



Twin Cities Campus

Mathematics B.A.

School of Mathematics

College of Liberal Arts

- Program Type: Baccalaureate
- Requirements for this program are current for Fall 2018
- Required credits to graduate with this degree: 120
- Required credits within the major: 42 to 82
- Degree: Bachelor of Arts

The mission of the program is to provide high-quality mathematics instruction in a stimulating intellectual atmosphere. The goal is to educate students at all levels to provide cultural enrichment, to give them the analytic tools they need to become responsible citizens, and to prepare them for careers involving mathematics.

The School of Mathematics offers a program in the College of Liberal Arts leading to a bachelor of arts degree. The course of study is flexible and may be adapted to satisfy a wide variety of interests and needs. Students may prepare for graduate study in mathematics or may emphasize various fields of interest, such as preparation for secondary school teaching, actuarial science, or programs in applied mathematics. This includes industrial mathematics, biology, mathematics applicable to computer science, and numerical analysis.

Program Delivery

This program is available:

- via classroom (the majority of instruction is face-to-face)

Admission Requirements

Students must complete 3 courses before admission to the program.

For information about University of Minnesota admission requirements, visit the [Office of Admissions website](#).

Required prerequisites

Calculus I & II

Take exactly 2 course(s) totaling exactly 8 credit(s) including 2 or more sub-requirements(s) from the following:

Calculus I

- [MATH 1271](#) - Calculus I [MATH] (4.0 cr)
- or [MATH 1371](#) - CSE Calculus I [MATH] (4.0 cr)
- or [MATH 1571H](#) - Honors Calculus I [MATH] (4.0 cr)

Calculus II

- [MATH 1272](#) - Calculus II (4.0 cr)
- or [MATH 1372](#) - CSE Calculus II (4.0 cr)
- or [MATH 1572H](#) - Honors Calculus II (4.0 cr)

2xxx/3xxxH-Level Calculus Course

Take exactly 1 course(s) totaling 4 - 5 credit(s) from the following:

Linear Algebra & Differential Equations

- [MATH 2243](#) - Linear Algebra and Differential Equations (4.0 cr)
- or [MATH 2373](#) - CSE Linear Algebra and Differential Equations (4.0 cr)
- or [MATH 2574H](#) - Honors Calculus IV (4.0 cr)

Multivariable Calculus

- [MATH 2263](#) - Multivariable Calculus (4.0 cr)
- or [MATH 2374](#) - CSE Multivariable Calculus and Vector Analysis (4.0 cr)
- or [MATH 2573H](#) - Honors Calculus III (4.0 cr)

Honors Mathematics

- [MATH 3592H](#) - Honors Mathematics I (5.0 cr)
- or [MATH 3593H](#) - Honors Mathematics II (5.0 cr)

General Requirements

All students are required to complete general University and college requirements including writing and liberal education courses. For more information about University-wide requirements, see the [liberal education requirements](#). Required courses for the major or minor in which a student receives a D grade (with or without plus or minus) do not count toward the major or minor (including transfer courses).



Program Requirements

Students are required to take 4 semester(s) of any second language.

CLA BA degrees require 18 upper division (3xxx-level or higher) credits outside the major designator. These credits must be taken in designators different from the major designator and cannot include courses that are cross-listed with the major designator. The major designator for the Mathematics BA is MATH.

STAT 5101 and STAT 5102 are the only courses from different department that may count towards the mathematics BA. The content of STAT 5101 is the same as MATH 5651, and only one of these courses may be taken, not both.

In addition to the specializations described below, students who wish to pursue a pure mathematics track, or are planning to go to graduate school in mathematics, should consult their advisor about appropriate course choices.

Students may earn no more than one undergraduate degree in mathematics: a BA, a BS, or a minor.

All incoming CLA freshmen must complete the First-Year Experience course sequence.

Remaining 2xxx/3xxxH-Level Calculus Course

Courses that counted towards the Admissions requirement for the mathematics BA may not also count towards this requirement.

Take exactly 1 course(s) totaling 4 - 5 credit(s) from the following:

Linear Algebra & Differential Equations

[MATH 2243](#) - Linear Algebra and Differential Equations (4.0 cr)

or [MATH 2373](#) - CSE Linear Algebra and Differential Equations (4.0 cr)

or [MATH 2574H](#) - Honors Calculus IV (4.0 cr)

or Multivariable Calculus

[MATH 2263](#) - Multivariable Calculus (4.0 cr)

or [MATH 2374](#) - CSE Multivariable Calculus and Vector Analysis (4.0 cr)

or [MATH 2573H](#) - Honors Calculus III (4.0 cr)

or Honors Mathematics

[MATH 3593H](#) - Honors Mathematics II (5.0 cr)

Sequences, Series, and Foundations

This course requirement will be waived for students who take MATH 3592H and 3593H.

Take exactly 1 course(s) totaling 3 - 4 credit(s) from the following:

• [MATH 2283](#) (~~Inactive~~) (3.0 cr)

or [MATH 3283W](#) - Sequences, Series, and Foundations: Writing Intensive [WI] (4.0 cr)

Capstone

Students pursuing the BA mathematics major program will develop not only the ability to identify, define, and solve mathematical problems but also the ability to communicate effectively about those problems and solutions. Students should consult with a mathematics advisor prior to beginning the senior year to determine possible topic and possible faculty mentor for the capstone.

Take exactly 1 course(s) totaling exactly 1 credit(s) from the following:

Students who double major and choose to complete the capstone requirement in their other major may waive the mathematics BA capstone, and they do not need to replace the 1 credit.

MATH 4995

A student in MATH 4995 will complete a project on mathematical content that is new to the student and at the level of an upper division MATH course. The project can be a 5-10 page paper or other project such as a computer program or lesson plan, subject to the approval of the instructor.

