Twin Cities Campus

Mathematics B.S.Math.

School of Mathematics

College of Science and Engineering

- Program Type: Baccalaureate
- Requirements for this program are current for Spring 2021
- Required credits to graduate with this degree: 120
- Required credits within the major: 71 to 93
- Degree: Bachelor of Science in Mathematics

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 leading to the bachelor of science 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 emphasize various fields of interest, such as preparation for secondary school teaching, actuarial science, or programs in applied mathematics, including 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 5 courses before admission to the program.

Freshman and transfer students students are usually admitted to pre-major status before admission to this major

For information about University of Minnesota admission requirements, visit the Office of Admissions website.

Required prerequisites

Calculus Sequence

CSE Calculus Sequence

Either MATH 2373 Linear Algebra & Differential Equations (here) or MATH 2374 Multivariable Calculus (see program requirements) can be taken to meet the requirement for admission to upper division.

Calculus I

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

Calculus II

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

Linear Algebra & Differential Equations OR Multivariable Calculus

Both linear algebra and differential equations and multivariable calculus are required to graduate from the program. Only one is required for admission to the program.

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 MATH 3592H - Honors Mathematics I (5.0 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 MATH 3593H - Honors Mathematics II (5.0 cr)

Physics

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)
PHYS 1302W - Introductory Physics for Science and Engineering II [PHYS, WI] (4.0 cr)

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or PHYS 1402V - Honors Physics II [PHYS, WI] (4.0 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

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.

MATH 3283W, 4067W, 49xx, and 59xx math courses neither satisfy upper division math course requirement nor the technical electives requirement.

At least 19 upper-division credits in the major must be taken at the University of Minnesota Twin Cities campus.

All freshmen in the College of Science and Engineering must complete CSE 1001: First-Year Experience.

Remaining Required Lower Division Calculus Courses

Linear Algebra & Differential Equations OR Multivariable Calculus

Students must complete both linear algebra and differential equations and multivariable calculus to graduate from this program. One of these courses must be taken prior to enrollment in the program.

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 MATH 3592H - Honors Mathematics I (5.0 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 MATH 3593H - Honors Mathematics II (5.0 cr)

Sequences, Series, & Foundations

MATH 3283W - Sequences, Series, and Foundations: Writing Intensive [WI] (4.0 cr)
or MATH 2283 *{Inactive}*(3.0 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)
- CSCI 4511W - Introduction to Artificial Intelligence [WI] (4.0 cr)

Specializations in Mathematics

Mathematics (No Specialization)

Students who do not choose one of the specializations must complete the basic mathematics major course requirements listed here.

For the technical electives requirement, students must take at least 6 credits of courses that meet the following criteria: prerequisite of calculus; 3xxx level or higher; courses form a coherent part of the student's program.

Algebra Requirement

Both courses can be from the theoretical algebra list.

Take 2 or more course(s) from the following:

Theoretical Algebra

Take 1 or more course(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)

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- MATH 5385 - Introduction to Computational Algebraic Geometry (4.0 cr)

•Further Discrete or Algebraic Math Courses

Take 0 or more course(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 Requirement

Take 2 or more course(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 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)
- STAT 5101 - Theory of Statistics I (4.0 cr)

Upper Division Math or Math-Related Courses

Take 4 or more course(s) totaling 14 or more credit(s) from the following:

- MATH 4065 - Theory of Interest (4.0 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 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 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)

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Information current as of March 28, 2024

- 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 5101 - Theory of Statistics I (4.0 cr)
- STAT 5102 - Theory of Statistics II (4.0 cr)

Computer Science Requirement

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)

Third Semester Physics Requirement

PHYS 2303 - Physics III: Physics of Matter (4.0 cr)
or PHYS 2311 *{Inactive}*(4.0 cr)
or PHYS 2503 - Physics III: Intro to Waves, Optics, and Special Relativity (4.0 cr)

Technical Electives Requirement

Any mathematics, science, or engineering course of technical nature that is not listed below and is not already used to fulfill specific BS mathematics requirements may be used as a technical elective course by permission. Contact the MATH director of undergraduate studies.

