MATHEMATICAL SCIENCES (MATH)

MATH 90 Basic Mathematics
0 cr. Undergraduate.
Arithmetic operations involving whole numbers, integers, positive and negative rational numbers; decimals, percents; ratio, proportion; radicals; descriptive statistics; units of measure; geometry; introduction to algebra.
Prerequisites: none.
Course Rules: Fee for 3 cr assessed; credits count toward credit load for Financial Aid and enrollment verification only. Not open to students eligible for math courses that carry graduation credit.
Current Offerings: http://uwm.edu/schedule

MATH 92 Mathematical Literacy for College Students I
0 cr. Undergraduate.
Introduction to numeracy, proportional reasoning, algebraic reasoning, and functions. Emphasis on developing conceptual and procedural tools that support the use of key mathematical concepts in context.
Prerequisites: none.
Course Rules: Fee for 3 cr assessed; counts as 3 cr toward cr load for Financial Aid & enrollment verification. Not recommended for students planning to take Calculus or Chem 100.
Current Offerings: http://uwm.edu/schedule

MATH 94 Foundations of Elementary Mathematics
0 cr. Undergraduate.
Arithmetic, geometry, and beginning algebra; develops mathematical reasoning, problem solving, and facility with basic mathematical objects and their relationships. Individualized instruction via adaptive learning software.
Prerequisites: none.
Course Rules: Fee for 6 cr assessed; credits count toward credit load for Financial Aid and enrollment verification only. Math 94 counts as repeat of Math 90 & 95.
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 95 Essentials of Algebra
0 cr. Undergraduate.
Number systems; linear equations, inequalities; exponent notation, radicals; polynomials, operations, factoring, rational expressions; coordinate geometry; linear systems; quadratic equations.
Prerequisites: math placement level 10, which is earned by any of the following: (a) Level 10 on Math Placement Test; (b) grade of C or better in Math 090; or (c) grade of D in Math 094.
Course Rules: Fee for 3 cr assessed; credits count toward credit load for Financial Aid and enrollment verification only.
Last Taught: Fall 2017, Summer 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 98 Algebraic Literacy I
0 cr. Undergraduate.
Arithmetic number systems; linear equations, inequalities; exponent notation, radicals; polynomials, operations, factoring; modeling; coordinate geometry; linear systems; quadratic equations. Fee for 3 cr assessed; counts as 3 cr toward credit load for Fin Aid & enrollment verification only.
Prerequisites: math placement level 10, which is earned by any of the following: (a) Level 10 on Math Placement Test; (b) grade of C or better in Math 090; or (c) grade of D in Math 094.
Current Offerings: http://uwm.edu/schedule

MATH 102 Mathematical Literacy for College Students II
3 cr. Undergraduate.
Continuation of Math 92, with an integrated approach to numeracy, proportional reasoning, algebraic reasoning, and functions.
Prerequisites: Grade of C or better in Math 92(P) or (C).
General Education Requirements: MTH
Current Offerings: http://uwm.edu/schedule

MATH 102X Mathematical Literacy for College Students II
3 cr. Undergraduate.
Continuation of Math 92, with an integrated approach to numeracy, proportional reasoning, algebraic reasoning, and functions.
Prerequisites: Grade of C or better in Math 92(P) or (C).
General Education Requirements: MTH
Current Offerings: http://uwm.edu/schedule

MATH 103 Contemporary Applications of Mathematics
3 cr. Undergraduate.
Logical inference, probability and statistical inference, geometric growth, with selected topics such as linear programming, patterns, binary codes.
Prerequisites: ACT math subscore of 18 or higher or Math Placement Level 20, which is earned by any of the following: (a) Level 10 on Math Placement Test; (b) Grade of C or better in Math 090; or (c) Grade of D in Math 094.
Course Rules: Not recom for students planning to take Calculus or Chem 100.
General Education Requirements: MTH
Current Offerings: http://uwm.edu/schedule

MATH 105 Introduction to College Algebra
3 cr. Undergraduate.
Algebraic techniques with polynomials, rational expressions, equations and inequalities, exponential and logarithmic functions, rational exponents, systems of linear equations.
Prerequisites: Math Placement Level 20, which is earned by any of the following: (a) Level 20 or 26 on Math Placement Test; (b) Grade of C or better in Math 094, 095, or 098; or (c) ACT math subscore of 24 or higher.
Course Rules: Not open for cr to students who have cr in Math 108(ER).
General Education Requirements: MTH
Current Offerings: http://uwm.edu/schedule
MATH 108 Algebraic Literacy II
3 cr. Undergraduate.
Continuation of Math 98 in polynomials, equations, and inequalities; exponential, logarithmic, and periodic functions; rational expressions and exponents; and systems of linear equations.
Prerequisites: C or better Math 98.
Course Rules: Not open for credit for students who have cr in Math 105(ER).
General Education Requirements: MTH
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 111 Introduction to Logic - Critical Reasoning
3 cr. Undergraduate.
Students learn a broad variety of fundamental logical methods - techniques used to identify, analyze, model, evaluate, and criticize different types of real-world reasoning.
Prerequisites: ACT math subscore of 18 or higher, or Math Placement Level 10, which is earned by any of the following: (a) Level 10 on Math Placement Test; (b) grade of C or better in Math 090; or (c) grade of D in Math 094.
Course Rules: Jointly offered w/ Philos 111; they count as repeats of one another.
General Education Requirements: HU
Current Offerings: http://uwm.edu/schedule

MATH 115 Precalculus
4 cr. Undergraduate.
Essential topics from college algebra and trigonometry for students intending to enroll in calculus.
Prerequisites: Math Placement Level 30, which is earned by any of the following: (a) Level 30, 35, or 36 on Math Placement Test; (b) grade of C or better in Math 105, 108, or 116; (c) score of 5 or higher on the IB Mathematical Studies - SL; (d) score of 3 or higher on the AP statistics exam; or (e) score of 63 or higher on the CLEP College Algebra Exam.
Course Rules: Repeats 2 cr of Math 115 & 2 cr of Math 117.
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 116 College Algebra
3 cr. Undergraduate.
Prerequisites: Math Placement Level 20, which is earned by any of the following: (a) Level 20 or 26 on Math Placement Test; (b) Grade of C or better in Math 094, 095, or 098; (c) ACT math subscore of 24 or higher.
Course Rules: 2 cr may be used to repeat 2 cr of Math 115.
General Education Requirements: MTH
Current Offerings: http://uwm.edu/schedule

MATH 117 Trigonometry
2 cr. Undergraduate.
Trigonometric functions; graphs, identities, equations, inequalities; inverse trigonometric functions; solutions of triangles with applications; complex numbers; polar coordinates.
Prerequisites: Math Placement Level 30, which is earned by any of the following: (a) Level 30, 35, or 36 on Math Placement Test; (b) grade of C or better in Math 105, 108, or 116; (c) score of 5 or higher on the IB Mathematical Studies - SL; (d) score of 3 or higher on the AP statistics exam; or (e) score of 63 or higher on the CLEP College Algebra Exam.
Course Rules: Repeats 2 cr of Math 115.
Current Offerings: http://uwm.edu/schedule