[MATH 4995](#) - Senior Project for CLA (1.0 cr)

or MATH 4997W

A student in MATH 4997W will complete a paper of at least 10 pages that goes through at least one cycle of revisions.

[MATH 4997W](#) - Senior project (Writing Intensive) [WI] (1.0 cr)

Upper Division Writing Intensive within the major

Students are required to take one upper division writing intensive course within the major. If that requirement has not been satisfied within the core major requirements, students must choose one course from the following list. Some of these courses may also fulfill other major requirements.

Take 0 - 1 course(s) from the following:

• [MATH 3283W](#) - Sequences, Series, and Foundations: Writing Intensive [WI] (4.0 cr)

• [MATH 4067W](#) - Actuarial Mathematics in Practice [WI] (3.0 cr)

• [MATH 4997W](#) - Senior project (Writing Intensive) [WI] (1.0 cr)

Mathematics Options



Mathematics (No Specialization)

Students who do not complete a sub-plan specialization must complete the following mathematics requirements.

The Mathematics BA with no specialization requires a minimum of six 4xxx-level and above mathematics courses (includes STAT 5101 and 5102). This does not include the capstone, and the courses must be chosen from the courses listed in this specialization.

For the Mathematics BA with no specialization, at least 11 upper-division credits in the major must be taken at the UM-TC campus. Take exactly 6 course(s) from the following:

Algebra

Both courses can be from the theoretical algebra list.

Take exactly 2 course(s) totaling exactly 8 credit(s) from the following:

Theoretical Algebra

Take 1 - 2 course(s) totaling 4 - 8 credit(s) from the following:

- [MATH 4281](#) - Introduction to Modern Algebra (4.0 cr)
- [MATH 5248](#) - Cryptology and Number Theory (4.0 cr)
- [MATH 5251](#) - Error-Correcting Codes, Finite Fields, Algebraic Curves (4.0 cr)
- [MATH 5285H](#) - Honors: Fundamental Structures of Algebra I (4.0 cr)
- [MATH 5286H](#) - Honors: Fundamental Structures of Algebra II (4.0 cr)
- [MATH 5385](#) - Introduction to Computational Algebraic Geometry (4.0 cr)

Further Discrete or Algebraic Math

Take 0 - 1 course(s) totaling 0 - 4 credit(s) from the following:

- [MATH 4242](#) - Applied Linear Algebra (4.0 cr)
- [MATH 5165](#) - Mathematical Logic I (4.0 cr)
- [MATH 5335](#) - Geometry I (4.0 cr)
- [MATH 5345H](#) - Honors: Introduction to Topology (4.0 cr)
- [MATH 5485](#) - Introduction to Numerical Methods I (4.0 cr)
- [MATH 5705](#) - Enumerative Combinatorics (4.0 cr)
- [MATH 5707](#) - Graph Theory and Non-enumerative Combinatorics (4.0 cr)
- [MATH 5711](#) - Linear Programming and Combinatorial Optimization (4.0 cr)

Analysis Electives

STAT 5102 does not count towards the Analysis requirement.

Take exactly 2 course(s) totaling exactly 8 credit(s) from the following:

- [MATH 4567](#) - Applied Fourier Analysis (4.0 cr)
- [MATH 4603](#) - Advanced Calculus I (4.0 cr)
- [MATH 4604](#) - Advanced Calculus II (4.0 cr)
- [MATH 5378](#) - Differential Geometry (4.0 cr)
- [MATH 5445](#) - Mathematical Analysis of Biological Networks (4.0 cr)
- [MATH 5447](#) - Theoretical Neuroscience (4.0 cr)
- [MATH 5467](#) - Introduction to the Mathematics of Image and Data Analysis (4.0 cr)
- [MATH 5486](#) - Introduction To Numerical Methods II (4.0 cr)
- [MATH 5525](#) - Introduction to Ordinary Differential Equations (4.0 cr)
- [MATH 5535](#) - Dynamical Systems and Chaos (4.0 cr)
- [MATH 5583](#) - Complex Analysis (4.0 cr)
- [MATH 5587](#) - Elementary Partial Differential Equations I (4.0 cr)
- [MATH 5588](#) - Elementary Partial Differential Equations II (4.0 cr)
- [MATH 5615H](#) - Honors: Introduction to Analysis I (4.0 cr)
- [MATH 5616H](#) - Honors: Introduction to Analysis II (4.0 cr)
- [MATH 5652](#) - Introduction to Stochastic Processes (4.0 cr)
- [MATH 5654](#) - Prediction and Filtering (4.0 cr)
- [MATH 5651](#) - Basic Theory of Probability and Statistics (4.0 cr)
- or [STAT 5101](#) - Theory of Statistics I (4.0 cr)

Mathematics Electives

Take exactly 2 course(s) totaling 6 - 8 credit(s) from the following:

- [MATH 4065](#) - Theory of Interest (4.0 cr)
- [MATH 4151](#) (*Inactive*) (3.0 cr)
- [MATH 4152](#) - Elementary Mathematical Logic (3.0 cr)
- [MATH 4242](#) - Applied Linear Algebra (4.0 cr)
- [MATH 4281](#) - Introduction to Modern Algebra (4.0 cr)
- [MATH 4428](#) - Mathematical Modeling (4.0 cr)
- [MATH 4512](#) - Differential Equations with Applications (3.0 cr)
- [MATH 4567](#) - Applied Fourier Analysis (4.0 cr)
- [MATH 4603](#) - Advanced Calculus I (4.0 cr)
- [MATH 4604](#) - Advanced Calculus II (4.0 cr)
- [MATH 4653](#) - Elementary Probability (4.0 cr)
- [MATH 4707](#) - Introduction to Combinatorics and Graph Theory (4.0 cr)
- [MATH 5067](#) - Actuarial Mathematics I (4.0 cr)



