing students experience the breadth of the field. Students complete (or have completed before entering the program) at least three credits in four of the following five areas:
1. Information Management: MSCS 5800 or EECE 5810
2. Architecture and Organization: EECE 5710, EECE 5730, or have completed COSC 2200 before beginning the program
3. Operating Systems: COSC 3250 or EECE 5820
4. Programming Concepts and Skills: COSC 3410 or EECE 5620
5. Software Engineering: MSCS 5860 or MSCS 6050 or EECE 5610

More advanced 6000-level classes designated by the program in each area also satisfy the breadth requirement.

Concentrations (18 credits)

Computing students gain both breadth and an in-depth knowledge of their field. Concentrations provide in-depth knowledge areas and often reflect possible long-term career objectives. Each student must have one primary concentration of at least 12 credits, and one different secondary concentration of at least six credits. For students in Plan A (thesis option), the six thesis credits are considered a secondary concentration.

Courses taken to satisfy the breadth requirement also count toward primary and secondary concentrations. No course may be counted toward satisfying both a primary and a secondary concentration. The breadth and concentration requirements may be satisfied with any combination of approved 5000- and 6000-level classes, subject to the overall Plan A or Plan B requirements for 6000-level credits. Primary or secondary concentrations include:

• Foundations of Computation
• Distributed Computing
• Software Engineering, Programming Concepts and Skills
• Intelligent Systems and Information Management
• Architecture and Organization.

Specific courses in each concentration are designated by the computing program.

ADDITIONAL COURSE WORK

Courses beyond the breadth and concentration requirements are taken from a list of computer science and computer engineering courses approved by the computing program. Six out-of-program elective credits may be selected from other Marquette graduate courses germane to computing or its applications.

Plan B Option (36 credits)

Students must complete 36 credit hours of course work, of which at least 12 hours must be earned in graduate-level courses (6000-level and above).

Plan A Option (30 credits)

Students must complete 24 credit hours of course work, of which at least 12 hours must be earned in graduate-level courses (6000-level and above). Students must also complete a master’s thesis for 6 credit hours and pass the oral examination concentrated on the thesis. The six thesis credits are considered the secondary concentration.

COURSE DESCRIPTIONS

Mathematics, Statistics and Computer Science (MSCS)

MSCS 5030. Concepts in Geometry and Calculus from an Advanced Standpoint 3 sem. 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. Offered alternate spring terms.
MSCS 5040. Concepts in High School Algebra and Number Theory from an Advanced Standpoint

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. Offered alternate spring terms.

MSCS 5110. Formal Languages and Computability

Regular languages, finite state automata, and formal analysis; context-free languages, push-down automata, parsing, and the rudiments of LL and LR parsers; general phrase-structure languages, Turing machines, the Church-Turing thesis, the halting problem, universal programming languages. Offered alternate years.

MSCS 5120. Abstract Algebra 1

3 sem. 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. Offered fall term.

MSCS 5121. Abstract Algebra 2

3 sem. hrs.
A continuation of MSCS 5120 with emphasis on groups, rings, fields, and modules.

MSCS 5200. Intermediate Analysis 1

3 sem. hrs.
Limits and continuity, differentiability, Riemann integration. Topology of N-dimensional spaces. Offered alternate fall terms.

MSCS 5201. Intermediate Analysis 2

3 sem. hrs.
Transformations of N-spaces, line and surface integrals, sequences and series, uniform convergence.

MSCS 5210. Complex Variables

3 sem. hrs.
Complex numbers, analytic functions, differentiation, series expansion, line integrals, singularities, and residues. Offered alternate spring terms.

MSCS 5300. History of Mathematical Ideas

3 sem. hrs.
Topics include: 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; 20th century problems. Current mathematics research and place of the discovery of non-Euclidean geometry; limit development of geometry including the effects (need for irrational and complex numbers); Separation axioms, compactness, local compactness and connectedness. Offered alternate spring terms.

MSCS 5350. Theory of Differential Equations

3 sem. hrs.
Existence and uniqueness theorems, linear and non-linear systems, numerical techniques, stability. Offered alternate fall terms.

