Mathematics

Professors Frey, LaVarnway, Poodiak (Chair) and True; Associate Professors McQuillan, Olsen, Olson and Timoszyk; Assistant Professors Kramer, Latulippe, C and Latulippe, J; Lecturers Herman, Ku and Mathai.

The Mathematics Department offers a four-year program leading to the Bachelor of Science degree in Mathematics. The courses offered are intended to:

1. prepare mathematics majors for graduate work in mathematics or careers in computer science, engineering, industry, business, actuary science, or teaching;
2. support the curricula in all disciplines, and
3. supply the students with the mathematics courses necessary to qualify for teacher licensure.

Courses required of the mathematics major are listed in the following pages. Mathematics majors must obtain grades of "C" or better in at least three of the four courses MA 121, MA 122, MA 223, MA 224 and in at least six math courses at the 300-400 level, other than MA 360. Courses listed in the third year and fourth year of the program as math electives are taken at the 300-400 level.

B.S. in Mathematics - Curriculum Map

First Year

Fall	Credits	Spring	Credits
MA 121 Calculus I	4	MA 122 Calculus II	4
EN 101 Composition and Literature I	3	EN 102 Composition and Literature II	3
Lab Science Elective	4	Lab Science Elective	4
Elective	3	MA 241 Mathematical Computation and Modeling	3
	14		**14**

Second Year

Fall	Credits	Spring	Credits
MA 223 Calculus III	4	MA 224 Differential Equations	4
MA 306 Discrete Mathematics	3	MA 310 Linear Algebra	3
EN 201 World Literature I	3	EN 202 World Literature II	3
General Education Elective	3	General Education Elective[1]	3
PS 211 University Physics I	4	PS 212 University Physics II	4
		MA 250 Communication in Mathematics	1
	17		**18**

Third Year

Fall	Credits	Spring	Credits
MA 303 Advanced Calculus I or 309 Algebraic Structures[2]	3	MA 304 Advanced Calculus II or 312 Statistical Methodology II[3]	3
MA 311 Statistical Methodology	3	MA Elective	3
General Education Elective[1]	3	General Education Elective[1]	3
Elective	3	Elective	3
Elective	3	MA Elective	3
	15		**15**

Fourth Year

Fall	Credits	Spring	Credits
MA 309 Algebraic Structures or 303 Advanced Calculus I	3	MA Elective	3
MA 411 Senior Seminars	3	MA Elective	3
Elective	3	Elective	3
Elective	3	Elective	3
Elective	3	Elective	3
	15		**15**

Total Credits: 123

[1] The four required general education electives are:
1. a course in History (except HI 209).
2. a Social Science Elective.
3. a course in Ethics, either PH 303 or PH 350.
4. a Humanities Elective.

[2] MA 303 and MA 309 alternate as fall semester courses; both courses are required. For year these courses are offered See Course Descriptions.

[3] MA 304 and MA 312 alternate as spring semester courses; one of the two courses is required.

B.S. in Mathematics - Actuarial Concentration - Curriculum Map

First Year

Fall	Credits	Spring	Credits
MA 121 Calculus I	4	MA 122 Calculus II	4
EN 101 Composition and Literature I	3	EN 102 Composition and Literature II	3
Lab Science Elective	4	Lab Science Elective	4
General Education Elective[1]	3	MA 241 Mathematical Computation and Modeling	3
	14		**14**

Second Year

Fall	Credits	Spring	Credits
MA 223 Calculus III	4	MA 224 Differential Equations	4
MA 306 Discrete Mathematics	3	MA 310 Linear Algebra	3
EN 201 World Literature I	3	EN 202 World Literature II	3
EC 201 Principles of Economics (Macro)	3	EC 202 Principles of Economics (Micro)	3
PS 211 University Physics I	4	PS 212 University Physics II	4
		MA 250 Communication in Mathematics	1
	17		**18**

Third Year

Fall	Credits	Spring	Credits
MA 303 Advanced Calculus I or 309 Algebraic Structures[2]	3	MA 312 Statistical Methodology II	3
MA 311 Statistical Methodology	3	MA Elective	3
MA 212 Finite Mathematics	3	General Education Elective[1]	3
General Education Elective[1]	3	Elective	3
Elective	3	MA Elective	3
	15		**15**

Fourth Year

Fall	Credits	Spring	Credits
MA 309 Algebraic Structures or 303 Advanced Calculus I[2]	3	MA 321 Financial Mathematics	3
MA 411 Senior Seminars	3	MA Elective	3
Elective	3	Elective	3
Elective	3	Elective	3
Elective	3	Elective	3
	15		**15**

Total Credits: 123

[1] The three required general education electives are:
1. a course in History (except HI 209).
2. a course in Ethics, either PH 303 or PH 350.
3. a Humanities Elective.