MATH 175 Mathematical Explorations for Elementary Teachers I
3 cr. Undergraduate.
Theory of arithmetic of whole numbers, fractions, and decimals. Introduction to algebra, estimation and problem-solving strategies.
Prerequisites: Registration in elementary, early childhood, or exceptional educ curriculum; either a grade of C or better in Math 102 or 103, or Math Placement Level at least 20, which is earned by any of the following: (a) Level 20 or 26 on Math Placement Test; (b) Grade of C or better in Math 094, 095, 098; (c) ACT math subscore of 24 or higher.
General Education Requirements: MTH
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 176 Mathematical Explorations for Elementary Teachers II
3 cr. Undergraduate.
A continuation of Math 175 in geometry, statistics, and probability.
Prerequisites: grade of C or better in Math 175(P).
General Education Requirements: QLB
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 194 First-Year Seminar
3 cr. Undergraduate.
Specific topics are announced in the Schedule of Classes each time the class is offered.
Prerequisites: none.
Course Rules: Open only to freshmen. Students may earn cr in just one L&S First-Year Sem (course numbers 192, 193, 194).
General Education Requirements: NS
Current Offerings: http://uwm.edu/schedule

MATH 199 Independent Study
1-3 cr. Undergraduate.
Regularly offered courses may not be taken as Independent Study.
Prerequisites: 2.5 gpa in all previous math courses; writ cons instr, dept chair & asst dean for SAS.
Course Rules: May be retaken w/chg in topic to 9 cr max.
Current Offerings: http://uwm.edu/schedule
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<th>Course Code</th>
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<td>MATH 205</td>
<td>Introductory Finite Mathematics</td>
<td>3 cr. Undergraduate</td>
<td>Elements of mathematical logic, structures in sets; partitions and counting; probability theory, stochastic processes.</td>
<td>NS, QLB</td>
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<td>MATH 211</td>
<td>Survey in Calculus and Analytic Geometry</td>
<td>4 cr. Undergraduate</td>
<td>A one-semester survey with applications to business administration, economics, and non-physical sciences. Topics include coordinate systems, equations of curves, limits, differentiation, integration, applications.</td>
<td>QLB, NS</td>
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<tr>
<td>MATH 213</td>
<td>Calculus with Life Sciences Applications</td>
<td>4 cr. Undergraduate</td>
<td>Limits, derivatives, graphing. Antiderivatives, the definite integral, and the fundamental theorem of calculus. Additional techniques and applications pertinent to the life sciences throughout the course.</td>
<td>NS, QLB</td>
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<tr>
<td>MATH 221</td>
<td>Honors Calculus I</td>
<td>5 cr. Undergraduate</td>
<td>Calculus of functions of one and several variables; sequences, series, differentiation, integration; introduction to differential equations; vectors and vector functions; applications.</td>
<td>QLB, NS</td>
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<tr>
<td>MATH 222</td>
<td>Honors Calculus II</td>
<td>5 cr. Undergraduate</td>
<td>Continuation of Math 221.</td>
<td>QLB, NS</td>
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<tr>
<td>MATH 231</td>
<td>Calculus and Analytic Geometry I</td>
<td>4 cr. Undergraduate</td>
<td>Limits, derivatives, and graphs of algebraic, trigonometric, exponential, and logarithmic functions; antiderivatives, the definite integral, and the fundamental theorem of calculus, with applications.</td>
<td>NS, QLB</td>
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<tr>
<td>MATH 232</td>
<td>Calculus and Analytic Geometry II</td>
<td>4 cr. Undergraduate</td>
<td>Continuation of Math 231. Applications of integration, techniques of integration; infinite sequences and series; parametric equations, conic sections, and polar coordinates.</td>
<td>NS, QLB</td>
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Note: Prerequisites and General Education Requirements vary depending on the course.
**MATH 233 Calculus and Analytic Geometry III**
4 cr. Undergraduate.
Continuation of Math 232. Three-dimensional analytic geometry and vectors; partial derivatives; multiple integrals; vector calculus, with applications.

**Prerequisites:** grade of C or better in Math 232(P).

**Course Rules:** Counts as repeat of Math 229.

**Last Taught:** Summer 2018, Spring 2018, Fall 2017, Summer 2017.

**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

**MATH 234 Linear Algebra and Differential Equations**
4 cr. Undergraduate.
Elementary differential equations. Vectors; matrices; linear transformations; quadratic forms; eigenvalues; applications.

**Prerequisites:** grade of C or better in Math 232(P).

**Last Taught:** Summer 2018, Spring 2018, Fall 2017, Summer 2017.

**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

**MATH 240 Matrices and Applications**
3 cr. Undergraduate.
Vectors, vector spaces, systems of linear equations, matrices, determinants, linear transformations, diagonalization, eigenvalues, eigenvectors; selected topics from quadratic forms, difference equations, numerical methods, and applications.

**Prerequisites:** Grade at least C in a Math or MthStat course numbered 200 or higher OR Math Placement Level 40, earned by any of: Level 40 Math Placement Test; grade at least C in Math 116 & 117; grade at least C in Math 211 & 117; grade at least C in Math 116 & Level 36 Math Placement Test; grade at least C in Math 211 & Level 36 Math Placement Test; grade at least C in Math 117 & Level 35 Math Placement Test; at least 61 on CLEP Precalculus exam.

**Last Taught:** Spring 2018, Fall 2017, Spring 2017, Fall 2016.

**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

**MATH 275 Problem Solving/Critical Thinking for Elementary Education Majors**
3 cr. Undergraduate.
Course provides a strong foundation in the exploration, teaching and communication (oral and written) of mathematical concepts via problem-solving experiences and discussion.

**Prerequisites:** grade of C or better in Math 175(P) or cons instr.

**Last Taught:** Spring 2018, Spring 2017, Spring 2016, Spring 2015.

**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

**MATH 276 Algebraic Structures for Elementary Education Majors**
3 cr. Undergraduate.
Topics for K-8 teachers. Basic patterns and rules that govern number systems, geometric transformations, and manipulation of algebraic expressions.

**Prerequisites:** grade of C or better in Math 175(P) or cons instr.

**Course Rules:** Counts as repeat of Math 299 w/same topic.

**Last Taught:** Spring 2018, Spring 2017, Spring 2016, Spring 2015.

**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

**MATH 277 Geometry for Elementary Education Majors**
3 cr. Undergraduate.
Topics for K-8 teachers. Geometry as measuring tool-congruence, similarity, area, volume, and coordinates; geometry as axiomatic system-definitions, conjectures, proofs, counterexamples; rigid motions, symmetry.

**Prerequisites:** grade of C or better in Math 176(P) or cons instr.

**Last Taught:** Fall 2017, Fall 2016, Fall 2015, Fall 2014.

**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

**MATH 278 Discrete Probability and Statistics for Elementary Education Majors**
3 cr. Undergraduate.
Random experiments; histograms; sample spaces; equally likely outcomes for random experiments; permutations; combinations; binomial, geometric, hypergeometric distributions; expectation; conditional probabilities; max likelihood estimation & inference.

**Prerequisites:** grade of C or better in Math 176(P) or cons instr.

**Course Rules:** Math 278 and MthStat 278 are jointly offered; they count as repeats of one another.

**Last Taught:** Fall 2017, Fall 2016, Fall 2015, Fall 2014.

**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

**MATH 290 Topics in Mathematics:**
3 cr. Undergraduate.
Specific topics and any additional prerequisites announced in Schedule of Classes each time course is offered.

**Prerequisites:** satisfaction of Quantitative Literacy Part A GER.

**Course Rules:** May be retaken w/chg in topic to 9 cr max.

**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

**MATH 297 Study Abroad:**
1-12 cr. Undergraduate.
Designed to enroll students in UWM sponsored programs before course work level, content and credits are determined and/or in specially prepared program course work.