MSCS 5510. Elementary Partial Differential Equations

3 sem. hrs.
Fourier series, method of separation of variables, eigenfunction expansions, application of eigenfunctions to partial differential equations, Green's functions and transform methods.

MSCS 5540. Numerical Analysis

3 sem. 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. Offered fall term.

MSCS 5600. Fundamentals of Artificial Intelligence

3 sem. hrs.
An introduction to the broad field of artificial intelligence. Topics include: problem solving by searching, knowledge representation, reasoning, planning, decision-making, learning, perception, and language processing. Offered alternate fall terms.

MSCS 5610. Data Mining

3 sem. hrs.
Techniques for extracting and evaluating patterns from large databases. Introduction to knowledge discovery process. Fundamental tasks including classification, prediction, clustering, association analysis, summarization, and discrimination. Basic techniques including decision trees, neural networks, statistics, partitional clustering, and hierarchical clustering. Offered alternate spring terms.

MSCS 5630. Mathematical Modeling and Analysis

3 sem. hrs.
Construction and analysis of mathematical models from biological, behavioral, and physical sciences. Offered spring term.

MSCS 5650. Theory of Optimization

3 sem. 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.

MSCS 5670. Applied Combinatorial Mathematics

3 sem. hrs.
Permutations and combinations, recurrence relations, inclusion and exclusion, Polya's theory of counting, graph theory, transport networks, matching theory.

MSCS 5700. Theory of Probability

3 sem. hrs.
Random variables, distributions, moment generating functions of random variables, various derived probabilistic models and applications.

MSCS 5710. Mathematical Statistics

3 sem. hrs.
Sampling theory and distributions, estimation and hypothesis testing, regression, correlation, analysis of variance, non-parametric methods, Bayesian statistics. Offered alternate spring terms.

MSCS 5715. Computational Statistics

3 sem. hrs.
Analysis of raw data and selection of appropriate estimation and hypothesis testing techniques. Emphasis on exploratory analysis, model building, data transformations, multivariate and stepwise techniques, error analysis. Extensive use of statistical computer packages.

MSCS 5720. Statistical Methods

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

MSCS 5740. Biostatistical Methods and Models

3 sem. 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. Offered fall term.

MSCS 5760. Time Series Analysis

3 sem. hrs.

MSCS 5780. Regression Analysis

3 sem. 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. Offered alternate spring terms.

MSCS 5800. Principles of Database Systems

3 sem. hrs.
Topics include: database concepts and architecture, data modeling, formal query languages such as relational algebra, commercial query language SQL, database access from application programs and a brief examination of advanced concepts including transactions, distributed databases, security and XML.

MSCS 5860. Component-Based Software Construction

3 sem. hrs.
Introduction to software components in the context of the object-oriented paradigm. Component development, component selection and adaptation/customization, component deployment and assembly/integration, and system architecture. Industry standards such as JavaBeans, CORBA Component Model, and Microsoft COM/DCOM/COM+. Offered fall term.

MSCS 5931. Topics in Mathematics, Statistics and Computer Science

1-3 sem. hrs.
Topics selected from one of the various branches of mathematics, statistics or computer science. Specific topics to be announced in the Schedule of Classes.
MSCS 6010. Probability 3 sem. hrs.
Foundations of probability for modeling random processes. 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. Offered annually. Prereq: Three semesters of mathematics beyond calculus.

MSCS 6020. Simulation 3 sem. hrs.

MSCS 6030. Applied Mathematical Analysis 3 sem. 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. Offered annually. Prereq: Multivariable calculus and linear algebra.

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

MSCS 6050. Elements of Software Development 3 sem. hrs.
Students explore the software design and development processes through a term project. Concepts covered include: requirements gathering and analysis, mapping requirements to a design, sound coding and documentation practices, configuration management, testing and quality assurance, system deployment and maintenance. Offered annually. Prereq: Programming in a high-level language, knowledge in data structures such as stacks, recursion, queues, trees and graphs.

