Bachelor of Science in Mathematics at Northern Michigan University

Curriculum Matrix

All of the program learning outcomes are addressed to some extent in all classes. For example, the ability to formulate precise mathematical statements and reason logically are essential skills that are progressively developed in the curriculum. There is more emphasis on certain skills in certain classes, however. Classes are intended to help students move to a new level of proficiency with a certain suite of mathematical skills. Upper division classes make heavy usage of foundational skills, and thus continue to improve the student's mastery of those skills, but they are not necessarily the primary focus of such classes. The following matrix indicates some of the connections that exist between the main objectives of our program and our lower and upper division mathematics classes.

✓ indicates a class in which the outcome is directly addressed with substantial instruction and assessment emphasis

◇ indicates a class in which the outcome plays an important role, but is not the primary focus

General Program Learning Outcomes:

- Critical Thinking (CT)
- Problem Solving (PS)
- Communication (Com)

Content-Specific Program Learning Outcomes:

- Algebra, Number Theory, Combinatorics (Alg)
- Analysis and Calculus (Calc)
- Geometry and Topology (Geo)

	Lower Division Classes	CT	PS	Com	Alg	Calc	Geo
MA 111	College Algebra		✓	◇	✓		
MA 113	Finite Mathematics		✓	◇	✓		
MA 115	Precalculus		✓	◇	✓	◇	
MA 161	Calculus I	◇	✓	✓	◇	✓	◇
MA 163	Calculus II	◇	✓	✓	◇	✓	◇
MA 211	Linear Algebra I	◇	✓	✓	✓		◇
MA 240	Discrete Mathematics		✓	◇	✓		

	Upper Division Classes	CT	PS	Com	Alg	Calc	Geo
MA 265	Calculus III	✓	✓	✓	◇	✓	◇
MA 312	Abstract Algebra I	✓	✓	✓	✓		
MA 340	Combinatorics	✓	✓	✓	✓		
MA 361	Differential Equations	◇	✓	◇	✓	◇	
MA 363	Analysis I	✓	✓	✓	◇	✓	◇
MA 366	General Topology	✓	✓	✓		◇	✓
MA 370	Interest Theory	◇	✓	◇	◇	◇	
MA 371	Probability	◇	✓	◇	◇	◇	
MA 380	Linear Programming	◇	✓	◇	◇	◇	
MA 412	Abstract Algebra II	✓	✓	✓	✓		◇
MA 430	Optimization	◇	✓	◇	◇	◇	
MA 463	Real Analysis I	✓	✓	✓	◇	✓	◇
MA 464	Analysis II	✓	✓	✓	◇	✓	◇
MA 465	Complex Variables	✓	✓	✓	◇	✓	✓
MA 467	Convex Analysis	✓	✓	✓	◇	✓	◇
MA 470	Financial Economics	◇	✓	◇	◇	◇	
MA 471	Life Contingencies	◇	✓	◇	◇	◇	
MA 472	Statistics I	◇	✓	◇	◇	◇	
MA 473	Numerical Analysis	✓	✓	✓	◇	✓	◇
MA 475	Statistics II	◇	✓	◇	◇	◇	
MA 481	Mathematical Logic	✓	✓	✓	◇		
MA 482	Foundations of Mathematics	✓	✓	✓	◇		
MA 483	Number Theory	✓	✓	✓	✓		
MA 484	History of Mathematical Thought	✓	✓	✓	◇	◇	◇

Program Learning Outcomes

The Bachelor of Science in Mathematics program at Northern Michigan University aims to teach students mathematical skills and knowledge for their inherent beauty, for their importance in the development of rigorous, critical, analytical thinking, and for their immense utility in the solution of real world problems in science, business, and industry.

To live well and effectively in a rapidly changing, complex, competitive, and interconnected society, students must develop, and consistently use, their analytical and critical problem solving skills. Students of mathematics, properly cultivated, learn to make and challenge logical assertions, recognize patterns, notice what is relevant and irrelevant, think deeply and precisely, and nurture the products of their imagination into reality, and clearly communicate their ideas and insights while seeking and valuing the insights of others.

Students majoring in mathematics gain proficiency in:

Critical Thinking

- formulate the basic rules of logic, including the role of axioms or assumptions
- construct logical arguments and rigorous mathematical proofs
- distinguish a coherent argument from a fallacy
- articulate the difference between deductive and inductive reasoning
- construct abstract general principles from examples

Problem Solving

- solve abstract mathematical problems
- formulate mathematical models of real-world problems
- apply mathematical methods to tackle open-ended real-world problems
- articulate the connections between the different areas of mathematics
- recognize the connections between mathematical theories and their applications

Communication

- present mathematics clearly to an audience of their peers and faculty
- recognize the role mathematical proof plays in the conveyance of mathematics
- recognize the difference between rigorous proofs and more vague arguments
- construct precise statements in the development of vague ideas and insights
- articulate mathematical ideas from multiple perspectives
- explain mathematical ideas or mathematical models of real-world problems to non-mathematicians

Students will gain these skills in the context of subject-specific knowledge within the three overarching areas of mathematics: Algebra, Analysis, and Geometry, at a more basic level in the lower division classes, and at a more advanced level in the upper division classes. Throughout the course of their study, students will master logical and deductive skills and also be able to articulate the interconnectedness of these subject areas that define mathematics as a whole.

Algebra, Number Theory, and Combinatorics

Abstract algebra involves the study of algebraic structures such as groups, rings, fields, loops, vector spaces, and modules. Linear algebra is a crucial subfield of algebra, both as an introduction to abstract algebraic structures and as a body of advanced results of immense importance in diverse areas of application. Number theorists study properties of the integers, as well as those of mathematical objects constructed from or generalizing the integers. Combinatorics involves finite or countable discrete structures, such as abstract graphs.

Analysis and Calculus

Analysis extends and refines calculus; it encompasses differentiation, integration, measure, limits, infinite series, and analytic functions, primarily in the context of real and complex number systems. In much of analysis, the emphasis is not on finding explicit solutions to specific problems, but rather on determining which problems can be solved and what general properties solutions may share. Ordinary and partial differential equations play a central role in analysis, and are widely used in modeling real-world systems.

Geometry and Topology

Geometry explores the implementation and far-reaching consequences of systems of measurement. Topology addresses questions pertaining to shape and global structure. Non-Euclidean geometry, differential geometry, and algebraic geometry generalize key results and techniques from Euclidean geometry to both familiar and exotic settings.