- [MATH 5068](#) - Actuarial Mathematics II (4.0 cr)
- [MATH 5075](#) - Mathematics of Options, Futures, and Derivative Securities I (4.0 cr)
- [MATH 5076](#) - Mathematics of Options, Futures, and Derivative Securities II (4.0 cr)
- [MATH 5165](#) - Mathematical Logic I (4.0 cr)
- [MATH 5166](#) (~~Inactive~~)(4.0 cr)
- [MATH 5248](#) - Cryptology and Number Theory (4.0 cr)
- [MATH 5251](#) - Error-Correcting Codes, Finite Fields, Algebraic Curves (4.0 cr)
- [MATH 5285H](#) - Honors: Fundamental Structures of Algebra I (4.0 cr)
- [MATH 5286H](#) - Honors: Fundamental Structures of Algebra II (4.0 cr)
- [MATH 5335](#) - Geometry I (4.0 cr)
- [MATH 5336](#) (~~Inactive~~)(4.0 cr)
- [MATH 5345H](#) - Honors: Introduction to Topology (4.0 cr)
- [MATH 5378](#) - Differential Geometry (4.0 cr)
- [MATH 5385](#) - Introduction to Computational Algebraic Geometry (4.0 cr)
- [MATH 5445](#) - Mathematical Analysis of Biological Networks (4.0 cr)
- [MATH 5447](#) - Theoretical Neuroscience (4.0 cr)
- [MATH 5467](#) - Introduction to the Mathematics of Image and Data Analysis (4.0 cr)
- [MATH 5485](#) - Introduction to Numerical Methods I (4.0 cr)
- [MATH 5486](#) - Introduction To Numerical Methods II (4.0 cr)
- [MATH 5525](#) - Introduction to Ordinary Differential Equations (4.0 cr)
- [MATH 5535](#) - Dynamical Systems and Chaos (4.0 cr)
- [MATH 5583](#) - Complex Analysis (4.0 cr)
- [MATH 5587](#) - Elementary Partial Differential Equations I (4.0 cr)
- [MATH 5588](#) - Elementary Partial Differential Equations II (4.0 cr)
- [MATH 5615H](#) - Honors: Introduction to Analysis I (4.0 cr)
- [MATH 5616H](#) - Honors: Introduction to Analysis II (4.0 cr)
- [MATH 5652](#) - Introduction to Stochastic Processes (4.0 cr)
- [MATH 5654](#) - Prediction and Filtering (4.0 cr)
- [MATH 5705](#) - Enumerative Combinatorics (4.0 cr)
- [MATH 5707](#) - Graph Theory and Non-enumerative Combinatorics (4.0 cr)
- [MATH 5711](#) - Linear Programming and Combinatorial Optimization (4.0 cr)
- [MATH 5651](#) - Basic Theory of Probability and Statistics (4.0 cr)
or [STAT 5101](#) - Theory of Statistics I (4.0 cr)
- [STAT 5102](#) - Theory of Statistics II (4.0 cr)

-OR-

Actuarial Science Specialization

Complete the requirements for the actuarial science sub-plan.

-OR-

Mathematics Education Specialization

Complete the requirements for the mathematics education sub-plan.

-OR-

Computer Applications Specialization

Complete the requirements for the computer applications sub-plan.

-OR-

Mathematical Biology: Genomics Specialization

Complete the requirements for the mathematical biology: genomics sub-plan.

-OR-

Mathematical Biology: Physiology Specialization

Complete the requirements for the mathematical biology: physiology sub-plan.

Program Sub-plans

A sub-plan is not required for this program.

Actuarial Science

The mathematics BA with a specialization in actuarial science requires a minimum of seven 4xxx-level and above mathematics courses (includes STAT 5101 and 5102). This does not include the capstone, and the courses must be chosen from the courses listed in this sub-plan.

Students pursuing the actuarial specialization may want to include MATH 4067W, which fulfills an upper division writing intensive



requirement, although it does not fulfill any of the upper division mathematics course requirements. It is recommended that students in this specialization should plan for a summer internship after junior year.

For the mathematics BA with a specialization in actuarial science, at least 22 upper division credits in the major must be taken at the University of Minnesota - Twin Cities campus.

Algebra

Theoretical Algebra

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 4281](#) - Introduction to Modern Algebra (4.0 cr)
- [MATH 5248](#) - Cryptology and Number Theory (4.0 cr)
- [MATH 5251](#) - Error-Correcting Codes, Finite Fields, Algebraic Curves (4.0 cr)
- [MATH 5285H](#) - Honors: Fundamental Structures of Algebra I (4.0 cr)
- [MATH 5286H](#) - Honors: Fundamental Structures of Algebra II (4.0 cr)
- [MATH 5385](#) - Introduction to Computational Algebraic Geometry (4.0 cr)

Applied Algebra

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 4242](#) - Applied Linear Algebra (4.0 cr)

Analysis

Probability and Statistics

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 5651](#) - Basic Theory of Probability and Statistics (4.0 cr)
- or [STAT 5101](#) - Theory of Statistics I (4.0 cr)

Stochastic Processes

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 5652](#) - Introduction to Stochastic Processes (4.0 cr)

Actuarial Mathematics

Take exactly 3 course(s) totaling exactly 12 credit(s) from the following:

- [MATH 4065](#) - Theory of Interest (4.0 cr)
- [MATH 5067](#) - Actuarial Mathematics I (4.0 cr)
- [MATH 5068](#) - Actuarial Mathematics II (4.0 cr)

Computer Science

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [CSCI 1103](#) - Introduction to Computer Programming in Java (4.0 cr)
- or [CSCI 1113](#) - Introduction to C/C++ Programming for Scientists and Engineers (4.0 cr)
- or [CSCI 1133](#) - Introduction to Computing and Programming Concepts (4.0 cr)

Introductory Economics and Business

Take exactly 4 course(s) totaling exactly 15 credit(s) from the following:

- [ECON 1101](#) - Principles of Microeconomics [SOCS, GP] (4.0 cr)
- [ECON 1102](#) - Principles of Macroeconomics (4.0 cr)
- [ACCT 2051](#) - Introduction to Financial Reporting (4.0 cr)
- [FINA 3001](#) - Finance Fundamentals (3.0 cr)

Statistics & Insurance or Economics & Insurance

Choose an emphasis in statistics and insurance, or in economics and insurance.