MSCS 6060. Parallel and Distributed Systems 3 sem. hrs.
Students use and develop software for parallel and distributed computing systems. Topics include: job submission and management, tools for parallel and distributed software development, approaches for implementing parallel and distributed computation, parallel and distributed system architectures, and essential evaluation techniques. Offered annually. Prereq: Data Structures and Algorithms 2 or equiv.

MSCS 6090. Research Methods/Professional Development 1 sem. hr.
Designed to introduce the process of research and communication of research in the computational sciences, including presentation and publication of research, preparation of grant proposals, and ethical considerations. May be repeated. Offered annually.

Applied discrete mathematics for the mathematician, engineer, 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. Offered alternate years. Prereq: COSC 1020 and MATH 1450 or equiv.; MATH 1451 and MATH 2100 or equiv.

MSCS 6120. Optimization 3 sem. hrs.

MSCS 6130. Dynamical Systems 3 sem. hrs.
Theory of discrete and continuous dynamical systems. Periodic solutions, bifurcations, chaotic systems, attractors, fractal dimension, and simulation of these systems. Offered alternate years. Prereq: MATH 5200 or equiv.

Brief review of sampling distributions, Central Limit Theorem and Law of Large Numbers. Estimation, testing hypotheses, regression and correlation analysis, non-parametric methods. Offered alternate years.

MSCS 6220. Analysis of Variance and Covariance 3 sem. 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 5710.

MSCS 6310. Computer Networks 1 3 sem. hrs.
An intensive study of computer networking and networking standards with hands-on experience. Following the ISO-DIS model, the first term concentrates on the lower four layers (physical, datalink, networking, and transport) and the second on the upper four (transport, session, presentation, and application). Offered regularly. Prereq: COSC 3250.

MSCS 6320. Computer Networks 2 3 sem. hrs.
See MSCS 6310. Prereq: COSC 3250.

MSCS 6330. Data Mining 3 sem. hrs.
Techniques for extracting “interesting” relationships and knowledge hidden in data, such as decision trees, association rules, clustering, neural networks, Bayesian classifiers, feature selection, pattern assessment, inductive logic programming, outlier analysis, data imputation, and data integration. Prereq: COSC 2100 and COSC 5800 or COSC 2100 and COSC 5800; or COSC 2100 and MATH 5720; or equiv.

MSCS 6340. Component Architecture 3 sem. hrs.
Focuses on designing and implementing software components, and ways of specifying their interconnection and interaction. The primary technology is Java Beans, although other approaches such as ActiveX are also considered. Examines general notions relating to specifying and identifying components and the general distribution of resources.

MSCS 6350. Distributed Computing 3 sem. hrs.
Focuses primarily on the interconnection of software components, both in the way they communicate with one another, and in the way they are themselves distributed. The concentration is not as much on the technical detail of standards such as Corba, Java RMI, and Distributed Network Architecture, but on the ways these technologies can be used to construct dynamic infrastructures for welding diverse local environments into one community of cooperating parts. The emphasis is very much upon allowing heterogeneity, and on solving business problems related to distributed concentrations of data.

MSCS 6355. Mobile Computing 3 sem. hrs.
Focuses on the fundamentals of mobile computing, challenges in mobile computing, mobility management, mobile data management, context awareness and wireless communications, ubiquity of wireless communication technologies and standards, seamless access network services and resources from anywhere, at anytime, middleware for mobile computing, operation systems, programming languages, network protocols and security aspects of mobile computing, concepts in sensor networks, including operating systems, programming languages, network protocols, and programming models. Prereq: COSC 2100 or equiv.

MSCS 6360. Enterprise Architecture 3 sem. hrs.
Focuses totally on the server side of communications, and on the ways of using software components as wrappers of all kinds of objects, so they can participate in highly distributed environments involving security and transactions. Attention is paid to establishing universal environments for naming and finding them, and to ways of managing the life cycle of both data and program components. The main technology considered is Enterprise Java Beans.

MSCS 6370. Information Representation 3 sem. hrs.
Focuses on using special grammars and their associated language for communicating business information universally amongst very diverse systems. The attention is not on the formalities of the grammars, but on the ways one can take advantage of knowing that documents are valid with respect to those grammars. The particular technology primarily considered is XML, and considers and uses many current standards from the XML community. Offered regularly.