[2] MA 303 and MA 309 alternate as fall semester courses; both courses are required. For years these courses are offered See Course Descriptions.

The required courses for the Actuarial Concentration are (to be completed with a grade of "C" or better); EC 201, EC 202, MA 212, MA 311, MA 312, and MA 321.

A grade of "B-" or better is required in EC 201, EC 202, MA 311, and MA 312 to meet the Society of Actuaries Validation by Educational Experience requirement.

B.S. in Mathematics - Curriculum Map

(meeting requirements for Teacher Licensure - grades 7-12 mathematics teacher)

First Year

Fall	Credits	Spring	Credits
MA 121 Calculus I	4	MA 122 Calculus II	4
EN 101 Composition and Literature I	3	EN 102 Composition and Literature II	3
Lab Science Elective	4	Lab Science Elective	4
PY 211 Introduction to Psychology	3	MA 241 Mathematical Computation and Modeling	3
ED 101 Foundations of Education I	1	ED 201 Foundations of Education III	1
ED 102 Foundations of Education II	1	ED 202 Foundations of Education IV	1
	16		**16**

Second Year

Fall	Credits	Spring	Credits
MA 223 Calculus III	4	MA 224 Differential Equations	4
MA 306 Discrete Mathematics	3	MA 310 Linear Algebra	3
EN 201 World Literature I	3	EN 202 World Literature II	3
ED 234 Learning and Teaching Strategies	4	PY 220 Developmental Psychology	3
PS 211 University Physics I	4	PS 212 University Physics II	4
		MA 250 Communication in Mathematics	1
	18		**18**

Third Year

Fall	Credits	Spring	Credits
MA 303 Advanced Calculus I or 309 Algebraic Structures[1]	3	MA 304 Advanced Calculus II or 312 Statistical Methodology II[2]	3
MA 311 Statistical Methodology	3	MA Elective	3
MA Elective	3	MA Elective	3
Elective (HI or PH or MA 360)	3	HU Elect, if program inc MA 360	3
PY 352 Learning and Memory	4	PY 324 Adolescent Psychology	3-4
PY 315 Exceptional Child I	3	ED 363 Reading and Writing in the Content Area	4
	19		**19-20**

Fourth Year

Fall	Credits	Spring	Credits
MA 309 Algebraic Structures or 303 Advanced Calculus I[1]	3	ED 425 Student Teaching	12
MA 411 Senior Seminars	3		
MA Elective	3		
Elective (HI or PH or MA 360)			
HU Elective			
ED 368 Curriculum & Methods in Secondary Subjects	4		
	13		**12**

Total Credits: 131-132

[1] MA 303 and MA 309 alternate as fall semester courses; both courses are required. For years these courses are offered, see Course Descriptions.

[2] MA 304 and MA 312 alternate as spring semester courses; one of the two courses is required.

Minor in Mathematics

Students must complete six courses of 3 or more credits each in mathematics (MA) above of MA 121 (https://nextcatalog.norwich.edu/residentialprogramscatalog/collegeofscienceandmathematics/mathematics) (at least three at the 300-400 level) with a grade of "C" or better. Students are invited to design their own programs so as to blend these courses with their academic majors, with the advice of the Mathematics Department.

Courses

MA 005. Preparatory Mathematics. 3 Credits.
A review of high school mathematics with some geometry in preparation for freshman level mathematics. Students assigned to MA 005 must satisfactorily complete it before the end of their first year at Norwich and enrolling in any other mathematics course.

