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 2018
- Required credits to graduate with this degree: 120
- Required credits within the major: 73 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

Successful completion of five (5) courses is required for admission to upper division as a math major: three (3) calculus courses: Calculus I (1371/1271/1571H), Calculus II (1372/1272/1572H), and one 2xxx level Calculus course - either Linear Algebra & Differential Equations (2373/2243/2574H/3592H) or Multivariable Calculus (2374/2263/2573H/3593H) - plus two (2) Calculus-based Physics courses (see list below).

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)

2xxx Level Calculus Course

MATH 2373 - CSE Linear Algebra and Differential Equations (4.0 cr)
or MATH 2243 - Linear Algebra and Differential Equations (4.0 cr)
or MATH 2374 - CSE Multivariable Calculus and Vector Analysis (4.0 cr)
or MATH 2263 - Multivariable Calculus (4.0 cr)
or **2xxx or 3xxx Level Honors Calculus Course**
MATH 2574H - Honors Calculus IV (4.0 cr)
or MATH 3592H - Honors Mathematics I (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)
or PHYS 1501V *{Inactive}*[PHYS, WI] (4.0 cr)

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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)
or PHYS 1502V *{Inactive}*[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

Students must complete eight (8) upper division math courses at 4xxx and above plus a computer science course (see list below) and two (2) technical elective courses at the 3xxx level or above with the prerequisite of Calculus I. The School of Mathematics will accept STAT 5101 and 5102 as part of the eight-course upper division mathematics requirement. The content of STAT 5101 is the same as MATH 5651. STAT 5102 does not fulfill the analysis requirement. No other courses from other departments may be used as part of the eight-course math requirement, although other courses may be used as technical electives.

MATH 3113, 3116, 3118, 4113, 4116, 4118, 3283W, 4005, 4067W, 49xx and 59xx math courses neither satisfy upper division math course requirement nor the technical electives requirement.

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.

Remaining Required Lower Division Calculus Courses

2xxx Level Calculus Course

MATH 2374 - CSE Multivariable Calculus and Vector Analysis (4.0 cr)
or MATH 2263 - Multivariable Calculus (4.0 cr)
or **2xxx or 3xxx Level Honors Calculus Course**
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)

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

- **Applied Algebra**

Take 0 or more course(s) from the following:

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- MATH 4242 - Applied Linear Algebra (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 5485 - Introduction to Numerical Methods I (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 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)

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)

Mathematics Electives Requirement

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

4xxx/5xxx Level Mathematics Courses

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

- MATH 4xxx
- MATH 5xxx

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.

Technical Electives Courses: Mathematics

Complete 6 credits of technical elective courses at the 3xxx level or above which have Calculus I (1271/1371/1571H) as a prerequisite. Technical electives are selected by consultation with and approval of the math faculty advisor. Courses for this requirement must form a coherent part of a student's program.

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

- MATH 4152 - Elementary Mathematical Logic (3.0 cr)
- MATH 5165 - Mathematical Logic I (4.0 cr)
- MATH 4567 - Applied Fourier Analysis (4.0 cr)
- MATH 5467 - Introduction to the Mathematics of Image and Data Analysis (4.0 cr)
- MATH 5345H - Honors: Introduction to Topology (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 5615H - Honors: Introduction to Analysis I (4.0 cr)
- MATH 5616H - Honors: Introduction to Analysis II (4.0 cr)
- MATH 5587 - Elementary Partial Differential Equations I (4.0 cr)
- MATH 5588 - Elementary Partial Differential Equations II (4.0 cr)
- MATH 5583 - Complex Analysis (4.0 cr)
- MATH 5525 - Introduction to Ordinary Differential Equations (4.0 cr)
- MATH 5535 - Dynamical Systems and Chaos (4.0 cr)
- MATH 5485 - Introduction to Numerical Methods I (4.0 cr)
- MATH 5486 - Introduction To Numerical Methods II (4.0 cr)
- MATH 5445 - Mathematical Analysis of Biological Networks (4.0 cr)
- MATH 5447 - Theoretical Neuroscience (4.0 cr)
- MATH 5378 - Differential Geometry (4.0 cr)