MSCS 6380. Advanced Database Systems 3 sem. hrs.
Accessing databases from Web, JavaScript, JDBC, Java Servlets, database technology to Web related areas such as semi-structured databases and data integration, XML, XQuery, XPath, XML Schemas, distributed database design, distributed database transactions, and distributed query processing. Prereq: Database Systems or equiv.
MSCS 6390. Professional Seminar in Computing 1 sem. hr.
Topic to be chosen each term from among issues important to all professionals in computing. All students in the computing program are expected to participate for the fall and spring terms, and one of the two summer terms. Offered every term. S/U grade assessment.
Prereq: Enrolled in M.S. in computing program.

MSCS 6410. Real Analysis 3 sem. hrs.
Involves study of algebraic structures of real analysis, function spaces, introduction to linear operators, measure and integration theory, convergence theorems, limits, continuity, derivatives. Offered alternate years. Prereq: MATH 5200.

MSCS 6420. Algebra 3 sem. 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, classical groups. Offered alternate years. Prereq: MATH 5120 or equiv.

MSCS 6430. Logic and Set Theory 3 sem. hrs.
Naïve set theory, first-order logic, elementary model theory, non-standard analysis, Gödel’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 5120 or equiv.

MSCS 6440. Topology 3 sem. 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 5200 or equiv.

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. Title and content vary.

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. Offered occasionally. Prereq: MSCS 6952. For students in MSST or College of Education.

MSCS 6956. Seminar in Mathematics, Statistics and Computer Science 1-3 sem. 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. Offered occasionally. Prereq: MSCS 6952. For students in MSST or College of Education.

MSCS 6956. Seminar in Mathematics, Statistics and Computer Science 1-3 sem. hrs.

MSCS 6974. Practicum for Research in Computational Sciences 1-3 sem. hrs.
Offered every term. S/U grade assessment.
Prereq: 3.00 MU GPA; must be enrolled in Plan B option of the M.S. in computing program and have completed at least 21 credit hours of course work with 15 credit hours earned in graduate (6000-level) courses. Available only to full-time students.

MSCS 6995. Master’s Thesis: Full-Time 0 sem. hrs.
Fee. SNC/UNC grade assessment.
Prereq: Cons. of dept. ch.

MSCS 6996. Master’s Thesis: Half-Time 0 sem. hrs.
Fee. SNC/UNC grade assessment.
Prereq: Cons. of dept. ch.

MSCS 6997. Master’s Thesis: Full-Time 0 sem. hrs.
Fee. SNC/UNC grade assessment.
Prereq: Cons. of dept. ch.

MSCS 6999. Doctoral Dissertation Continuation: Less than Half-Time 0 sem. hrs.
Fee. SNC/UNC grade assessment.
Prereq: Cons. of dept. ch.

Fee. SNC/UNC grade assessment.
Prereq: Cons. of dept. ch.

MSCS 9998. Doctoral Dissertation Continuation: Full-Time 0 sem. hrs.
Fee. SNC/UNC grade assessment.
Prereq: Cons. of dept. ch.

MSCS 9999. Doctoral Dissertation Continuation: Less than Half-Time 0 sem. hrs.
Fee. SNC/UNC grade assessment.
Prereq: Cons. of dept. ch.

Fee. SNC/UNC grade assessment.
Prereq: Cons. of dept. ch.

MSCS 9998. Doctoral Dissertation Continuation: Full-Time 0 sem. hrs.
Fee. SNC/UNC grade assessment.
Prereq: Cons. of dept. ch.

MSCS 9999. Doctoral Dissertation Continuation: Less than Half-Time 0 sem. hrs.
Fee. SNC/UNC grade assessment.
Prereq: Cons. of dept. ch.

Bioinformatics (BIIN)

BIIN 6000. Introduction to Bioinformatics 3 sem. hrs.
The application of knowledge gained through previous course work in informatics, information systems, mathematics, medical and/or biological research to the design, development, implementation and evaluation of information systems and analysis methods applied to biomedical data. Prereq: BIOL 1004 and CHEM 2112 which may be taken concurrently; and COSC 2100, and cons. of dept. ch.