**Prerequisites:** acceptance for Study Abroad Prog.

**Course Rules:** May be retaken w/chg in topic.

**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

**MATH 299 Ad Hoc:**
1-6 cr. Undergraduate.
Course created expressly for offering in a specified enrollment period. Requires only dept & assoc dean approval. In exceptional circumstances, can be offered in one add'l sem.

**Prerequisites:** none; add'l prereqs may be assigned to specific topic.

**Course Rules:** May be retaken w/chg in topic.

**Last Taught:** Spring 2012, Summer 2007, Spring 2007, Summer 2006.

**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)
MATH 305 Introduction to Mathematical and Computational Modeling
3 cr. Undergraduate/Graduate.
Construction and analysis of discrete and continuous mathematical models in applied, natural, and social sciences. Elements of programming, simulations, case studies from scientific literature.
Prerequisites: jr st, grade of C or better in Math 211(P) & one addl 200-level or higher Math or MthStat course, or grade of B or better in Math 213(P), or grade of C or better in Math 231(P), or cons instr.
Course Rules: Counts as repeat of Math 690(675) w/topic Adv Math Models with Apps.
Current Offerings: http://uwm.edu/schedule

MATH 311 Theory of Interest
4 cr. Undergraduate.
Prerequisites: grade of C or better in Math 232(P).
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 313 Linear Programming and Optimization
3 cr. Undergraduate/Graduate.
Primal and dual formulations of linear programming problems; simplex and related methods of solution; algorithms for transportation; optimization.
Prerequisites: jr st, grade of C or better in Math/ElemEng 234(P) or Math 240(P); or grad st.
Last Taught: Fall 2016, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATH 313G Linear Programming and Optimization
3 cr. Undergraduate/Graduate.
Primal and dual formulations of linear programming problems; simplex and related methods of solution; algorithms for transportation; optimization.
Prerequisites: jr st, grade of C or better in Math/ElemEng 234(P) or Math 240(P); or grad st.
Last Taught: Fall 2016, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATH 315 Mathematical Programming and Optimization
3 cr. Undergraduate/Graduate.
Introduction to operations research. Network analysis; integer programming; game theory; nonlinear programming; dynamic programming.
Prerequisites: jr st, grade of C or better in either Math 234(P) or 240(P), & grade of C or better in either Math 211(P) or 233(P); or cons instr; or grad st.
Current Offerings: http://uwm.edu/schedule

MATH 318 Topics in Discrete Mathematics
3 cr. Undergraduate.
Number theory topics related to cryptography; discrete structures including graphs, partial orders, Latin squares and block designs; advanced counting techniques.
Prerequisites: a grade of C or better in CompSci 317(P) or Math 341(P).
Course Rules: Jointly offered with & count as repeat of CompSci 318.
Current Offerings: http://uwm.edu/schedule

MATH 320 Introduction to Differential Equations
3 cr. Undergraduate/Graduate.
Elementary types and systems of differential equations, series solutions, numerical methods, Laplace transforms, selected applications.
Prerequisites: jr st, grade of C or better in both Math 232(P) & 240(P), or grade of C or better in Math/ElecEng 234(P); or grad st.
Course Rules: No grad cr in Math Sci.
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATH 321 Vector Analysis
3 cr. Undergraduate/Graduate.
Topics selected from vector algebra; scalar and vector fields; line, surface, and volume integrals; theorems of Green, Gauss, and Stokes; vector differential calculus.
Prerequisites: jr st, grade of C or better in Math 233(P); or grad st.
Current Offerings: http://uwm.edu/schedule

MATH 322 Introduction to Partial Differential Equations
3 cr. Undergraduate/Graduate.
Partial differential equations of mathematical physics, boundary value problems in heat flow, vibrations, potentials, etc. Solved by Fourier series; Bessel functions and Legendre polynomials.
Prerequisites: jr st, Math 320(P), & grade of C or better in Math 233(P); or grad st.
Current Offerings: http://uwm.edu/schedule

MATH 341 Seminar: Introduction to the Language and Practice of Mathematics
3 cr. Undergraduate.
Facility with mathematical language and method of conjecture, proof and counter example, with emphasis on proofs. Topics: logic, sets, functions and others.
Prerequisites: Math Placement Level 40, which is earned by any of the following: (a) Level 40 on Math Placement Test; (b) grade of C or better in Math 115; (c) grade of C or better in both Math 116 and Math 117; (d) grade of C or better in both Math 211 and Math 117; (e) grade of C or better in Math 116 and Level 36 on Math Placement Test; (f) grade of C or better in Math 211 and Level 36 on Math Placement Test; (g) grade of C or better in Math 117 and Level 35 on Math Placement Test; or (h) score of 61 or higher on the CLEP Precalculus Exam.
Current Offerings: http://uwm.edu/schedule

MATH 345 Mathematics from a Historical Perspective:
3 cr. Undergraduate.
Topics from the development of mathematics, such as famous problems, mathematicians, calculating devices; chronological outlines. Significant reading and writing assignments.
Prerequisites: Math Placement Level 40, which is earned by any of the following: (a) Level 40 on Math Placement Test; (b) grade of C or better in Math 115; (c) grade of C or better in both Math 116 and Math 117; (d) grade of C or better in both Math 211 and Math 117; (e) grade of C or better in Math 116 and Level 36 on Math Placement Test; (f) grade of C or better in Math 211 and Level 36 on Math Placement Test; (g) grade of C or better in Math 117 and Level 35 on Math Placement Test; or (h) score of 61 or higher on the CLEP Precalculus Exam.
Current Offerings: http://uwm.edu/schedule
MATH 371 Introduction to Stochastic Models in Finance
3 cr. Undergraduate/Graduate.
Elementary modeling of financial instruments for students in mathematics, economics, business, etc. Statistical and stochastic tools leading to the Black-Scholes model. Real data parameter fitting.
Prerequisites: jr st & one of the following pairs; Econ 413(431)(P) & 506(P), Bus Adm 210(P) & 350(P), Bus Adm 701(P) & 702(P), or Math 234(P) & MthStat 361(P), or cons instr; or grad st.
Last Taught: Fall 2001, Fall 2000.
Current Offerings: http://uwm.edu/schedule

MATH 381 Honors Seminar:
3 cr. Undergraduate.
Significant topics to illustrate to non-mathematicians the characteristic features of mathematical thought. Only H.S. algebra and geometry assumed.
Prerequisites: soph st, Honors 200(P); cons Honors College dir.
Course Rules: May be retaken w/chg in topic to 9 cr max. Not open for cr toward a major in Math.
General Education Requirements: NS
Last Taught: Fall 2015, Fall 2013, Spring 2011, Spring 2010.
Current Offerings: http://uwm.edu/schedule