Chemistry Technical Electives

Take 2 or more course(s) totaling 6 or more credit(s) from the following:

- CHEM 4501 - Introduction to Thermodynamics, Kinetics, and Statistical Mechanics (3.0 cr)
- CHEM 4502 - Introduction to Quantum Mechanics and Spectroscopy (3.0 cr)

or **Chemical Engineering/Material Science Technical Elec.**

Take 2 or more course(s) totaling 6 or more credit(s) from the following:

- CHEN 3101 - Chemical Engineering Thermodynamics (4.0 cr)
- CHEN 3102 - Reaction Kinetics and Reactor Engineering (4.0 cr)

or **Computer Science Technical Electives**

Take 2 or more course(s) totaling 6 or more credit(s) from the following:

- CSCI 4011 - Formal Languages and Automata Theory (4.0 cr)
- CSCI 4041 - Algorithms and Data Structures (4.0 cr)
- CSCI 4061 - Introduction to Operating Systems (4.0 cr)
- CSCI 4611 - Programming Interactive Computer Graphics and Games (3.0 cr)
- CSCI 5106 - Programming Languages (3.0 cr)
- CSCI 5304 - Computational Aspects of Matrix Theory (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 5471 - Modern Cryptography (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 5523 - Introduction to Data Mining (3.0 cr)
- CSCI 5607 - Fundamentals of Computer Graphics 1 (3.0 cr)
- CSCI 5608 - Fundamentals of Computer Graphics II (3.0 cr)

or **Physics Technical Electives**

Take 2 or more course(s) totaling 6 or more credit(s) from the following:

- PHYS 4001 - Analytical Mechanics (4.0 cr)
- PHYS 4002 - Electricity and Magnetism (4.0 cr)
- PHYS 4051 - Methods of Experimental Physics I (5.0 cr)
- PHYS 4101 - Quantum Mechanics (4.0 cr)
- PHYS 4201 - Statistical and Thermal Physics (3.0 cr)
- PHYS 4511 - Introduction to Nuclear and Particle Physics (3.0 cr)
- PHYS 5001 - Quantum Mechanics I (4.0 cr)

or **Economics Technical Electives**

ECON 3101 - Intermediate Microeconomics (4.0 cr)

Additional Economics Technical Elective Course

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

- ECON 3102 - Intermediate Macroeconomics (4.0 cr)
- ECON 4261 - Introduction to Econometrics (4.0 cr)
- ECON 4751 - Financial Economics (3.0 cr)

or **Statistics Technical Electives**

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Take 2 or more course(s) totaling 6 or more credit(s) from the following:
- STAT 3021 - Introduction to Probability and Statistics (3.0 cr)
- STAT 3022 - Data Analysis (4.0 cr)
- STAT 3701 - Introduction to Statistical Computing (4.0 cr)
- STAT 5021 - Statistical Analysis (4.0 cr)
- STAT 5302 - Applied Regression Analysis (4.0 cr)
- STAT 5303 - Designing Experiments (4.0 cr)
- STAT 5421 - Analysis of Categorical Data (3.0 cr)

or **Mathematics Technical Electives**

Courses from the algebra, analysis, and mathematics electives lists which have not already used to fulfill those requirements may be taken to fulfill the technical elective requirement.

Take 2 or more course(s) totaling 6 or more credit(s) from the following:
- MATH 4xxx
- MATH 5xxx
- STAT 5101 - Theory of Statistics I (4.0 cr)
- STAT 5102 - Theory of Statistics II (4.0 cr)

-OR-

Actuarial Specialization

Complete the requirements for the actuarial 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

Complete the requirements for the genomics sub-plan.

-OR-

Mathematical Biology: Physiology

Complete the requirements for the physiology sub-plan.

Program Sub-plans

A sub-plan is not required for this program.

Actuarial Science

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 math course requirements. It is recommended in this specialization to plan for a summer internship after the junior year.

For the actuarial specialization, students must complete specific courses in economics, accounting, finance, insurance, and statistics. Thus, the required courses in these disciplines take the place of a technical electives package for students who successfully complete the actuarial specialization.

A third semester of physics is not required for the actuarial specialization.

Mathematics Course Requirements

Algebra

Theoretical Algebra

Take 1 or more course(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

MATH 4242 - Applied Linear Algebra (4.0 cr)