BIIN 6005. Bioinformatics 2 3 sem. hrs.
The application of knowledge gained through previous course work in informatics, information systems, mathematics, medical and/or biological research to the design, development, implementation and evaluation of information systems and analysis methods applied to biomedical data. Prereq: BIIN 6000.
BIIN 6931. Topics in Bioinformatics 3 sem. hrs. 
Prereq: Cons. of dept. ch.

BIIN 6947. Medical College of Wisconsin/ 
BIIN-Joint Degree 1-8 sem. hrs. 
Graduate-level course in selected areas of the life sciences offered at Medical College of Wisconsin. 
Prereq: Cons. of dept. ch.

BIIN 6960. Seminar in Bioinformatics 
1-3 sem. hrs. 
Seminars in research and development tools and applications designed for M.S. in bioinformatics program.

BIIN 6980. Practicum in Bioinformatics 
3 sem. hrs. 
An opportunity to participate in the practice of research and/or development in the area of bioinformatics. 
Prereq: Admitted to BIIN program; BIIN 6000; and cons. of dept. ch.

BIIN 6995. Independent Study in Bioinformatics 1-3 sem. hrs. 
Prereq: Admitted to BIIN program; cons. of dept. ch.

BIIN 6999. Master’s Thesis 1-6 sem. hrs. 
S/U grade assessment. 
Prereq: Cons. of dept. ch.

MECHANICAL ENGINEERING (MEEN)
Chairperson and Professor: Kim
Associate Chairperson, Director of Undergraduate Studies and Professor: Fournelle
Director of Graduate Studies and Associate Professor: Rice
Professor: Blumenthal (Emeritus), Brebrick (Emeritus), Brower (Emeritus), Cartz (Emeritus), Craig, Harris, Heinrich, Marklin, Matar (Emeritus), Ngo (Emeritus), Reid (Emeritus), Schimmels, Seitz (Emeritus), Stango, Widera
Assistant Professor: Borg, Cariapa, Domblesky, Jensen, Nagurka, Silver-Thorn, Weber
Assistant Professor: Goldsborough, Koch, Voglweide
Adjunct Professor: Bishop, Janc, Stolp
Adjunct Associate Professor: Hoffman, Shana, Toth
Research Professor: Gaggioli (Emeritus)
Research Associate Professor: Park
Research Assistant Professor: Bowman, Huang
Note: Faculty members and their ranks are for the 2009–2010 academic year.

DEGREES OFFERED
Master of Science, students are admitted under Plan A (thesis option) but Plan B (non-thesis option) is also offered; Doctor of Philosophy

MISSION STATEMENT
In embracing the missions of the university and the College of Engineering, it is the mission of the Department of Mechanical Engineering to offer high quality, up-to-date, nationally-recognized engineering programs that prepare students for successful careers. This success is marked by the graduates’ commitment to lifelong learning, a deep concern for the impact of their work on others, research that advances technical and scientific knowledge, and service to professional and civic communities. The department also strives to develop students and faculty who will be recognized as exceptional in their pursuit of excellence, sense of community, spirit of collaboration, and ability to define problems and accomplish goals.

SPECIALIZATIONS
Energy Systems, Manufacturing Systems, Mechanical Systems

PROGRAM DESCRIPTION
The Department of Mechanical Engineering offers a master’s and a doctoral program in mechanical engineering.

Course work and research in the mechanical engineering program may involve the broad fundamentals of mechanical engineering or may concentrate on one or more of the following fields: energy systems, manufacturing systems, and mechanical systems. In these fields, engineering principles are applied not only to traditional equipment and methods but also to modern and emerging technologies. Typically, the engineering course work and research are augmented by laboratory studies. Although the study of advanced engineering mathematics and, often, basic science is necessary in all programs of study, the selection of subjects may vary depending upon the field of specialization and the student’s professional objectives.