Statistics and Insurance

Statistics

- [STAT 3021](#) - Introduction to Probability and Statistics (3.0 cr)
- [STAT 3032](#) - Regression and Correlated Data (4.0 cr)
- [STAT 5102](#) - Theory of Statistics II (4.0 cr)

Insurance

Take exactly 1 course(s) totaling exactly 2 credit(s) from the following:

- [INS 4105](#) - Corporate Risk Management (2.0 cr)
- [INS 4101](#) - Employee Benefits (2.0 cr)
- [INS 4205](#) - Insurance Theory and Practice (2.0 cr)

or **Economics and Insurance**

Economics

- [ECON 3101](#) - Intermediate Microeconomics (4.0 cr)
- [ECON 4261](#) - Introduction to Econometrics (4.0 cr)

Insurance

Take exactly 2 course(s) totaling exactly 4 credit(s) from the following:

- [INS 4105](#) - Corporate Risk Management (2.0 cr)
- [INS 4101](#) - Employee Benefits (2.0 cr)
- [INS 4205](#) - Insurance Theory and Practice (2.0 cr)

Computer Applications

The mathematics BA with a specialization in computer applications requires a minimum of six 4xxx-level and above mathematics



courses (includes STAT 5101 and 5102). This does not include the capstone, and the courses must be chosen from the courses listed in this sub-plan.

Students who complete the computer applications specialization also meet requirements for a minor in computer science.

For the mathematics BA with a specialization in computer applications, at least 15 upper division credits in the major must be taken at the University of Minnesota - Twin Cities campus.

Algebra

Theoretical Algebra

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 4281](#) - Introduction to Modern Algebra (4.0 cr)
- [MATH 5248](#) - Cryptology and Number Theory (4.0 cr)
- [MATH 5251](#) - Error-Correcting Codes, Finite Fields, Algebraic Curves (4.0 cr)
- [MATH 5285H](#) - Honors: Fundamental Structures of Algebra I (4.0 cr)
- [MATH 5286H](#) - Honors: Fundamental Structures of Algebra II (4.0 cr)
- [MATH 5385](#) - Introduction to Computational Algebraic Geometry (4.0 cr)

Applied Algebra

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 5485](#) - Introduction to Numerical Methods I (4.0 cr)

Analysis

STAT 5102 does not count towards the analysis requirement.

Numerical Methods

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 5486](#) - Introduction To Numerical Methods II (4.0 cr)

Analysis Elective

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 4567](#) - Applied Fourier Analysis (4.0 cr)
- [MATH 4603](#) - Advanced Calculus I (4.0 cr)
- [MATH 4604](#) - Advanced Calculus II (4.0 cr)
- [MATH 5378](#) - Differential Geometry (4.0 cr)
- [MATH 5445](#) - Mathematical Analysis of Biological Networks (4.0 cr)
- [MATH 5447](#) - Theoretical Neuroscience (4.0 cr)
- [MATH 5467](#) - Introduction to the Mathematics of Image and Data Analysis (4.0 cr)
- [MATH 5525](#) - Introduction to Ordinary Differential Equations (4.0 cr)
- [MATH 5535](#) - Dynamical Systems and Chaos (4.0 cr)
- [MATH 5583](#) - Complex Analysis (4.0 cr)
- [MATH 5587](#) - Elementary Partial Differential Equations I (4.0 cr)
- [MATH 5588](#) - Elementary Partial Differential Equations II (4.0 cr)
- [MATH 5615H](#) - Honors: Introduction to Analysis I (4.0 cr)
- [MATH 5616H](#) - Honors: Introduction to Analysis II (4.0 cr)
- [MATH 5652](#) - Introduction to Stochastic Processes (4.0 cr)
- [MATH 5654](#) - Prediction and Filtering (4.0 cr)
- [MATH 5651](#) - Basic Theory of Probability and Statistics (4.0 cr)
or [STAT 5101](#) - Theory of Statistics I (4.0 cr)

Introductory Computer Science

Introduction to Computing and Programming Concepts

Take exactly 2 course(s) totaling exactly 8 credit(s) from the following:

- [CSCI 1133](#) - Introduction to Computing and Programming Concepts (4.0 cr)
or [CSCI 1133H](#) - Honors Introduction to Computing and Programming Concepts (4.0 cr)
- [CSCI 1933](#) - Introduction to Algorithms and Data Structures (4.0 cr)

or Introduction to Computer Programming

Take exactly 2 course(s) totaling exactly 8 credit(s) from the following:

- [CSCI 1913](#) - Introduction to Algorithms, Data Structures, and Program Development (4.0 cr)
- [CSCI 1103](#) - Introduction to Computer Programming in Java (4.0 cr)
or [CSCI 1113](#) - Introduction to C/C++ Programming for Scientists and Engineers (4.0 cr)

Discrete Structures

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [CSCI 2011](#) - Discrete Structures of Computer Science (4.0 cr)
or [CSCI 2011H](#) - Honors Discrete Structures of Computer Science (4.0 cr)

Computing-Related Mathematics

Mathematical Logic

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 5165](#) - Mathematical Logic I (4.0 cr)

Computer-Related Mathematics Electives

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:



- [MATH 4242](#) - Applied Linear Algebra (4.0 cr)
- [MATH 5166](#) *{Inactive}*(4.0 cr)
- [MATH 5248](#) - Cryptology and Number Theory (4.0 cr)
- [MATH 5251](#) - Error-Correcting Codes, Finite Fields, Algebraic Curves (4.0 cr)
- [MATH 5285H](#) - Honors: Fundamental Structures of Algebra I (4.0 cr)
- [MATH 5286H](#) - Honors: Fundamental Structures of Algebra II (4.0 cr)
- [MATH 5385](#) - Introduction to Computational Algebraic Geometry (4.0 cr)
- [MATH 5705](#) - Enumerative Combinatorics (4.0 cr)
- [MATH 5707](#) - Graph Theory and Non-enumerative Combinatorics (4.0 cr)
- [MATH 5711](#) - Linear Programming and Combinatorial Optimization (4.0 cr)

Upper-Division Computer Science Electives

Take exactly 2 course(s) totaling 6 - 8 credit(s) from the following:

- [CSCI 4011](#) - Formal Languages and Automata Theory (4.0 cr)
- [CSCI 4511W](#) - Introduction to Artificial Intelligence [WI] (4.0 cr)
- [CSCI 5607](#) - Fundamentals of Computer Graphics I (3.0 cr)
- [CSCI 5608](#) - Fundamentals of Computer Graphics II (3.0 cr)
- [CSCI 5421](#) - Advanced Algorithms and Data Structures (3.0 cr)
- [CSCI 5451](#) - Introduction to Parallel Computing: Architectures, Algorithms, and Programming (3.0 cr)
- [CSCI 5511](#) - Artificial Intelligence I (3.0 cr)
- [CSCI 5512](#) - Artificial Intelligence II (3.0 cr)
- [CSCI 5521](#) - Machine Learning Fundamentals (3.0 cr)
- [CSCI 4041](#) - Algorithms and Data Structures (4.0 cr)
or [CSCI 4041H](#) *{Inactive}*(4.0 cr)

Mathematics Education

The mathematics BA with a specialization in mathematics education requires a minimum of six 4xxx-level and above mathematics courses (includes STAT 5101 and 5102). This does not include the capstone, and the courses must be chosen from the courses listed in this sub-plan.

These courses prepare students to meet admission requirements for the secondary teaching licensure program in mathematics. The topics covered by these courses include theoretical and applied algebra-combinatorics, probability, mathematical analysis, and geometry.

For the mathematics BA with a specialization in mathematics education, at least 12 upper division credits in the major must be taken at the University of Minnesota - Twin Cities campus.

Algebra

Theoretical Algebra

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 4281](#) - Introduction to Modern Algebra (4.0 cr)
- [MATH 5248](#) - Cryptology and Number Theory (4.0 cr)
- [MATH 5251](#) - Error-Correcting Codes, Finite Fields, Algebraic Curves (4.0 cr)
- [MATH 5285H](#) - Honors: Fundamental Structures of Algebra I (4.0 cr)

Applied Algebra: Combinatorics

Note: MATH 4707 fulfills the applied algebra requirement only for the mathematics education specialization.

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 4707](#) - Introduction to Combinatorics and Graph Theory (4.0 cr)
- [MATH 5705](#) - Enumerative Combinatorics (4.0 cr)
- [MATH 5707](#) - Graph Theory and Non-enumerative Combinatorics (4.0 cr)

Geometry

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 5335](#) - Geometry I (4.0 cr)

Probability and Statistics

MATH 5651/STAT 5101 can count towards the the probability and statistics and the analysis electives requirement.

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 4653](#) - Elementary Probability (4.0 cr)
- [MATH 5651](#) - Basic Theory of Probability and Statistics (4.0 cr)
or [STAT 5101](#) - Theory of Statistics I (4.0 cr)

Analysis Electives

MATH 5651/STAT 5101 can count towards the the probability and statistics and the analysis electives requirement. STAT 5102 does not count towards the analysis requirement.

Take exactly 2 course(s) totaling exactly 8 credit(s) from the following:

- [MATH 4567](#) - Applied Fourier Analysis (4.0 cr)
- [MATH 4603](#) - Advanced Calculus I (4.0 cr)
- [MATH 4604](#) - Advanced Calculus II (4.0 cr)



- [MATH 5378](#) - Differential Geometry (4.0 cr)
- [MATH 5445](#) - Mathematical Analysis of Biological Networks (4.0 cr)
- [MATH 5447](#) - Theoretical Neuroscience (4.0 cr)
- [MATH 5467](#) - Introduction to the Mathematics of Image and Data Analysis (4.0 cr)
- [MATH 5486](#) - Introduction To Numerical Methods II (4.0 cr)
- [MATH 5525](#) - Introduction to Ordinary Differential Equations (4.0 cr)
- [MATH 5535](#) - Dynamical Systems and Chaos (4.0 cr)
- [MATH 5583](#) - Complex Analysis (4.0 cr)
- [MATH 5587](#) - Elementary Partial Differential Equations I (4.0 cr)
- [MATH 5588](#) - Elementary Partial Differential Equations II (4.0 cr)
- [MATH 5615H](#) - Honors: Introduction to Analysis I (4.0 cr)
- [MATH 5616H](#) - Honors: Introduction to Analysis II (4.0 cr)
- [MATH 5652](#) - Introduction to Stochastic Processes (4.0 cr)
- [MATH 5654](#) - Prediction and Filtering (4.0 cr)
- [MATH 5651](#) - Basic Theory of Probability and Statistics (4.0 cr)
or [STAT 5101](#) - Theory of Statistics I (4.0 cr)

Mathematics Elective

If a sixth mathematics course is needed after requirements for this specialization have been met, a course this list may be taken. Any course listed below that is not already counting towards another major requirement may count as a mathematics elective.