Analysis for Actuarial Specialization

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Theory of Probability & Statistics
MATH 5651 - Basic Theory of Probability and Statistics (4.0 cr)
or STAT 5101 - Theory of Statistics I (4.0 cr)
Stochastic Processes
MATH 5652 - Introduction to Stochastic Processes (4.0 cr)
Actuarial Mathematics
MATH 4065 - Theory of Interest (4.0 cr)
MATH 5067 - Actuarial Mathematics I (4.0 cr)
MATH 5068 - Actuarial Mathematics II (4.0 cr)
Upper Division Math Elective for Actuarial
Courses recommended for this specializations are MATH 4428, 5075, 5076, and 5485, but other MATH 4XXX- and 5XXX-level elective courses worth 3 or more credits will be accepted.
MATH 4428 - Mathematical Modeling (4.0 cr)
or MATH 5075 - Mathematics of Options, Futures, and Derivative Securities I (4.0 cr)
or MATH 5076 - Mathematics of Options, Futures, and Derivative Securities II (4.0 cr)
or MATH 5485 - Introduction to Numerical Methods I (4.0 cr)
or MATH 4xxx
or MATH 5xxx
Computer Science Requirement
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 & Business
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
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
INS 4105 - Corporate Risk Management (2.0 cr)
or INS 4205 - Insurance Theory and Practice (2.0 cr)

Computer Applications

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

Mathematics Course Requirements for Computer Applications
Algebra Requirements
Theoretical Algebra
Take 1 or more course(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
MATH 5485 - Introduction to Numerical Methods I (4.0 cr)
Analysis Requirements
Numerical Methods
MATH 5486 - Introduction To Numerical Methods II (4.0 cr)
Additional Analysis Course
Take 1 or more course(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)

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•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)
•STAT 5101 - Theory of Statistics I (4.0 cr)

Computing-Related Mathematics

MATH 5165 - Mathematical Logic I (4.0 cr)

Computer-Related Mathematics Electives

Take 1 or more course(s) from the following:
•MATH 4242 - Applied Linear 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)
•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)

Mathematics Electives

Mathematics courses in the algebra, analysis, or computing-related mathematics lists which are not used to fulfill those requirements may be taken as mathematics elective courses.
Take 2 or more course(s) totaling 6 or more credit(s) from the following:
•MATH 4xxx
•MATH 5xxx
•STAT 5101 - Theory of Statistics I (4.0 cr)
•STAT 5102 - Theory of Statistics II (4.0 cr)

Introductory Computer Science

Computing and Programming Concepts

Take 1 or more course(s) from the following:
•CSCI 1133 - Introduction to Computing and Programming Concepts (4.0 cr)
•CSCI 1133H - Honors Introduction to Computing and Programming Concepts (4.0 cr)

Take 1 or more course(s) from the following:
•CSCI 1933 - Introduction to Algorithms and Data Structures (4.0 cr)
•CSCI 1933H - Honors Introduction to Algorithms and Data Structures (4.0 cr)

or **Computer Programming**

Introduction to Programming in Java or C/C++

Take 1 or more course(s) from the following:
•CSCI 1103 - Introduction to Computer Programming in Java (4.0 cr)
•CSCI 1113 - Introduction to C/C++ Programming for Scientists and Engineers (4.0 cr)

Computer Programming

Take 1 or more course(s) from the following:
•CSCI 1913 - Introduction to Algorithms, Data Structures, and Program Development (4.0 cr)

Discrete Structures

CSCI 2011 - Discrete Structures of Computer Science (4.0 cr)

Computer Science Courses & Technical Electives

Upper division computer science courses may be counted as technical electives.
Take 2 or more course(s) from the following:
•CSCI 4011 - Formal Languages and Automata Theory (4.0 cr)
•CSCI 4041 - Algorithms and Data Structures (4.0 cr)
•CSCI 4511W - Introduction to Artificial Intelligence [WI] (4.0 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 5607 - Fundamentals of Computer Graphics 1 (3.0 cr)
•CSCI 5608 - Fundamentals of Computer Graphics II (3.0 cr)

Third Semester Physics Requirement

A physics course from the following list should be taken during the the second year to fulfill this requirement.
PHYS 2303 - Physics III: Physics of Matter (4.0 cr)
or PHYS 2311 *{Inactive}*(4.0 cr)
or PHYS 2503 - Physics III: Intro to Waves, Optics, and Special Relativity (4.0 cr)

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Mathematics Education

Preparation for teaching mathematics in secondary education.

The eight (8) required upper division (4xxx level or above) mathematics courses for the mathematics education specialization include courses that meet admission requirements for the secondary teaching licensure program in mathematics.

MATH 4653 is recommended to meet admission requirements for the Math Education Licensure Program, but it does not fulfill the analysis requirement for the major.

Courses that are recommended for this specialization (but not required) include MATH 5652 Stochastic Processes and STAT 5102 Theory of Statistics II.