ENERGY SYSTEMS
A concentration in energy systems typically entails advanced study of a) thermodynamics, fluid mechanics, heat and mass transfer, and combustion; b) the application of these principles to phenomena and devices which constitute energy-conversion systems; and c) the analysis, simulation, and design of such systems as well as plants; e.g., chemical, metallurgical, food, etc., which are energy-intensive. Current research topics include: plant optimization, fuel cells, cogeneration systems, fluid mechanics and heat transfer in surface mount technology, engine emissions/process effluents, and jet engine propulsion systems.

MANUFACTURING SYSTEMS
A concentration in manufacturing systems engineering allows students to focus on a broad range of topics. These topics range from micro issues, such as material-related issues and cutting mechanics in material removal processes, to macro analysis of complex manufacturing systems from either a process or ergonomics perspective. The focus of this concentration may be computer integrated manufacturing, material processing, mechanical behavior of materials, manufacturing processes, quality systems, or ergonomics within manufacturing. Normally, each of these multi-disciplinary areas requires certain core courses along with specialized studies, which may include advanced courses in other engineering disciplines, courses in mathematics and statistics, and/or courses in business administration. Current research topics include: cellular manufacturing, polishing and mass finishing processes, rapid prototyping, robotic systems, production integration (IFT, TQC, CIM), ergonomics of assembly operations, reliability/quality estimation, human performance and safety evaluation, and materials forming and joining processes.

MECHANICAL SYSTEMS
A concentration in mechanical systems typically entails advanced study of a) mechanical system design and analysis and b) modeling, simulation, and control. Mechanical design and analysis focuses on the use of physical and mathematical principles to understand the behavior of mechanical systems. It includes computer-aided design engineering, such as the design of multi-body, multi-degree-of-freedom mechanical systems. Modeling, simulation, and control involve the study of theoretical mechanics in conjunction with computational applications including advanced dynamics, kinematics, and stress analysis. Other applications include the modeling and control of manufacturing processes, including robotics and automated deformation processing. Current research areas include: surface mount technology, composite and polymeric materials, control in automated assembly, surface finishing processes, design of compliant machine tools, metal cutting/forming mechanics, finite element methods, and pressure vessels comprised of multi-layered composites.

PREREQUISITES FOR ADMISSION
Admission to the program requires 24 semester hours of college-level study and a minimum of the following courses: mathematics, physics, chemistry or another suitable science course. Applicants are encouraged to have completed a college-level mathematics course, specifically differential equations. Students who have not had an adequate background in these areas should plan to take appropriate remedial courses early in their graduate program.

APPLICATION REQUIREMENTS
Applicants must submit, directly to the Graduate School:
1. A completed online application form and fee.
2. Official transcripts from all current and previous colleges/universities except Marquette.
3. Three letters of recommendation.
4. (For doctoral applicants only) a brief statement of purpose and copies of any published work, including master’s theses and essays.
5. (For international applicants only) a TOEFL score or other acceptable proof of English proficiency.
6. GRE scores (General Test only). Waived if applicant has an undergraduate degree from Marquette with GPA of 3.00 or above.

BACHELOR’S–MASTER’S PROGRAM
This program enables students to earn both their master of science degree in mechanical engineering and a bachelor of science degree from the College of Engineering in the span of five years. Only the thesis option is available with this program. Qualified students (3.500/4.000 GPA) who are enrolled in the Mechanical Engineering Department at Marquette University may apply for admission to this program during their undergraduate junior year. Students must submit an application to the Graduate School, indicate their interest in the five year program, and meet all other admission criteria as stated in the Application Requirements section. (GRE test scores are not required.)

Students select graduate level courses in their senior undergraduate year as their electives; these elective courses double-count toward the undergraduate and graduate degrees. However, only a maximum of 6 credit hours will apply toward the graduate degree. Upon completion of the first term as a master’s candidate, the student must petition the Graduate School to transfer courses taken as an undergraduate to the master’s degree.

Students begin their research for the thesis the summer between their junior and senior years. Their research is continued the summer between their senior and fifth years and throughout their fifth year, culminating in the preparation of a written thesis and defense.

MASTER’S REQUIREMENTS
A master’s student may pursue a thesis program (Plan A) or a non-thesis program (Plan B). However, students who intend to continue for the doctoral