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•MATH 5385 - Introduction to Computational Algebraic Geometry (4.0 cr)
•MATH 5335 - Geometry I (4.0 cr)
•MATH 4281 - Introduction to Modern Algebra (4.0 cr)
•MATH 4653 - Elementary Probability (4.0 cr)
•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)
•MATH 5711 - Linear Programming and Combinatorial Optimization (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 4603 - Advanced Calculus I (4.0 cr)
•MATH 4604 - Advanced Calculus II (4.0 cr)
•MATH 4512 - Differential Equations with Applications (3.0 cr)
•MATH 4242 - Applied Linear Algebra (4.0 cr)
•MATH 4428 - Mathematical Modeling (4.0 cr)
•MATH 4065 - Theory of Interest (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 5067 - Actuarial Mathematics I (4.0 cr)
•MATH 5068 - Actuarial Mathematics II (4.0 cr)

or **Chemistry Technical Elective**

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

or **Computer Science Technical Elective**

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 5607 - Fundamentals of Computer Graphics 1 (3.0 cr)
•CSCI 5608 - Fundamentals of Computer Graphics II (3.0 cr)
•CSCI 5403 *{Inactive}*(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)

or **Economics Technical Elective**

ECON 3101 - Intermediate Microeconomics (4.0 cr)
ECON 3102 - Intermediate Macroeconomics (4.0 cr)
or ECON 4261 - Introduction to Econometrics (4.0 cr)

or **Physics Technical Elective**

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 **Statistics Technical Elective**

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 5021 - Statistical Analysis (4.0 cr)
•STAT 5031 *{Inactive}*(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-

Actuarial Specialization

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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

The BS mathematics with actuarial specialization requires a minimum of 8 upper division (4xxx level and above) mathematics courses, as indicated in the lists below. 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, insurance, and finance. Thus, these required courses in economics and finance 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 Requirement
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 Requirement
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 Requirement
MATH 4065 - Theory of Interest (4.0 cr)
MATH 5067 - Actuarial Mathematics I (4.0 cr)
MATH 5068 - Actuarial Mathematics II (4.0 cr)
Additional Math Requirements for Actuarial Specialization
Courses recommended for this specialization are MATH 5075, 4428, 5485, 5076.
4xxx or 5xxx Level Math Courses offered in Fall
Take 1 or more course(s) from the following:
•MATH 4xxx
•MATH 5xxx
•MATH 5075 - Mathematics of Options, Futures, and Derivative Securities I (4.0 cr)
•MATH 5485 - Introduction to Numerical Methods I (4.0 cr)
or **4xxx or 5xxx Level Math Courses offered in Spring**

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Take 1 or more course(s) from the following:
•MATH 4xxx
•MATH 5xxx
•MATH 4428 - Mathematical Modeling (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)

Economics and Business

Introductory Economics

ECON 1101 - Principles of Microeconomics [SOCS, GP] (4.0 cr)
ECON 1102 - Principles of Macroeconomics (4.0 cr)

Economics and Finance

ACCT 2051 - Introduction to Financial Reporting (4.0 cr)
ECON 3101 - Intermediate Microeconomics (4.0 cr)
ECON 4261 - Introduction to Econometrics (4.0 cr)
FINA 3001 - Finance Fundamentals (3.0 cr)

Insurance

Take 2 or more course(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 upper division (4xxx level or above) mathematics courses, a 3rd semester of physics, and a minimum 24 credits of math and computer science courses relating to computer applications (from the courses listed below) are needed to fulfill the requirements for the BS mathematics with computer applications specialization. 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 5535 - Dynamical Systems and Chaos (4.0 cr)
•MATH 5525 - Introduction to Ordinary Differential Equations (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 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) from the following:
•MATH 4xxx

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•MATH 5xxx

Computing-Related Mathematics

Mathematical Logic Requirement

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 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)

Computer Applications Lower Division Requirements

Introduction to Computing and Programming Concepts

CSCI 1133 - 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**

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

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 5607 - Fundamentals of Computer Graphics 1 (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)

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)

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. Additional requirements for the BS mathematics with mathematics education specialization include a 3rd semester of physics, a minimum of one (1) computer science course, and a technical electives course package.