Take 0 - 1 course(s) totaling 0 - 4 credit(s) from the following:

- [MATH 4065](#) - Theory of Interest (4.0 cr)
- [MATH 4151](#) (~~Inactive~~)(3.0 cr)
- [MATH 4152](#) - Elementary Mathematical Logic (3.0 cr)
- [MATH 4242](#) - Applied Linear Algebra (4.0 cr)
- [MATH 4281](#) - Introduction to Modern Algebra (4.0 cr)
- [MATH 4428](#) - Mathematical Modeling (4.0 cr)
- [MATH 4512](#) - Differential Equations with Applications (3.0 cr)
- [MATH 4567](#) - Applied Fourier Analysis (4.0 cr)
- [MATH 4603](#) - Advanced Calculus I (4.0 cr)
- [MATH 4604](#) - Advanced Calculus II (4.0 cr)
- [MATH 4653](#) - Elementary Probability (4.0 cr)
- [MATH 4707](#) - Introduction to Combinatorics and Graph Theory (4.0 cr)
- [MATH 5067](#) - Actuarial Mathematics I (4.0 cr)
- [MATH 5068](#) - Actuarial Mathematics II (4.0 cr)
- [MATH 5075](#) - Mathematics of Options, Futures, and Derivative Securities I (4.0 cr)
- [MATH 5076](#) - Mathematics of Options, Futures, and Derivative Securities II (4.0 cr)
- [MATH 5165](#) - Mathematical Logic I (4.0 cr)
- [MATH 5166](#) (~~Inactive~~)(4.0 cr)
- [MATH 5248](#) - Cryptology and Number Theory (4.0 cr)
- [MATH 5251](#) - Error-Correcting Codes, Finite Fields, Algebraic Curves (4.0 cr)
- [MATH 5285H](#) - Honors: Fundamental Structures of Algebra I (4.0 cr)
- [MATH 5286H](#) - Honors: Fundamental Structures of Algebra II (4.0 cr)
- [MATH 5336](#) (~~Inactive~~)(4.0 cr)
- [MATH 5345H](#) - Honors: Introduction to Topology (4.0 cr)
- [MATH 5378](#) - Differential Geometry (4.0 cr)
- [MATH 5385](#) - Introduction to Computational Algebraic Geometry (4.0 cr)
- [MATH 5445](#) - Mathematical Analysis of Biological Networks (4.0 cr)
- [MATH 5447](#) - Theoretical Neuroscience (4.0 cr)
- [MATH 5467](#) - Introduction to the Mathematics of Image and Data Analysis (4.0 cr)
- [MATH 5485](#) - Introduction to Numerical Methods I (4.0 cr)
- [MATH 5486](#) - Introduction To Numerical Methods II (4.0 cr)
- [MATH 5525](#) - Introduction to Ordinary Differential Equations (4.0 cr)
- [MATH 5535](#) - Dynamical Systems and Chaos (4.0 cr)
- [MATH 5583](#) - Complex Analysis (4.0 cr)
- [MATH 5587](#) - Elementary Partial Differential Equations I (4.0 cr)
- [MATH 5588](#) - Elementary Partial Differential Equations II (4.0 cr)
- [MATH 5615H](#) - Honors: Introduction to Analysis I (4.0 cr)
- [MATH 5616H](#) - Honors: Introduction to Analysis II (4.0 cr)
- [MATH 5651](#) - Basic Theory of Probability and Statistics (4.0 cr)
- [MATH 5652](#) - Introduction to Stochastic Processes (4.0 cr)
- [MATH 5654](#) - Prediction and Filtering (4.0 cr)
- [MATH 5705](#) - Enumerative Combinatorics (4.0 cr)
- [MATH 5707](#) - Graph Theory and Non-enumerative Combinatorics (4.0 cr)
- [MATH 5711](#) - Linear Programming and Combinatorial Optimization (4.0 cr)
- [STAT 5102](#) - Theory of Statistics II (4.0 cr)



Mathematical Biology: Genomics

The mathematics BA with a specialization in mathematical biology: Genomics requires a minimum of six 4xxx-level and above mathematics courses (includes STAT 5101 and 5102). This does not include the capstone, and the courses must be chosen from the courses listed in this sub-plan.

For the mathematics BA with a specialization in mathematical biology: genomics, at least 16 upper division credits in the major must be taken at the University of Minnesota - Twin Cities campus.

Mathematical Modeling

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 4428](#) - Mathematical Modeling (4.0 cr)

Algebra

Theoretical Algebra

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 4281](#) - Introduction to Modern Algebra (4.0 cr)
- [MATH 5248](#) - Cryptology and Number Theory (4.0 cr)
- [MATH 5251](#) - Error-Correcting Codes, Finite Fields, Algebraic Curves (4.0 cr)
- [MATH 5285H](#) - Honors: Fundamental Structures of Algebra I (4.0 cr)
- [MATH 5286H](#) - Honors: Fundamental Structures of Algebra II (4.0 cr)
- [MATH 5385](#) - Introduction to Computational Algebraic Geometry (4.0 cr)

Applied Algebra

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 4242](#) - Applied Linear Algebra (4.0 cr)

Analysis

STAT 5102 does not count towards the analysis requirement.

Genomics Analysis

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 5525](#) - Introduction to Ordinary Differential Equations (4.0 cr)
- [MATH 5535](#) - Dynamical Systems and Chaos (4.0 cr)

Probability and Statistics

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 5651](#) - Basic Theory of Probability and Statistics (4.0 cr)
- or [STAT 5101](#) - Theory of Statistics I (4.0 cr)

Biology

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

General Biology

- [BIOL 1009](#) - General Biology [BIOL] (4.0 cr)
- or [BIOL 1009H](#) - Honors: General Biology [BIOL] (4.0 cr)

Genetics

Take exactly 1 course(s) totaling exactly 3 credit(s) from the following:

- [GCD 3022](#) - Genetics (3.0 cr)

Genomics Elective

If the genomics elective course chosen does not require a chemistry sequence, then it is still recommended that one semester of chemistry is taken (CHEM 1061 & CHEM 1065 Lab) which will also fulfill the physical sciences liberal education degree requirement. Some of these courses may have additional prerequisites.