Mathematics Education Specialization Requirements

Algebra Requirements

Theoretical Algebra

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

Applied Algebra: Combinatorics

Note: MATH 4707 fulfills the applied algebra requirements only for the mathematics education specialization.
MATH 4707 - Introduction to Combinatorics and Graph Theory (4.0 cr)
or MATH 5705 - Enumerative Combinatorics (4.0 cr)
or MATH 5707 - Graph Theory and Non-enumerative Combinatorics (4.0 cr)

Geometry

MATH 5335 - Geometry I (4.0 cr)

Probability and Statistics

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

Analysis Requirements

Take 2 or more course(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 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)
•STAT 5101 - Theory of Statistics I (4.0 cr)

Mathematics Education Electives Requirement

Recommended math elective courses for this specialization are MATH 4242, MATH 5652, STAT 5102. Courses from the algebra or analysis lists not used to fulfill those requirements may also be taken to fulfill this math electives requirement.
Take 2 or more course(s) totaling 6 or more credit(s) from the following:
•MATH 4xxx
•MATH 5xxx
•MATH 4242 - Applied Linear Algebra (4.0 cr)
•STAT 5102 - Theory of Statistics II (4.0 cr)
•MATH 5652 - Introduction to Stochastic Processes (4.0 cr)

Computer Science Requirement

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)

Third Semester Physics Requirement

Take one of the following physics courses in the third semester (fall semester of the second year).

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PHYS 2303 - Physics III: Physics of Matter (4.0 cr)
or PHYS 2311 *{Inactive}*(4.0 cr)
or PHYS 2503 - Physics III: Intro to Waves, Optics, and Special Relativity (4.0 cr)

Technical Electives Courses

Students must complete 6 credits of courses at the 3xxx level or above which have Calculus I (1271, 1371, 1571H) as a prerequisite and which form a coherent part of student's program. Technical electives are selected by consultation and approval of your math advisor. Earliest semester: Y3 fall; latest semester: Y4 spring.

Chemistry

Take 2 or more course(s) totaling 6 or more credit(s) from the following:
- CHEM 4501 - Introduction to Thermodynamics, Kinetics, and Statistical Mechanics (3.0 cr)
- CHEM 4502 - Introduction to Quantum Mechanics and Spectroscopy (3.0 cr)

or **Chemical Engineering**

Take 2 or more course(s) totaling 6 or more credit(s) from the following:
- CHEN 3101 - Chemical Engineering Thermodynamics (4.0 cr)
- CHEN 3102 - Reaction Kinetics and Reactor Engineering (4.0 cr)

or **Computer Science Technical Elective Courses**

Take 2 or more course(s) totaling 6 or more credit(s) from the following:
- CSCI 4011 - Formal Languages and Automata Theory (4.0 cr)
- CSCI 4041 - Algorithms and Data Structures (4.0 cr)
- CSCI 4061 - Introduction to Operating Systems (4.0 cr)
- CSCI 4611 - Programming Interactive Computer Graphics and Games (3.0 cr)
- CSCI 5106 - Programming Languages (3.0 cr)
- CSCI 5304 - Computational Aspects of Matrix Theory (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 5523 - Introduction to Data Mining (3.0 cr)
- CSCI 5607 - Fundamentals of Computer Graphics 1 (3.0 cr)
- CSCI 5608 - Fundamentals of Computer Graphics II (3.0 cr)

or **Physics Technical Elective Courses**

Take 2 or more course(s) totaling 6 or more credit(s) from the following:
- PHYS 4001 - Analytical Mechanics (4.0 cr)
- PHYS 4002 - Electricity and Magnetism (4.0 cr)
- PHYS 4051 - Methods of Experimental Physics I (5.0 cr)
- PHYS 4101 - Quantum Mechanics (4.0 cr)
- PHYS 4201 - Statistical and Thermal Physics (3.0 cr)
- PHYS 4511 - Introduction to Nuclear and Particle Physics (3.0 cr)
- PHYS 5001 - Quantum Mechanics I (4.0 cr)

or **Economics Technical Electives Courses**

ECON 3101 - Intermediate Microeconomics (4.0 cr)
Take 1 or more course(s) totaling 3 or more credit(s) from the following:
- ECON 3102 - Intermediate Macroeconomics (4.0 cr)
- ECON 4261 - Introduction to Econometrics (4.0 cr)
- ECON 4751 - Financial Economics (3.0 cr)