MA 101. Mathematics: A Liberal Art. 3 Credits.
An investigation of mathematical concepts and methods with emphasis given to their impact on current and ancient problems. Topics include logic, counting problems, probability, geometry and mathematics of finance. Emphasis is on techniques of problem solving. Prerequisite: Satisfactory completion of MA 005 or equivalent as determined by departmental placement testing. Not open for the first time to a student with a grade of "C" or higher in MA 107, or with credit for any mathematics course requiring MA 107 as a prerequisite. Offered fall semesters.

MA 102. Mathematics: A Liberal Art. 3 Credits.
An investigation of mathematical concepts and methods with emphasis given to their impact on current and ancient problems. Topics include mathematics of voting systems, basic graph theory including Euler circuits and the traveling salesman problem, the mathematics of population growth, statistics, and finding fair shares. Emphasis is on techniques of problem solving. Prerequisite: Satisfactory completion of MA 005 or equivalent as determined by departmental placement testing. Not open for the first time to a student with a grade of "C" or higher in MA 107, or with credit for any mathematics course requiring MA 107 as a prerequisite. Offered spring semesters.

MA 103. College Algebra I. 3 Credits.
A comprehensive study of algebraic topics, this course provides a strong foundation for subsequent mathematics-based courses. Topics include: sets, the real number systems, polynomials and factoring, linear and quadratic equations. Prerequisite: Satisfactory completion of MA 005 or equivalent as determined by departmental placement testing. Not open for the first time to students who have received degree credit in any math course except MA 101, MA 102. This course does not fulfill the General Education requirement in mathematics.

MA 107. Precalculus Mathematics. 4 Credits.
A course on topics in precalculus mathematics involving algebra and trigonometry designed to prepare students to progress into introductory calculus. It is a rapid development of elementary topics in algebra to linear, quadratic, logarithmic, and exponential functions, followed by an analytical treatment of trigonometry. Prerequisite: Grade of "C" or better in MA 103 or equivalent as determined by departmental placement testing. Not open for the first time to students with credit in any course requiring MA 107 as a prerequisite.

MA 108. Applied Calculus. 4 Credits.
A course on topics in analytical geometry progressing to differential and integral calculus. Presentation of a wide variety of practical application to technology, business, and science. Not open for the first time to a student with credit in MA 121 or any course requiring MA 108 as a prerequisite. Prerequisite: MA 107 or equivalent as determined by departmental placement testing. Not more than one of MA 108 or MA 121 may count as degree credit.

MA 121. Calculus I. 4 Credits.
An introduction to plane analytic geometry and to differential and integral calculus. Prerequisite: grade of "C" or better in MA 107 or equivalent as determined by departmental placement testing. Not more than one of MA 108 or MA 121 may count as degree credit.

MA 122. Calculus II. 4 Credits.
A continuation of MA121. Transcendental functions, methods of integration, vectors, polar coordinates, indeterminate forms, L'Hopital's Rule, improper integrals, infinite sequences and series. Prerequisite: MA121 or "C" or better in MA108 and permission of the department.

MA 212. Finite Mathematics. 3 Credits.
This course includes linear algebra with applications to systems of equations, linear programming, math of finance, sets, combinatorial analysis, and probability theory. Prerequisite: MA 107 or equivalent as determined by department placement testing. Offered spring semesters.

MA 220. Geometry in Action. 3 Credits.

MA 223. Calculus III. 4 Credits.
A course that continues MA 122. Topics include multiple integration, solid analytic geometry, partial differentiation, two- and three- dimensional vector analysis. Prerequisite: MA 122. Offered fall semesters.

MA 224. Differential Equations. 4 Credits.
Ordinary differential equations are developed as models of physical phenomena. Differential equations are investigated by finding exact solutions and using computer software to determine the solution to linear and non-linear problems. Solution techniques include operator methods, Laplace transforms, and numerical methods. Prerequisite: MA 122. Offered spring semesters.

MA 232. Elementary Statistics. 3 Credits.
A course that covers the study of frequency distributions, averages and standard deviations, normal curve, probability, decision-making, sampling techniques, testing hypotheses, chi-square, students-t and F-distributions, correlation and linear regression. This course is valuable for those who plan to enter teaching. Prerequisite: A college level mathematics course or equivalent as determined by departmental placement testing. Not open to students with credit in MA 311.