MATH 405 Mathematical Models and Applications
3 cr. Undergraduate/Graduate.
Modeling techniques for analysis and decision-making in social and life sciences and industry. Deterministic and stochastic modeling. Topics may vary with instructors.
Prerequisites: jr st; one of: grade of C or better in Math 211(P), grade of B or better in Math 213(P), or grade of C or better in Math 231(P); & grade of C or better in either Math/ElecEng 234(P) or Math 240(P); or grad st.
Last Taught: Fall 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 405G Mathematical Models and Applications
3 cr. Undergraduate/Graduate.
Modeling techniques for analysis and decision-making in social and life sciences and industry. Deterministic and stochastic modeling. Topics may vary with instructors.
Prerequisites: jr st; one of: grade of C or better in Math 211(P), grade of B or better in Math 213(P), or grade of C or better in Math 231(P); & grade of C or better in either Math/ElecEng 234(P) or Math 240(P); or grad st.
Last Taught: Fall 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 413G Introduction to Numerical Analysis
3 cr. Undergraduate/Graduate.
Root finding and solution of nonlinear systems; direct solution of linear systems; interpolation & approximation of functions; least squares; fast Fourier transform; quadrature.
Prerequisites: jr st, grade of C or better in Math 233(C), & grade of C or better in Math/ElecEng 234(C); or grad st.
Last Taught: Fall 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 415 Introduction to Scientific Computing
3 cr. Undergraduate/Graduate.
Nonlinear systems; iterative solution of linear systems; initial value problems in ordinary differential equations; boundary value problems in ordinary and partial differential equations.
Prerequisites: jr st, grade of C or better in Math 233(C), & grade of C or better in Math/ElecEng 234(C); or grad st.
Current Offerings: http://uwm.edu/schedule

MATH 423 Complex Analysis
3 cr. Undergraduate/Graduate.
Complex numbers; definition and properties of analytic functions of a complex variable; conformal mapping; calculus of residues; applications to mathematics and physics. See also Math 713.
Prerequisites: jr st; grade of C or better in Math 233(P); or grad st.
Last Taught: Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATH 431 Modern Algebra with Applications
3 cr. Undergraduate/Graduate.
Groups, rings, fields, Boolean algebras with emphasis on their applications to computer science and other areas.
Prerequisites: jr st & grade of C or better in Math 232(P); or grad st.
Course Rules: Does not carry grad cr in math sci.
Last Taught: Fall 2014, Fall 2015, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 451 Axiomatic Geometry
3 cr. Undergraduate/Graduate.
An axiomatic approach to Euclidean and non-Euclidean geometry (historic role of the parallel postulate and models).
Prerequisites: jr st, grade of C or better in both Math 341(P) & Math 232(C); or grad st.
Course Rules: Dept cons req'd for grad cr in math sci.
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule
MATH 453 Transformations in Geometry
3 cr. Undergraduate/Graduate.
Selected topics from vector geometry and geometric transformations such as the study of invariants and conics.
**Prerequisites:** jr st, grade of C or better in both Math 341(P) & Math 232(C); or grad st.
**Course Rules:** Recom for secondary school teachers. Dept cons req’d for grad cr in math sci.
**Last Taught:** Summer 2007, Summer 2005, Summer 2003, Summer 2002.
**Current Offerings:** http://uwm.edu/schedule

MATH 489 Internship in Mathematics, Upper Division
1-6 cr. Undergraduate.
Application of advanced principles of mathematics in a business, organizational, educational, governmental, or other appropriate setting.
**Prerequisites:** jr st; 6 cr 300-level or above in math or math stats; 2.5 gpa in the major; cons supervising faculty member.
**Course Rules:** One cr earned for academic work based on 40 hours in internship. May be retaken to 6 cr max.
**Last Taught:** Summer 2018, Spring 2015, Fall 2014, Spring 2009.
**Current Offerings:** http://uwm.edu/schedule

MATH 490 Topics in Mathematics:
3 cr. Undergraduate/Graduate.
Specific topics and any additional prerequisites announced in Schedule of Classes each time course is offered. May be retaken w/chg in topic to 9 cr max.
**Prerequisites:** jr st; grade of C or better in a Math or MthStat course at the 200 level or above; or grad st.
**Current Offerings:** http://uwm.edu/schedule

MATH 497 Study Abroad:
1-12 cr. Undergraduate/Graduate.
Designed to enroll students in UWM sponsored programs before course work level, content and credits are determined and/or in specially prepared program course work.
**Prerequisites:** jr st; acceptance for Study Abroad Prog.
**Course Rules:** May be retaken w/chg in topic.
**Last Taught:** Fall 2015, Spring 2012, Fall 2010, Spring 2003.
**Current Offerings:** http://uwm.edu/schedule

MATH 499 Ad Hoc:
1-6 cr. Undergraduate.
Course created expressly for offering in a specified enrollment period. Requires only dept & assoc dean approval. In exceptional circumstances, can be offered in one add’l sem.
**Prerequisites:** jr st; add’l prereqs may be assigned to specific topic.
**Course Rules:** May be retaken w/chg in topic.
**Last Taught:** Spring 2010, Spring 2008, Fall 2007, Fall 1999.
**Current Offerings:** http://uwm.edu/schedule

MATH 511 Symbolic Logic
3 cr. Undergraduate/Graduate.
First-order predicate calculus; formal properties of theoretical systems; chief results of modern mathematical logic; advanced topics such as completeness and computability.
**Prerequisites:** jr st & either Philos 212(P) or 6 cr in math at the 300-level or above.
**Course Rules:** CompSci 511, Math 511 & Philos 511 are jointly offered; they count as repeats of one another.
**Last Taught:** Spring 2017, Fall 2015, Fall 2013, Spring 2003.
**Current Offerings:** http://uwm.edu/schedule

MATH 521 Advanced Calculus I
3 cr. Undergraduate/Graduate.
Fundamental notions of sets and functions; limits, continuity, Riemann integral, improper integral; infinite series; uniform convergence; power series; improper integrals with a parameter.
**Prerequisites:** jr st; grades of C or better in Math 232(P) & 341(P); or grad st.
**Last Taught:** Fall 2017, Fall 2016.
**Current Offerings:** http://uwm.edu/schedule

MATH 521G Advanced Calculus I
3 cr. Undergraduate/Graduate.
Fundamental notions of sets and functions; limits, continuity, Riemann integral, improper integral; infinite series; uniform convergence; power series; improper integrals with a parameter.
**Prerequisites:** jr st; grades of C or better in Math 232(P) & 341(P); or grad st.
**Last Taught:** Fall 2017, Fall 2016.
**Current Offerings:** http://uwm.edu/schedule

MATH 522 Advanced Calculus II
3 cr. Undergraduate/Graduate.
Linear functions; differentiation of functions of several variables (implicit functions, Jacobians); change of variable in multiple integrals; integrals over curves, surfaces; Green, Gauss, Stokes theorems.
**Prerequisites:** jr st, Math 521(P), grade of C or better in Math 233(P), & grade of C or better in either Math 234(P) or 240(P); or grad st.
**Last Taught:** Spring 2018, Spring 2017, Spring 2016, Spring 2015.
**Current Offerings:** http://uwm.edu/schedule

MATH 531 Modern Algebra
3 cr. Undergraduate/Graduate.
Integers; groups; rings; fields; emphasis on proofs.
**Prerequisites:** jr st; grade of C or better in Math 341(P).
**Last Taught:** Spring 2018, Spring 2017, Spring 2016, Spring 2015.
**Current Offerings:** http://uwm.edu/schedule

MATH 535 Linear Algebra
3 cr. Undergraduate/Graduate.
Vector spaces; linear transformations and matrices; characteristic values and vectors; canonical forms; bilinear, quadratic, and Hermitian forms; selected applications.
**Prerequisites:** jr st, grade of C or better in either Math 234(P) or 240(P), & grade of C or better in Math 341(P); or grad st.
**Last Taught:** Fall 2017, Fall 2016.
**Current Offerings:** http://uwm.edu/schedule