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, STAT 5102 Theory of Statistics II, and MATH 5336 Geometry 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)

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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 5651 or STAT 5101 may be used to fulfill this requirement.

MATH 4653 - Elementary Probability (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 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 5336, 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) from the following:
•MATH 4xxx
•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)

Third Semester Physics Requirement

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

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.

Mathematical Biology: Genomics

Note that some Genomics Elective choices have additional prerequisite courses.

Mathematics Requirements for MathBio: Genomics

Mathematical Modeling Requirement

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

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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) from the following:

- MATH 4xxx
- MATH 5xxx
- MATH 5445 - Mathematical Analysis of Biological Networks (4.0 cr)

Computer Science Requirements for Genomics

Introduction to Computing and Programming Concepts

CSCI 1133 - 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**

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)

5xxx Level CSCI Course Requirements

CSCI 2011 & CSCI 4041 may together serve as the substitute prerequisite courses for CSCI 5461.

Functional Genomics, Systems Biol., Bioinformatics

CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)

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

or **Computational Techniques for Genomics**

CSCI 5481 - Computational Techniques for Genomics (3.0 cr)

CSCI 4041 - Algorithms and Data Structures (4.0 cr)

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

Genomics, Biology Requirements

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).

1xxx Level Biology

BIOL 1009H may be substituted.

BIOL 1009 - General Biology [BIOL] (4.0 cr)

Genetics Requirement

GCD 3022 - Genetics (3.0 cr)

Genomics Elective Requirement

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.

MATH 5445 may be used to fulfill this requirement.

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)
- MATH 5445 - Mathematical Analysis of Biological Networks (4.0 cr)
- **Plant Genomics**

  PBIO 5301 has additional prerequisite courses: CHEM 1061, CHEM 1065 (lab), CHEM 1062, CHEM 1066 (lab), CHEM 2301, BIOC 3021.

  - PMB 5301 *{Inactive}*(3.0 cr)
- **Molecular Biology of Cancer**

  GCD 4151 has additional prerequisite courses: CHEM 1061, CHEM 1065 (lab), CHEM 1062, CHEM 1066 (lab), CHEM 2301, BIOC 3021, BIOL 4003.

  - GCD 4151 - Molecular Biology of Cancer (3.0 cr)

Mathematical Biology: Physiology

Note that some Physiology Elective choices have additional prerequisite courses.

Mathematics Requirements for MathBio: Physiology

Mathematical Modeling Requirement

MATH 4428 - Mathematical Modeling (4.0 cr)

Biological Networks or Neuroscience

MATH 5445 - Mathematical Analysis of Biological Networks (4.0 cr)

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or MATH 5447 - Theoretical Neuroscience (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)
- 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)

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) from the following:

- MATH 4xxx
- MATH 5xxx

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

Physiology Requirement

PHSL 3061 - Principles of Physiology (4.0 cr)

1xxx Level Biology Requirement

BIOL 1009H may be substituted.

BIOL 1009 - General Biology [BIOL] (4.0 cr)

1xxx Level Chemistry Requirements

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)
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 Electives

Whichever course - Math 5445 or Math 5447 - was not taken to fulfill the mathematics requirement can be taken to fulfill this electives requirement.

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

- PHSL 4702 - Cell Physiology (3.0 cr)
- PHSL 5444 - Muscle (3.0 cr)
- NSC 5202 has additional prerequisite courses: CHEM 2301, BIOC 3021, NSCI 3101, NSCI 3102.
  - NSC 5202 - Theoretical Neuroscience: Systems and Information Processing (3.0 cr)

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