The 5xxx-level CSCI course which was not taken to fulfill the computer science requirement may (with its prerequisites) be used to fulfill the genomics elective requirement. GCD 4151 has these additional prerequisite courses: CHEM 1061, CHEM 1065 (lab), CHEM 1062, CHEM 1066 (lab), CHEM 2301; BIOC 3021; BIOL 4003.

Take exactly 1 course(s) totaling 3 - 4 credit(s) from the following:

- [EEB 5042](#) - Quantitative Genetics (3.0 cr)
- [GCD 4143](#) - Human Genetics and Genomics (3.0 cr)
- [GCD 4151](#) - Molecular Biology of Cancer (3.0 cr)
- [MATH 5445](#) - Mathematical Analysis of Biological Networks (4.0 cr)

Computer Science Prerequisites

Option 1: Fulfills prerequisites for CSCI 5461 only

Take exactly 1 course(s) totaling exactly 3 credit(s) from the following:

CSCI 3003

- [CSCI 3003](#) - Introduction to Computing in Biology (3.0 cr)

or Option 2: Fulfills prerequisites for CSCI 5461 and 5481

Take exactly 4 course(s) totaling exactly 16 credit(s) from the following:

CSCI 1103 or 1113

- [CSCI 1103](#) - Introduction to Computer Programming in Java (4.0 cr)
- or [CSCI 1133](#) - Introduction to Computing and Programming Concepts (4.0 cr)

CSCI 1913

- [CSCI 1933](#) - Introduction to Algorithms and Data Structures (4.0 cr)

- [CSCI 2011/H and 4041/H](#)



CSCI 2011 - Discrete Structures of Computer Science (4.0 cr)
or CSCI 2011H - Honors Discrete Structures of Computer Science (4.0 cr)
CSCI 4041 - Algorithms and Data Structures (4.0 cr)
or CSCI 4041H *{Inactive}*(4.0 cr)

or **Option 3: Fulfills prerequisites for CSCI 5461 and 5481**

Take exactly 4 course(s) totaling exactly 16 credit(s) from the following:

CSCI 1133/H

•CSCI 1133 - Introduction to Computing and Programming Concepts (4.0 cr)
or CSCI 1133H - Honors Introduction to Computing and Programming Concepts (4.0 cr)

CSCI 1933

•CSCI 1933 - Introduction to Algorithms and Data Structures (4.0 cr)

CSCI 2011/H and 4041/H

CSCI 2011 - Discrete Structures of Computer Science (4.0 cr)
or CSCI 2011H - Honors Discrete Structures of Computer Science (4.0 cr)
CSCI 4041 - Algorithms and Data Structures (4.0 cr)
or CSCI 4041H *{Inactive}*(4.0 cr)

Computer Science

Take exactly 1 course(s) totaling exactly 3 credit(s) from the following:

•CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)
or CSCI 5481 - Computational Techniques for Genomics (3.0 cr)

Mathematics Elective

If MATH 5445 not is chosen as the genomics elective course, then a sixth upper division mathematics course is needed for this specialization. Any course listed below that is not already counting towards another major requirement may count as a mathematics elective.

Take 0 - 1 course(s) totaling 0 - 4 credit(s) from the following:

•MATH 4065 - Theory of Interest (4.0 cr)
•MATH 4151 *{Inactive}*(3.0 cr)
•MATH 4152 - Elementary Mathematical Logic (3.0 cr)
•MATH 4242 - Applied Linear Algebra (4.0 cr)
•MATH 4281 - Introduction to Modern Algebra (4.0 cr)
•MATH 4428 - Mathematical Modeling (4.0 cr)
•MATH 4512 - Differential Equations with Applications (3.0 cr)
•MATH 4567 - Applied Fourier Analysis (4.0 cr)
•MATH 4603 - Advanced Calculus I (4.0 cr)
•MATH 4604 - Advanced Calculus II (4.0 cr)
•MATH 4653 - Elementary Probability (4.0 cr)
•MATH 4707 - Introduction to Combinatorics and Graph Theory (4.0 cr)
•MATH 5067 - Actuarial Mathematics I (4.0 cr)
•MATH 5068 - Actuarial Mathematics II (4.0 cr)
•MATH 5075 - Mathematics of Options, Futures, and Derivative Securities I (4.0 cr)
•MATH 5076 - Mathematics of Options, Futures, and Derivative Securities II (4.0 cr)
•MATH 5165 - Mathematical Logic I (4.0 cr)
•MATH 5166 *{Inactive}*(4.0 cr)
•MATH 5248 - Cryptology and Number Theory (4.0 cr)
•MATH 5251 - Error-Correcting Codes, Finite Fields, Algebraic Curves (4.0 cr)
•MATH 5285H - Honors: Fundamental Structures of Algebra I (4.0 cr)
•MATH 5286H - Honors: Fundamental Structures of Algebra II (4.0 cr)
•MATH 5335 - Geometry I (4.0 cr)
•MATH 5336 *{Inactive}*(4.0 cr)
•MATH 5345H - Honors: Introduction to Topology (4.0 cr)
•MATH 5378 - Differential Geometry (4.0 cr)
•MATH 5385 - Introduction to Computational Algebraic Geometry (4.0 cr)
•MATH 5445 - Mathematical Analysis of Biological Networks (4.0 cr)
•MATH 5447 - Theoretical Neuroscience (4.0 cr)
•MATH 5467 - Introduction to the Mathematics of Image and Data Analysis (4.0 cr)
•MATH 5485 - Introduction to Numerical Methods I (4.0 cr)
•MATH 5486 - Introduction To Numerical Methods II (4.0 cr)
•MATH 5525 - Introduction to Ordinary Differential Equations (4.0 cr)
•MATH 5535 - Dynamical Systems and Chaos (4.0 cr)
•MATH 5583 - Complex Analysis (4.0 cr)
•MATH 5587 - Elementary Partial Differential Equations I (4.0 cr)
•MATH 5588 - Elementary Partial Differential Equations II (4.0 cr)
•MATH 5615H - Honors: Introduction to Analysis I (4.0 cr)
•MATH 5616H - Honors: Introduction to Analysis II (4.0 cr)
•MATH 5652 - Introduction to Stochastic Processes (4.0 cr)
•MATH 5654 - Prediction and Filtering (4.0 cr)