MATH 535G Linear Algebra
3 cr. Undergraduate/Graduate.
Vector spaces; linear transformations and matrices; characteristic values and vectors; canonical forms; bilinear, quadratic, and Hermitian forms; selected applications.
**Prerequisites:** jr st, grade of C or better in either Math 234(P) or 240(P), & grade of C or better in Math 341(P); or grad st.
**Last Taught:** Fall 2017, Fall 2016.
**Current Offerings:** http://uwm.edu/schedule
MATH 537 Number Theory
3 cr. Undergraduate/Graduate.
Number theoretic functions; distribution of primes; Diophantine approximation; partitions; additive number theory; quadratic reciprocity.
Prerequisites: jr st, grade of C or better in both Math 232(P) & 341(P); or grad st.
Last Taught: Fall 2016, Fall 2014, Fall 2012, Fall 2010.
Current Offerings: http://uwm.edu/schedule

MATH 551 Elementary Topology
3 cr. Undergraduate/Graduate.
General theory of point sets in Euclidean spaces, with emphasis on topology of two-dimensional and three-dimensional spaces; elementary notions of metric spaces; applications.
Prerequisites: jr st; grades of C or better in Math 233(P) & 341(P); or grad st.
Current Offerings: http://uwm.edu/schedule

MATH 553 Differential Geometry
3 cr. Undergraduate/Graduate.
The theory of curves and surfaces by differential methods.
Prerequisites: jr st, grade of C or better in all of Math 233(P), 234(P) & 341(P); or grad st.
Last Taught: Spring 2018, Fall 2013, Fall 2011, Fall 2009.
Current Offerings: http://uwm.edu/schedule

MATH 571 Introduction to Probability Models
3 cr. Undergraduate/Graduate.
Prerequisites: jr st; grade of C or better in Math 233(P), 234(P) & 341(P); or grad st.
Last Taught: Spring 2018, Fall 2013, Fall 2011, Fall 2009.
Current Offerings: http://uwm.edu/schedule

MATH 571G Introduction to Probability Models
3 cr. Undergraduate/Graduate.
Prerequisites: jr st; grade of C or better in Math 233(P), 234(P) & 341(P); or grad st.
Last Taught: Spring 2018, Fall 2017.
Current Offerings: http://uwm.edu/schedule

MATH 575 High School Mathematics from an Advanced Viewpoint
3 cr. Undergraduate/Graduate.
Number systems; algebra of polynomials; theory of equations; functions; modeling; geometric measurement; geometric transformations; connections between advanced mathematics and high school topics.
Prerequisites: jr st, either Math 451(P) or 453(P), & either Math 431(P) or 531(P); or cons instr; or grad st.
Course Rules: Counts as repeat of Math 690(675) w/similar topic.
Current Offerings: http://uwm.edu/schedule

MATH 581 Introduction to the Theory of Chaotic Dynamical Systems
3 cr. Undergraduate/Graduate.
Iterated mappings, one parameter families, attracting and repelling periodic orbits, topological transitivity, Sarkovski’s theorem, chaos, bifurcation theory, period doubling route to chaos, horseshoe maps, attractors.
Prerequisites: jr st & Math 521(P), 529(P) or 621(P), or cons instr; or grad st.
Current Offerings: http://uwm.edu/schedule

MATH 591 Undergraduate Seminar
1 cr. Undergraduate.
Specific topics and any additional prerequisites announced in Schedule of Classes each time course is offered.
Prerequisites: jr st; cons instr.
Course Rules: May be retaken w/chg in topic to 4 cr max.
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 599 Capstone Experience
1 cr. Undergraduate.
Student writes a paper under supervision of an advisor on an approved topic not covered in the student’s regular course work.
Prerequisites: sr st; cons instr.
Course Rules: May be retaken w/chg in topic to 2 cr max.
Current Offerings: http://uwm.edu/schedule

MATH 601 Advanced Engineering Mathematics I
3 cr. Undergraduate/Graduate.
Sequences and series, elementary complex analysis; Fourier series; linear and nonlinear ordinary differential equations; matrix theory, elementary functional analysis; elementary solution of partial differential equations.
Prerequisites: jr st; grade of C or better in both of Math 233(P) and Math/ElecEng 234(P); 3 cr Math at 300-level or above; or cons instr; or grad st.
Last Taught: Fall 2016, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATH 601G Advanced Engineering Mathematics I
3 cr. Undergraduate/Graduate.
Sequences and series, elementary complex analysis; Fourier series; linear and nonlinear ordinary differential equations; matrix theory, elementary functional analysis; elementary solution of partial differential equations.
Prerequisites: jr st; grade of C or better in both of Math 233(P) and Math/ElecEng 234(P); 3 cr Math at 300-level or above; or cons instr; or grad st.
Last Taught: Fall 2016, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATH 602 Advanced Engineering Mathematics II
3 cr. Undergraduate/Graduate.
Prerequisites: jr st, Math 601(P).
Current Offerings: http://uwm.edu/schedule
MATH 615 Numerical Solution of Partial Differential Equations
3 cr. Undergraduate/Graduate.
Finite difference solution of elliptic boundary value problems and of evolution problems; solution of hyperbolic conservation laws; finite volume methods; finite element methods.
Prerequisites: jr st; Math 413(P), 415(414)(P), or 417(416)(P); Math 322(P) or 602(P); or cons instr.
Current Offerings: http://uwm.edu/schedule

MATH 617 Optimization
3 cr. Undergraduate/Graduate.
Unconstrained and constrained optimization: linear, nonlinear, and dynamic programming; barrier, penalty, and Lagrangian methods; Karush-Kuhn-Tucker theory, quadratic, and sequential quadratic programming; evolutionary algorithms.
Prerequisites: jr st; Math 321(P) or 602(P); or grad st or cons instr.
Current Offerings: http://uwm.edu/schedule

MATH 621 Introduction to Analysis I
3 cr. Undergraduate/Graduate.
Topology of Euclidean space; continuity; differentiation of real and vector-valued functions; Riemann-Stieltjes integration.
Prerequisites: jr st; grades of C or better in Math 233(P), 341(P), & either 234(P) or 240(P); cons dept advisor; or grad st.
Last Taught: Fall 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 621G Introduction to Analysis I
3 cr. Undergraduate/Graduate.
Topology of Euclidean space; continuity; differentiation of real and vector-valued functions; Riemann-Stieltjes integration.
Prerequisites: jr st; grades of C or better in Math 233(P), 341(P), & either 234(P) or 240(P); cons dept advisor; or grad st.
Last Taught: Fall 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 622 Introduction to Analysis II
3 cr. Undergraduate/Graduate.
Continues Math 621. Sequences and series of functions; uniform convergence; power series; functions of several variables; inverse and implicit function theorems; differential forms; Stokes’ theorem.
Prerequisites: jr st; Math 621(P) or cons instr; or grad st.
Current Offerings: http://uwm.edu/schedule

MATH 631 Modern Algebra I
3 cr. Undergraduate/Graduate.
Group theory, including normal subgroups, quotients, permutation groups, Sylow’s theorems, Abelian groups; field theory; linear algebra over general fields.
Prerequisites: jr st; grade of C or better in Math 341(P) & either Math 234(P) or 240(P); cons dept advisor; or grad st.
Last Taught: Fall 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 631G Modern Algebra I
3 cr. Undergraduate/Graduate.
Group theory, including normal subgroups, quotients, permutation groups, Sylow’s theorems, Abelian groups; field theory; linear algebra over general fields.
Prerequisites: jr st; grade of C or better in Math 341(P) & either Math 234(P) or 240(P); cons dept advisor; or grad st.
Last Taught: Fall 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 632 Modern Algebra II
3 cr. Undergraduate/Graduate.
Continuation of Math 631. Ring theory, including ideals, quotient rings, Euclidean rings, polynomial rings, unique factorization; modules, including vector spaces, linear transformations, canonical forms; bilinear forms.
Prerequisites: jr st; Math 631(P) or cons instr; or grad st.
Current Offerings: http://uwm.edu/schedule