MA 235. Clinical Mathematical Methods. 3 Credits.
A course investigating mathematical concepts and methods used in the health care settings. This course will cover the essential math for medication calculations, the continued development of statistical techniques utilized in scientific research, and the mathematics of population dynamics and epidemiological studies. Case studies will be used where appropriate. Emphasis will be on critical thinking and logic of math in a health care environment and in health care research and administration. This is a mathematics course for Nursing Majors. Prerequisites: MA 232. Offered Fall semesters. 3 lecture hours and 1 laboratory hour. 3 credits.

MA 240. Introduction to Number Theory and Cryptology. 3 Credits.
An introduction to fundamental topics in number theory, including the real number system, prime numbers, modular arithmetic, the Euclidean Algorithm, Fermat's Theorem, Euler's Theorem, Euler's Phi Function. Topics will be applied to Caesar and affine ciphers and the Chinese Remainder Theorem. Prerequisite: MA 107 and knowledge of a programming language or permission of the instructor. Offered fall semesters.

MA 241. Mathematical Computation and Modeling. 3 Credits.
A course designed to introduce effective problem solving strategies and modeling techniques to find solutions to complex and often ill-defined problems. Introductory material chosen from common experiences encompassing many academic disciplines. Emphasis is placed on the development of mathematical models and computation on a variety of computing platforms and programming environments. Prerequisite: MA 108, MA 121 or permission of instructor. Offered spring semesters.

MA 250. Communication in Mathematics. 1 Credit.
This course illustrates the organization of the mathematical literature, the efficient search of the literature and a formal introduction to writing mathematics. Prerequisite: Sophomore Mathematics Major or permission of the instructor.

MA 303. Advanced Calculus I. 3 Credits.
A course that provides an extension of concepts of basic calculus to functions of several variables to include limits, continuity, differentiation, and Riemann integration. Treatment of selected topics not included in the basic calculus series as a foundation for more advanced courses in analysis and applied mathematics is also included. Prerequisite: MA 223 and either MA 306 or permission of the instructor. Offered Fall semesters of even numbered years. 3 lecture hours.

MA 304. Advanced Calculus II. 3 Credits.
A course that continues with the content of MA 303, including limits, continuity, differentiation, and Riemann integration. Treatment of selected topics not included in the basic calculus series as a foundation for more advanced courses in analysis and applied mathematics is also included. Prerequisite: MA 303. Offered Spring semesters of odd numbered years.

MA 306. Discrete Mathematics. 3 Credits.
A course in logic, sets, techniques of proof, relations and functions, directed and undirected graphs, algebraic systems, Boolean algebra, and emphasis on applications in various areas of computer science. Prerequisite: MA 108 or MA 121 and knowledge of computer programming. Offered fall semesters.

MA 308. Modern Geometry. 3 Credits.
A course in modern geometries that includes foundations of Euclidean geometry and the development of non-Euclidean geometries. Recommended for prospective teachers. Prerequisite: MA 108 or MA 121. Offered Spring 2010 and every third year. 3 lecture hours.

MA 309. Algebraic Structures. 3 Credits.
A course on groups, rings, fields, morphisms, vector spaces; special topics selected from group theory, algebraic number theory, field theory, Galois theory. Prerequisite: MA 306 or permission of the instructor. Offered Fall semesters of odd numbered years. 3 lecture hours.

MA 310. Linear Algebra. 3 Credits.
A theoretical course on such topics as matrices, determinants, linear equations, vector spaces, bases and dimensions, linear transformations, eigenvalues, and eigenvectors. Prerequisite: MA 223 or permission of the instructor. Offered spring semesters.

MA 311. Statistical Methodology. 3 Credits.
A course designed to provide a firm foundation for the employment of statistical methodology in engineering and the sciences. Examples drawn from the technical fields will be used throughout. The course will cover probability, continuous and discrete statistical distributions, estimation, tests of hypotheses, and sample regression. As time permits, other topics may be examined based on the interests of the students. Prerequisite: MA 223. Offered fall semesters. 3 lecture hours.

MA 312. Statistical Methodology II. 3 Credits.
A continuation of MA 311. Continued development of statistical techniques utilized in scientific and engineering research. Topics to be covered include regression, multiple regression, analysis of variance, experimental design, statistical quality control, time series/forecasting, and reliability analysis. Prerequisite: MA 311. Offered Spring semester of even numbered years. 3 lecture hours.