or **Statistics Technical Electives Courses**

Take 2 or more course(s) totaling 6 or more credit(s) from the following:
- STAT 3021 - Introduction to Probability and Statistics (3.0 cr)
- STAT 3022 - Data Analysis (4.0 cr)
- STAT 3701 - Introduction to Statistical Computing (4.0 cr)
- STAT 5021 - Statistical Analysis (4.0 cr)
- STAT 5302 - Applied Regression Analysis (4.0 cr)
- STAT 5303 - Designing Experiments (4.0 cr)
- STAT 5421 - Analysis of Categorical Data (3.0 cr)

or **Mathematics Courses for Technical Electives**

Take 2 or more course(s) totaling 6 or more credit(s) from the following:
- MATH 4xxx
- MATH 5xxx

Mathematical Biology: Genomics

Note that some genomics elective choices have additional prerequisite courses. A third semester of physics is not required for the mathematical biology: genomics specialization.

Mathematics Requirements for MathBio: Genomics

Mathematical Modeling Requirement

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MATH 4428 - Mathematical Modeling (4.0 cr)

Algebra Requirements

Theoretical Algebra

Take 1 or more course(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

MATH 4242 - Applied Linear Algebra (4.0 cr)

Analysis Requirements

Genomics Analysis Requirement

Take 1 or more course(s) from the following:

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

Theory of Probability & Statistics I

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

Mathematics Electives

Mathematics courses from the algebra, analysis, and genomics electives lists which were not used to fulfill those requirements may be taken as mathematics electives to meet the 8 course requirement for the major.

Take 3 or more course(s) totaling 9 or more credit(s) from the following:

- MATH 4xxx
- MATH 5xxx
- STAT 5102 - Theory of Statistics II (4.0 cr)

Lower Division Computer Science Requirement

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)

Computer Science Requirements for Genoomics

5xxx level Computer Science

Note the computer science prerequisite courses.

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

Genomics Genetics, Biology Requirements

MATH 5445 may only count if it is not counting towards another sub-plan requirement.

General Biology

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

Genetics

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). 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 prerequisite courses: CHEM 1061, CHEM 1065 (lab), CHEM 1062, CHEM 1066 (lab), CHEM 2301; BIOC 3021; BIOL 4003.

Take 1 or more course(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)

Mathematical Biology: Physiology

Note that some physiology elective choices have additional prerequisite courses. A third semester of physics is not required for the mathematical biology: physiology specialization.

Mathematics Requirements for MathBio: Physiology

Mathematical Modeling Requirement

MATH 4428 - Mathematical Modeling (4.0 cr)

Theoretical Algebra

Take 1 or more course(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)

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•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 Requirement

MATH 4242 - Applied Linear Algebra (4.0 cr)

Analysis Requirements

Physiology Analysis Requirement

Take 1 or more course(s) from the following:
•MATH 5525 - Introduction to Ordinary Differential Equations (4.0 cr)
•MATH 5535 - Dynamical Systems and Chaos (4.0 cr)

Theory of Probability & Statistics

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

Biological Networks or Neuroscience

MATH 5445 - Mathematical Analysis of Biological Networks (4.0 cr)
or MATH 5447 - Theoretical Neuroscience (4.0 cr)

Mathematics Electives

Mathematics courses from the algebra, analysis, or required mathematics for physiology lists which were not used to fulfill those requirements may be used to fulfill this requirement.
Take 2 or more course(s) totaling 6 or more credit(s) from the following:
•MATH 4xxx
•MATH 5xxx
•STAT 5102 - Theory of Statistics II (4.0 cr)

Lower Division Computer Science Requirement

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)

Physiology, Biology, Chemistry Requirements

Biology

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

Chemistry

Chemical Principles I

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

Chemical Principles II

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

Physiology Requirement

PHSL 3061 - Principles of Physiology (4.0 cr)

Physiology Electives

MATH 5445 or MATH 5447 may only count if it is not already counting towards another sub-plan requirement. Some of these courses may have additional prerequisites. NSC 5202 has the following prerequisites: CHEM 2301, BIOC 3021, NSCI 3101, NSCI 3102.
Take 1 or more course(s) from the following:
•PHSL 4702 - Cell Physiology (3.0 cr)
•PHSL 5444 - Muscle (3.0 cr)
•NSC 5202 - Theoretical Neuroscience: Systems and Information Processing (3.0 cr)
•MATH 5445 - Mathematical Analysis of Biological Networks (4.0 cr)
•MATH 5447 - Theoretical Neuroscience (4.0 cr)

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