MATH 690 Topics in Mathematics
3 cr. Undergraduate/Graduate.
Specific topics and any additional prerequisites announced in Schedule of Classes each time course is offered.
Prerequisites: jr st, at least one U/G Math or MthStat course; cons instr; or grad st.
Course Rules: May be retaken w/chg in topic to 9 cr max.
Current Offerings: http://uwm.edu/schedule

MATH 699 Independent Reading
1-3 cr. Undergraduate.
See Advanced Independent Study. For further information, consult dept chair.
Prerequisites: jr st; 2.5 gpa, & writ cons instr, dept chair, & asst dean for SAS.
Course Rules: May be retaken w/chg in topic.
Current Offerings: http://uwm.edu/schedule

MATH 701 Industrial Mathematics I
3 cr. Graduate.
Elementary functional analysis, wavelets, control theory. Use of mathematical software emphasized throughout.
Prerequisites: grad st in nat sci discipline; Math 522(P) or 602(P) or 622(P).
Last Taught: Fall 2017, Fall 2015, Fall 2013, Fall 2011.
Current Offerings: http://uwm.edu/schedule

MATH 702 Industrial Mathematics II
3 cr. Graduate.
Optimal control theory, digital signal processing, image processing, linear programming, nonlinear optimization, artificial neural networks. Use of mathematical software emphasized throughout.
Prerequisites: grad st in nat sci discipline; Math 701(P).
Current Offerings: http://uwm.edu/schedule
MATH 703 Boundary Value Problems
3 cr. Graduate.
Prerequisites: grad st; Math 322(P) & 623(P).
Current Offerings: http://uwm.edu/schedule

MATH 709 Differential Geometry
3 cr. Graduate.
The theory of curves, surfaces, and manifolds in modern terminology. Global results on closed surfaces, geodesics, differential forms and tensor calculus.introduction to riemannian geometry.
Prerequisites: grad st; Math 522(P) or 622(P).
Last Taught: Fall 2007, Fall 2000.
Current Offerings: http://uwm.edu/schedule

MATH 711 Theory of Functions of a Real Variable I
3 cr. Graduate.
Equivalence relations; cardinal and ordinal numbers; topology of real line; cantor and borel sets; lebesgue measure on real line; baire and measurable functions; lebesgue integral.
Prerequisites: grad st; Math 522(P) & 551(P); or Math 622(P).
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATH 712 Theory of Functions of a Real Variable II
3 cr. Graduate.
Lebesgue integration; modes of convergence; lp spaces; vitalli covering and lebesgue density theorems; dini derivates; differentiation; fundamental theorem of the lebesgue integral calculus; fubini’s theorem.
Prerequisites: grad st; Math 711(P).
Current Offerings: http://uwm.edu/schedule

MATH 713 Theory of Functions of a Complex Variable I
3 cr. Graduate.
Complex numbers; linear transformations; elementary functions; conformal mapping; complex integration; infinite sequences; dirichlet problem; multivalued functions.
Prerequisites: grad st; Math 522(P) or 621(P).
Last Taught: Fall 2016, Fall 2014, Fall 2012, Fall 2010.
Current Offerings: http://uwm.edu/schedule

MATH 714 Theory of Functions of a Complex Variable II
3 cr. Graduate.
Continuation of Math 713.
Prerequisites: grad st; Math 713(P).
Current Offerings: http://uwm.edu/schedule

MATH 715 Numerical Analysis
3 cr. Graduate.
Interpolation and approximation; differentiation and quadrature; numerical solution of ordinary differential equations; solution of linear and nonlinear algebraic equations.
Prerequisites: grad st; Math 413(P); Math 521(P) or 621(P).
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATH 716 Ordinary Differential Equations
3 cr. Graduate.
Existence and uniqueness theorems for systems of ode; qualitative properties of solutions, including stability and asymptotic behavior; general theory of linear systems; sturm-liouville problems.
Prerequisites: grad st; Math 522(P) or 622(P).
Last Taught: Fall 2017, Fall 2015, Fall 2013, Fall 2011.
Current Offerings: http://uwm.edu/schedule

MATH 719 Partial Differential Equations
3 cr. Graduate.
First and second order equations; characteristics, cauchy problem; classical solutions of linear elliptic, parabolic and hyperbolic equations.
Prerequisites: grad st; Math 522(P) or 622(P); math 320(P).
Current Offerings: http://uwm.edu/schedule

MATH 721 Abstract Measure and Integration
3 cr. Graduate.
General theory of measures and integration; differentiation of set functions; relation to stochastic variables; atomic measures; haar measure and integral applications to probability theory.
Prerequisites: grad st; Math 712(P).
Current Offerings: http://uwm.edu/schedule

MATH 726 Introduction to Functional Analysis
3 cr. Graduate.
Basic notions of functional analysis in hilbert space will be introduced. The concepts will be illustrated by applications to elementary differential and integral equation problems.
Prerequisites: grad st; Math 522(P) or 622(P).
Last Taught: Fall 2016, Fall 2014, Fall 2012, Fall 2010.
Current Offerings: http://uwm.edu/schedule

MATH 731 Abstract Algebra I
3 cr. Graduate.
Basic course which is prerequisite for all other 700-799 level courses in algebra; groups, rings, fields, galois theory, modules, and categories.
Prerequisites: grad st; Math 632(P); cons instr.
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

MATH 732 Abstract Algebra II
3 cr. Graduate.
Continuation of Math 731.
Prerequisites: grad st; Math 731(P).
Current Offerings: http://uwm.edu/schedule