MA 318. Cryptology. 3 Credits.
A course that covers fundamental mathematical concepts from modern algebra, number theory, and other areas of mathematics. Provides a foundation for the understanding of classical encryption systems and modern encryption methods. Emphasis on the mathematical underpinnings germane to cryptoloty. Prepares students for advanced study of modern cryptography. Experience implementing encryption, decryption and cryptanalytic methods on a variety of systems. Prerequisite: MA 240 and knowledge of a programming language or permission of instructor. Offered spring semesters. 3 lecture hours.

MA 321. Financial Mathematics. 3 Credits.
A course designed to extend the student's understanding of the fundamental concepts of financial mathematics, and application of these concepts in calculating present and accumulated values for various streams of cash flows as a basis for future use in reserving, valuation, pricing, asset/liability management, investment income, capital budgeting and valuing contingent cash flows. The student will also be given an introduction to financial instruments, including derivatives, and the concept of no–arbitrage as it relates to financial mathematics. Offered Spring semesters of odd years. Prerequisites: MA 121 or MA 108, and MA 212. 3 lecture hours.

MA 360. Teaching Mathematics at the Elementary - Middle School Level. 3 Credits.
A course in the content, methods, and materials for the teaching of elementary and middle school mathematics. Prerequisites: MA 107. 3 lecture hours.

MA 370. Introduction to Operations Research. 3 Credits.
A course that concentrates on the fundamental concepts and techniques necessary to enable an individual to obtain "optimal" solutions to problems in business, economics, engineering, and the physical and behavioral sciences. Topics include linear programming, network analysis, dynamic programming. Prerequisites: MA 212 or MA 223. Offered Spring semesters of odd numbered years. 3 lecture hours.

MA 380. Theory of Computation. 3 Credits.
This course introduces the theory of computability, including important results from the study of automata and formal languages. Includes introductory material about the theory of directed graphs and trees. A discussion of automata and their relationship to regular, context free and context-sensitive languages. General theories of computability, including Turing machines, and recursive functions. Further topics include decidability, undecidability and computational complexity. Prerequisite: MA 306. Offered Spring semesters of even numbered years. 3 lecture hours.

MA 390. Numerical Linear Algebra and Analysis. 3 Credits.
Numerical techniques for solving problems in linear algebra and analysis. Topics to be studied include integration, interpolation, function approximation, solutions of systems of equations, locating Eigen values. Attention will be paid to the theoretical aspects of the techniques, with particular emphasis on estimation of errors and on convergence properties of iterative techniques. Prerequisites: MA 241, MA 224. Offered Spring 2009 and every third year. 3 lecture hours.

MA 399. Mathematical Problem Solving. 3 Credits.

MA 405. Complex Analysis. 3 Credits.
A course in complex numbers, analytic functions, differentiation, and integration of complex functions, Taylor and Laurent series, evaluation of improper real integrals. Prerequisites: MA 223 and either MA 306 or permission of the instructor. Offered Spring 2011 and every third year. 3 lecture hours.

MA 407. Vector Analysis. 3 Credits.
A course that analyzes scalar and vector fields. Topics included are Newtonian kinematics and Kepler's Law of Planetary Motion, gradient, divergence, curl, theorems of Green, Stokes, Gauss, curvilinear coordinates. Prerequisite: MA 223. Offered Fall 2009 and every third year. 3 lecture hours.

MA 411. Senior Seminars. 3 Credits.
Advanced study designed to develop student competence in working independently and to afford students an opportunity to pursue topics not otherwise offered by the department. Prerequisite: senior standing in mathematics or permission of the instructor. This is the capstone course for the Mathematics Major. 3 lecture hours.

MA 412. Senior Seminars. 3 Credits.
Advanced study designed to enhance student competence in working independently and to afford students an opportunity to pursue topics not otherwise offered by the department. Topics may extend research performed in MA 411 or be a topic independent of MA 411. Prerequisite: MA 411. 3 lecture hours.

MA 421. Number Theory. 3 Credits.
A course in the properties of integers, prime numbers, congruencies, Diophantine equations, quadratic reciprocity. Prerequisite: MA306 or permission of the instructor. Offered Spring 2011 and every third year. 3 lecture hours.