- [MATH 5705](#) - Enumerative Combinatorics (4.0 cr)
- [MATH 5707](#) - Graph Theory and Non-enumerative Combinatorics (4.0 cr)
- [MATH 5711](#) - Linear Programming and Combinatorial Optimization (4.0 cr)
- [STAT 5102](#) - Theory of Statistics II (4.0 cr)

Mathematical Biology: Physiology

The mathematics BA with a specialization in mathematical biology: physiology requires a minimum of six 4xxx-level and above mathematics courses (includes STAT 5101 and 5102). This does not include the capstone, and the courses must be chosen from the courses listed in this sub-plan.

For the mathematics BA with a specialization in mathematical biology: physiology, at least 16 upper division credits in the major must be taken at the University of Minnesota - Twin Cities campus.

Mathematical Modeling

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 4428](#) - Mathematical Modeling (4.0 cr)

Biological Networks or Neuroscience

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 5445](#) - Mathematical Analysis of Biological Networks (4.0 cr)
- [MATH 5447](#) - Theoretical Neuroscience (4.0 cr)

Algebra

Theoretical Algebra

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 4281](#) - Introduction to Modern Algebra (4.0 cr)
- [MATH 5248](#) - Cryptology and Number Theory (4.0 cr)
- [MATH 5251](#) - Error-Correcting Codes, Finite Fields, Algebraic Curves (4.0 cr)
- [MATH 5285H](#) - Honors: Fundamental Structures of Algebra I (4.0 cr)
- [MATH 5286H](#) - Honors: Fundamental Structures of Algebra II (4.0 cr)
- [MATH 5385](#) - Introduction to Computational Algebraic Geometry (4.0 cr)

Applied Algebra

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 4242](#) - Applied Linear Algebra (4.0 cr)

Analysis

STAT 5102 does not count towards the analysis requirement.

Physiology Analysis

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 5525](#) - Introduction to Ordinary Differential Equations (4.0 cr)
- [MATH 5535](#) - Dynamical Systems and Chaos (4.0 cr)

Probability & Statistics

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- [MATH 5651](#) - Basic Theory of Probability and Statistics (4.0 cr)
- or [STAT 5101](#) - Theory of Statistics I (4.0 cr)

Biology

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

General Biology

- [BIOL 1009](#) - General Biology [BIOL] (4.0 cr)
- or [BIOL 1009H](#) - Honors: General Biology [BIOL] (4.0 cr)

Physics

Introductory Physics I

Take exactly 1 course(s) totaling 4 - 5 credit(s) from the following:

- [PHYS 1201W](#) *{Inactive}* [PHYS, WI] (5.0 cr)
- or [PHYS 1301W](#) - Introductory Physics for Science and Engineering I [PHYS, WI] (4.0 cr)
- or [PHYS 1401V](#) - Honors Physics I [PHYS, WI] (4.0 cr)

Introductory Physics II

Take exactly 1 course(s) totaling 4 - 5 credit(s) from the following:

- [PHYS 1202W](#) *{Inactive}* [PHYS, WI] (5.0 cr)
- or [PHYS 1302W](#) - Introductory Physics for Science and Engineering II [PHYS, WI] (4.0 cr)
- or [PHYS 1402V](#) - Honors Physics II [PHYS, WI] (4.0 cr)

Chemistry

Take exactly 4 course(s) totaling exactly 8 credit(s) from the following:

Chemical Principles I

- [CHEM 1061](#) - Chemical Principles I [PHYS] (3.0 cr)
- with [CHEM 1065](#) - Chemical Principles I Laboratory [PHYS] (1.0 cr)
- or [CHEM 1071H](#) - Honors Chemistry I [PHYS] (3.0 cr)
- with [CHEM 1075H](#) - Honors Chemistry I Laboratory [PHYS] (1.0 cr)

•Chemical Principles II



CHEM 1062 - Chemical Principles II [PHYS] (3.0 cr)
with CHEM 1066 - Chemical Principles II Laboratory [PHYS] (1.0 cr)
or CHEM 1072H - Honors Chemistry II [PHYS] (3.0 cr)
with CHEM 1076H - Honors Chemistry II Laboratory [PHYS] (1.0 cr)

Physiology

Principles of Physiology

Take exactly 1 course(s) totaling exactly 4 credit(s) from the following:

- PHSL 3061 - Principles of Physiology (4.0 cr)

Physiology Electives

MATH 5445/5447 may only count if it is not counting towards another sub-plan requirement. Some of these courses many have additional prerequisites. NSC 5202 has the following prerequisites: CHEM 2301, BIOC 3021, NSCI 3101, NSCI 3102.

Take exactly 1 course(s) totaling 3 - 4 credit(s) from the following:

- MATH 5445 - Mathematical Analysis of Biological Networks (4.0 cr)
- MATH 5447 - Theoretical Neuroscience (4.0 cr)
- NSC 5202 - Theoretical Neuroscience: Systems and Information Processing (3.0 cr)
- PHSL 4702 - Cell Physiology (3.0 cr)
- PHSL 5444 - Muscle (3.0 cr)