MATH 735 Theory of Groups
3 cr. Graduate.
Topics selected from permutation groups; representations of groups and algebras; group algebras; group characters; extension problems; simple groups; solvable and nilpotent groups.
Prerequisites: grad st; Math 732(P).
Current Offerings: http://uwm.edu/schedule
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Semester Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 736</td>
<td>Theory of Rings and Modules I</td>
<td>3 cr. Graduate.</td>
</tr>
<tr>
<td></td>
<td>Noetherian and artinian rings and modules; primitive, prime and simple rings and ideals; radicals; localization; monoid theory; construction and study of special classes of rings.</td>
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<tr>
<td>Prerequisites</td>
<td>grad st; Math 732(P).</td>
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<tr>
<td>Last Taught</td>
<td>Fall 2005, Fall 1991, Fall 1988, Fall 1986.</td>
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<tr>
<td>Current Offerings</td>
<td><a href="http://uwm.edu/schedule">http://uwm.edu/schedule</a></td>
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<tr>
<td>MATH 737</td>
<td>Theory of Rings and Modules II</td>
<td>3 cr. Graduate.</td>
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<tr>
<td></td>
<td>Continuation of Math 736.</td>
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<tr>
<td>Prerequisites</td>
<td>grad st; Math 736(P) or cons instr.</td>
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<tr>
<td>Current Offerings</td>
<td><a href="http://uwm.edu/schedule">http://uwm.edu/schedule</a></td>
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<tr>
<td>MATH 751</td>
<td>Introductory Topology I</td>
<td>3 cr. Graduate.</td>
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<tr>
<td></td>
<td>Fundamental properties and examples of topological spaces and continuous functions, including compactness, connectedness, metrizability, completeness, product and quotient spaces, homeomorphisms, embedding, extension, and euclidean spaces.</td>
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<tr>
<td>Prerequisites</td>
<td>grad st; Math 522(P) or 621(P).</td>
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<tr>
<td>Last Taught</td>
<td>Fall 2017, Fall 2016, Fall 2015, Fall 2014.</td>
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<tr>
<td>Current Offerings</td>
<td><a href="http://uwm.edu/schedule">http://uwm.edu/schedule</a></td>
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<tr>
<td>MATH 752</td>
<td>Introductory Topology II</td>
<td>3 cr. Graduate.</td>
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<td></td>
<td>Continuation of Math 751.</td>
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<tr>
<td>Prerequisites</td>
<td>grad st; Math 751(P).</td>
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<td>Current Offerings</td>
<td><a href="http://uwm.edu/schedule">http://uwm.edu/schedule</a></td>
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<tr>
<td>MATH 753</td>
<td>Introduction to Algebraic Topology I</td>
<td>3 cr. Graduate.</td>
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<tr>
<td></td>
<td>Homology theory; complexes and simplicial homology theory; general homology theories; cohomology rings; applications to manifolds, fixed point theorems, etc.</td>
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<tr>
<td>Prerequisites</td>
<td>grad st; Math 632(P); Math 551(P) or 751(P) or cons instr.</td>
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<tr>
<td>Last Taught</td>
<td>Fall 2016, Fall 2014, Fall 2012, Fall 2010.</td>
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<td>Current Offerings</td>
<td><a href="http://uwm.edu/schedule">http://uwm.edu/schedule</a></td>
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<tr>
<td>MATH 754</td>
<td>Introduction to Algebraic Topology II</td>
<td>3 cr. Graduate.</td>
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<tr>
<td></td>
<td>Continuation of Math 753.</td>
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<tr>
<td>Prerequisites</td>
<td>grad st; Math 753(P).</td>
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<tr>
<td>Current Offerings</td>
<td><a href="http://uwm.edu/schedule">http://uwm.edu/schedule</a></td>
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<tr>
<td>MATH 767</td>
<td>Statistical Methods for Engineers and Scientists</td>
<td>3 cr. Graduate.</td>
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<tr>
<td></td>
<td>Elementary bayesian decision theory; prior posterior and predictive distributions; posterior and pre-posterior analysis of two action decision problems; concept of likelihood functions for binomial, poisson, exponential and normal distributions; simple and multiple regression analysis; introduction to autoregressive models.</td>
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<tr>
<td>Prerequisites</td>
<td>grad st; Math 362(P) or math 467(P).</td>
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<tr>
<td>Course Rules</td>
<td>Not open to students who have cr in ElecEng 767, which is identical to Math 767.</td>
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<tr>
<td>Current Offerings</td>
<td><a href="http://uwm.edu/schedule">http://uwm.edu/schedule</a></td>
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<tr>
<td>MATH 768</td>
<td>Applied Stochastic Processes</td>
<td>3 cr. Graduate.</td>
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<td></td>
<td>Concepts in queuing theory; exponential channels; applications of markov chains to queuing problems; queue disciplines with priorities.</td>
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<tr>
<td>Prerequisites</td>
<td>grad st; Math 361(P) or math 467(P).</td>
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<tr>
<td>Course Rules</td>
<td>Not open to students who have cr in ElecEng 768, which is identical to Math 768.</td>
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<tr>
<td>Last Taught</td>
<td>Fall 2017, Fall 2016, Fall 2015, Fall 2014.</td>
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<td>Current Offerings</td>
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</tr>
<tr>
<td>MATH 771</td>
<td>Theory of Probability</td>
<td>3 cr. Graduate.</td>
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<td></td>
<td>Measure-theoretic foundations; limit-law theorems; weak and strong laws of large numbers; central limit problem; conditional expectations, martingales; stochastic processes.</td>
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<tr>
<td>Prerequisites</td>
<td>grad st; Math 471(C) or 712(C).</td>
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<tr>
<td>Current Offerings</td>
<td><a href="http://uwm.edu/schedule">http://uwm.edu/schedule</a></td>
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<tr>
<td>MATH 781</td>
<td>Iterated Maps as Dynamical Systems</td>
<td>3 cr. Graduate.</td>
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<td>Periodic, recurrent and non-wandering points, kneading theory, unstable manifolds, unimodal mappings, turbulent and chaotic maps, symbolic dynamics, structural stability, topological conjugacy, topological dynamics.</td>
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<tr>
<td>Prerequisites</td>
<td>grad st; Math 711(P) or cons instr.</td>
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<tr>
<td>Last Taught</td>
<td>Fall 2000, Fall 1993, Fall 1992.</td>
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<tr>
<td>Current Offerings</td>
<td><a href="http://uwm.edu/schedule">http://uwm.edu/schedule</a></td>
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<tr>
<td>MATH 790</td>
<td>Master's Thesis</td>
<td>1-3 cr. Graduate.</td>
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<tr>
<td>Prerequisites</td>
<td>grad st; cons instr.</td>
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<tr>
<td>Course Rules</td>
<td>Cr count toward masters degree only if student completes thesis option.</td>
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<tr>
<td>Last Taught</td>
<td>Spring 2018, Spring 2017, Spring 2016, Fall 2015.</td>
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<tr>
<td>Current Offerings</td>
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<tr>
<td>MATH 791</td>
<td>Master's Seminar</td>
<td>1-3 cr. Graduate.</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>grad st; cons instr.</td>
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<tr>
<td>Course Rules</td>
<td>May not be taken for cr more than once.</td>
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<tr>
<td>Last Taught</td>
<td>Summer 2018, Spring 2014, Fall 2013, Spring 2012.</td>
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<tr>
<td>Current Offerings</td>
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<tr>
<td>MATH 792</td>
<td>Industrial Internship</td>
<td>1-3 cr. Graduate.</td>
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<tr>
<td></td>
<td>Students earn credits for serving in an industrial internship that involves work of an advanced mathematical nature. They must prepare a report based on the internship.</td>
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<tr>
<td>Prerequisites</td>
<td>grad st; cons instr.</td>
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<tr>
<td>Course Rules</td>
<td>Retakable w/chg in topic to 6 cr max.</td>
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<tr>
<td>Current Offerings</td>
<td><a href="http://uwm.edu/schedule">http://uwm.edu/schedule</a></td>
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<tr>
<td>MATH 793</td>
<td>Scientific Computational Laboratory</td>
<td>1-2 cr. Graduate.</td>
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<tr>
<td>Prerequisites</td>
<td>grad st; Math 715(C).</td>
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<tr>
<td>Course Rules</td>
<td>Retakable w/chg in topic to 6 cr max.</td>
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<tr>
<td>Current Offerings</td>
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<td></td>
</tr>
</tbody>
</table>
MATH 799 Seminar in Mathematics:
1-3 cr. Graduate.
Specific topics and any additional prerequisites announced in Timetable each time course is offered.
Prerequisites: grad st & cons instr.
Course Rules: Retakable w/chg in topic to 9 cr max.
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 801 Topics in Applied Mathematics:
3 cr. Graduate.
Specific topics and any additional prerequisites will be announced in the Timetable each time the course is offered.
Prerequisites: grad st; Math 715(P).
Course Rules: Retakable w/chg in topic to 9 cr max.
Last Taught: Fall 2016, Spring 2015, Fall 2008, Fall 2006.
Current Offerings: http://uwm.edu/schedule

MATH 807 Group Theory and Its Applications to Physics
3 cr. Graduate.
Representations of discrete and continuous groups, including rotation groups, unitary groups and crystal point and space groups. Symmetries of elementary particles. Molecular orbitals, energy bands.
Prerequisites: grad st; Physics 532(P).
Course Rules: Counts as a repeat of Physics 807.
Last Taught: Spring 2018.
Current Offerings: http://uwm.edu/schedule

MATH 809 Topics in Differential Geometry:
1-3 cr. Graduate.
Specific topics and any additional prerequisites will be announced in the Timetable each time the course is offered. Topics may be selected from Riemannian geometry, minimal surfaces and surfaces of prescribed mean curvature, geometric partial differential equations, or related areas of geometry.
Prerequisites: grad st; cons instr.
Course Rules: Retakable w/chg in topic to 9 cr max.
Current Offerings: http://uwm.edu/schedule

MATH 811 Advanced Topics in Functional Analysis:
3 cr. Graduate.
Continuation of Math 810; topological methods.
Prerequisites: grad st; Math 816(P).
Course Rules: Retakable w/chg in topic to 9 cr max.
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 812 Advanced Ordinary Differential Equations
3 cr. Graduate.
Existence and uniqueness theorems; singularity of solutions; oscillation and comparison theorems; poincare-bendixon theory.
Prerequisites: grad st; Math 716(P).
Current Offerings: http://uwm.edu/schedule

MATH 813 Numerical Solution of Ordinary Differential Equations
3 cr. Graduate.
Methods for initial value and boundary value problems; stiff equations, singular points and bifurcation.
Prerequisites: grad st; Math 715(P).
Last Taught: Fall 2001, Fall 1998, Fall 1987, Fall 1986.
Current Offerings: http://uwm.edu/schedule

MATH 814 Numerical Solution of Partial Differential Equations
3 cr. Graduate.
Finite difference and finite element methods for linear elliptic, parabolic and hyperbolic equations; nonlinear equations.
Prerequisites: grad st; Math 715(P).
Current Offerings: http://uwm.edu/schedule

MATH 815 Topics in Numerical Analysis:
3 cr. Graduate.
Prerequisites: grad st; Math 715(P).
Course Rules: Retakable w/chg in topic to 9 cr max.
Current Offerings: http://uwm.edu/schedule

MATH 816 Advanced Ordinary Differential Equations
3 cr. Graduate.
Existence and uniqueness theorems; singularity of solutions; oscillation and comparison theorems; poincare-bendixon theory.
Prerequisites: grad st; Math 716(P).
Current Offerings: http://uwm.edu/schedule

MATH 817 Advanced Ordinary Differential Equations II
3 cr. Graduate.
Continuation of Math 816; dynamical systems, bifurcation theory, topological methods.
Prerequisites: grad st; Math 816(P).
Current Offerings: http://uwm.edu/schedule

MATH 818 Advanced Topics in Real Analysis:
3 cr. Graduate.
Basic theorems of b-spaces and f-spaces including the closed graph; Hahn-Banach and Banach-Steinhaus theorems; Banach algebras; generalized functions; spectral theory.
Prerequisites: grad st; Math 712(P).
Course Rules: Retakable w/chg in topic to 9 cr max.
Current Offerings: http://uwm.edu/schedule

MATH 819 Advanced Topics in Functional Analysis
3 cr. Graduate.
Continuation of Math 818; spectral theory.
Prerequisites: grad st; Math 712(P).
Course Rules: Retakable w/chg in topic to 9 cr max.
Last Taught: Spring 2013, Fall 1998, Fall 1994, Fall 1993.
Current Offerings: http://uwm.edu/schedule

MATH 821 Advanced Topics in Real Analysis:
3 cr. Graduate.
Basic theorems of b-spaces and f-spaces including the closed graph; Hahn-Banach and Banach-Steinhaus theorems; Banach algebras; generalized functions; spectral theory.
Prerequisites: grad st; Math 712(P).
Course Rules: Retakable w/chg in topic to 9 cr max.
Last Taught: Spring 2013, Fall 1998, Fall 1994, Fall 1993.
Current Offerings: http://uwm.edu/schedule

MATH 825 Functional Analysis
3 cr. Graduate.
Continuation of Math 818; spectral theory.
Prerequisites: grad st; Math 712(P).
Course Rules: Retakable w/chg in topic to 9 cr max.
Last Taught: Spring 2013, Fall 1998, Fall 1994, Fall 1993.
Current Offerings: http://uwm.edu/schedule

MATH 841 Advanced Topics in Algebra:
3 cr. Graduate.
Specific topics and any additional prerequisites will be announced in the Timetable each time the course is offered.
Prerequisites: grad st; Math 732(P); cons instr.
Course Rules: Retakable w/chg in topic to 9 cr max.
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 842 Homological Algebra II
3 cr. Graduate.
Modules; diagrams; categories; functors; complexes; cohomology; extensions; resolutions; injective and projective systems; graded modules; homological dimension; spectral sequences; derived functors.
Prerequisites: grad st; Math 731(P).
Last Taught: Fall 2015, Fall 2010, Fall 2002, Fall 1999.
Current Offerings: http://uwm.edu/schedule

MATH 843 Homological Algebra I
3 cr. Graduate.
Modules; diagrams; categories; functors; complexes; cohomology; extensions; resolutions; injective and projective systems; graded modules; homological dimension; spectral sequences; derived functors.
Prerequisites: grad st; Math 731(P).
Last Taught: Fall 2015, Fall 2010, Fall 2002, Fall 1999.
Current Offerings: http://uwm.edu/schedule

MATH 844 Homological Algebra II
3 cr. Graduate.
Continuation of Math 843.
Prerequisites: grad st; Math 843(P).
Current Offerings: http://uwm.edu/schedule
MATH 851 Advanced Topics in Topology:
3 cr. Graduate.
Specific topics and any additional prerequisites will be announced in the Timetable each time the course is offered.
Prerequisites: grad st; Math 752(P); cons instr.
Course Rules: Retakable w/chg in topic to 9 cr max.
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

MATH 873 Advanced Topics in Probability:
3 cr. Graduate.
Specific topics and any additional prerequisites will be announced in the Timetable each time the course is offered.
Prerequisites: grad st; cons instr.
Course Rules: Retakable w/chg in topic to 9 cr max.
Last Taught: Spring 2018, Fall 2017, Fall 2016, Fall 2015.
Current Offerings: http://uwm.edu/schedule

MATH 881 Topics in Nonlinear Dynamics:
3 cr. Graduate.
Specific topics and any additional prerequisites will be announced in the Timetable each time the course is offered.
Prerequisites: grad st; Math 711(P); cons instr.
Course Rules: Retakable w/chg in topic to 9 cr max.
Current Offerings: http://uwm.edu/schedule

MATH 888 Candidate for Degree
0 cr. Graduate.
Available for graduate students who must meet minimum credit load requirement.
Prerequisites: grad st.
Course Rules: Fee for 1 cr assessed.
Last Taught: Summer 2017.
Current Offerings: http://uwm.edu/schedule

MATH 990 Reading and Research
1-6 cr. Graduate.
To be arranged with your instructor and department chair.
Prerequisites: grad st.
Course Rules: Retakable.
Current Offerings: http://uwm.edu/schedule