The Department of Mathematics and Computer Science offers undergraduate majors in mathematics and in computer science. We also participate in the Informatics and Modeling Certificate Program. The department's graduate programs include a PhD in mathematics and MA programs in mathematics and in computer science.

Each student's course of study is designed to provide an introduction to the basic areas of mathematics or computer science and to provide the technical tools that will be useful later in the student's career. The course of study is planned in consultation with the student's faculty advisor and the department's advisory committees, DADCOM for mathematics and CADCOM for computer science.

The department's graduate programs include a PhD program in mathematics and MA programs in mathematics and in computer science. The research emphasis at Wesleyan at the doctoral level is in pure mathematics and theoretical computer science. One of the distinctive features of our department is the close interaction between the computer science faculty and the mathematics faculty, particularly those in logic and discrete mathematics.

Graduate students at Wesleyan enjoy small classes and close interactions with faculty and fellow graduate students. Graduate students normally register for three classes a semester and are expected to attend departmental colloquia and at least one regular seminar. The number of graduate students ranges from 17 to 21, with an entering class of three to six each year. There have always been both male and female students, graduates of small colleges and large universities, and U.S. and international students, including, in recent years, students from Bulgaria, Chile, China, Germany, India, Iran, and Sri Lanka. All of the department's recent PhD recipients have obtained faculty positions. Some have subsequently moved to mathematical careers in industry and government.

For additional information, please visit wesleyan.edu/mathcs/graduate/(http://www.wesleyan.edu/mathcs/graduate).

**FACULTY**

Ilesanmi Adeboye  
PHD, University of Michigan  
Assistant Professor of Mathematics

Wai Kiu Chan  
BS, University of Hong Kong; MPHIL, University of Hong Kong; PHD, The Ohio State University  
Professor of Mathematics

Karen L. Collins  
BA, Smith College; PHD, Massachusetts Institute of Technology  
Professor of Mathematics; Professor, Integrative Sciences

David A. Constantine  
BS, Eastern Nazarene College; PHD, University of Michigan  
Assistant Professor of Mathematics

Norman Danner  
BA, University of California, Berkeley; PHD, Indiana University Bloomington  
Associate Professor of Computer Science

Adam Fieldsteel

BA, Brown University; MAA, Wesleyan University; PHD, University of California, Berkeley  
Professor of Mathematics; Chair, Mathematics and Computer Science

Cameron Donnay Hill  
BA, Yale University; PHD, University of California, Berkeley  
Assistant Professor of Mathematics

Mark A. Hovey  
BS, Ohio State University; PHD, Massachusetts Institute of Technology  
Associate Provost; Professor of Mathematics

Daniel Krizanc  
BS, University of Toronto; PHD, Harvard University  
Professor of Computer Science; Vice-Chair, Mathematics and Computer Science; Professor, Integrative Sciences; Professor, Environmental Studies

Constance Leidy  
BS, Tulane University; PHD, Rice University  
Associate Professor of Mathematics

Han Li  
BS, Nankai University; PHD, Yale University  
Assistant Professor of Mathematics

Dan Licata  
BS, Brown University; PHD, Carnegie Mellon University  
Assistant Professor of Computer Science

James Lipton  
BS, U Nebraska Lincoln; MSC, Cornell University; PHD, Cornell University  
Professor of Computer Science

Victoria Ursula Manfredi  
BA, Smith College; MS, University of Massachusetts Amherst; PHD, University of Massachusetts Amherst  
Assistant Professor of Computer Science

David Pollack  
MA, Harvard University; PHD, Harvard University; SB, University of Chicago  
Associate Professor of Mathematics

Felipe A. Ramirez  
BS, Colorado St University; PHD, University of Michigan  
Assistant Professor of Mathematics

Christopher Rasmussen  
BA, University of Virginia; MS, University of Virginia; PHD, University of Arizona  
Associate Professor of Mathematics

Philip H. Scowcroft  
BA, Harvard University; MA, Cornell University; PHD, Cornell University  
Edward Burr Van Vleck Professor of Mathematics; Professor of Mathematics

Saray Shai  
BS, Israel Institute of Technology; PHD, University of St Andrews  
Assistant Professor of Computer Science

**AFFILIATED FACULTY**

Sara Kalisnik Verovsek  
Assistant Professor of Math, starting in Fall 2018

Tsampikos Kottos
BA, University of Crete; MS, University of Crete; PHD, University of Crete
Professor of Physics; Professor, Integrative Sciences; Professor, Mathematics

VISITING FACULTY

Cameron Bishop
MS, Fairfield University
Graduate Student, MATH-PHD; Visiting Instructor in Mathematics

Alyson Hildum
BA, Colorado School Mines; PHD, Brandeis University
Visiting Assistant Professor of Mathematics

Jonathan Huang
BA, Dartmouth College; PHD, University of Maryland College Park
Visiting Assistant Professor of Mathematics

Lisa Marie Kaylor
Graduate Student, MATH-PHD; Visiting Instructor in Mathematics

Mostafa Mirabi
Graduate Student, MATH-PHD; Visiting Instructor in Mathematics

Edward Morehouse
BS, University of California, Santa Barbara; PHD, Wesleyan University
Postdoctoral Fellow in Computer Science

Andre Oliveira
Graduate Student, MATH-PHD; Visiting Instructor in Mathematics

MATHEMATICS

Carol S. Wood
AB, Randolph Macon W College; MAA, Wesleyan University; PHD, Yale University
Edward Burr Van Vleck Professor of Mathematics, Emerita

EMERITI

Ethan M. Coven
BA, University of Rochester; MA, Yale University; MAA, Wesleyan University;
PHD, Yale University
Professor of Mathematics, Emeritus

Anthony W. Hager
BS, Pennsylvania State University; PHD, Pennsylvania State University
Professor of Mathematics, Emeritus

Michael S. Keane
BA, University of Texas Austin; MS, University of Gottingen; PHD, University of
Erlangen-Nurnber
Professor of Mathematics, Emeritus

Michael D. Rice
BS, Western Mich University; MS, Western Mich University; PHD, Wesleyan
University
Professor of Computer Science, Emeritus

Lewis C. Robertson
BS, University of Chicago; MS, University of Chicago; PHD, University of California
LA
Professor of Mathematics, Emeritus

Robert A. Rosenbaum
MAA, Wesleyan University
University Professor of Sciences and Mathematics, Emeritus

DEPARTMENTAL UNDERGRADUATE ADVISING EXPERTS

DADCOM provides advice and transfer credit approval for students in mathematics. CADCOM provides advice and transfer credit approval for students in computer science.

- Undergraduate Computer Science Major (catalog.wesleyan.edu/departments/math/ugrd-comp)
- Undergraduate Mathematics Major (catalog.wesleyan.edu/departments/math/ugrd-math)
- Doctor of Philosophy in Mathematics (catalog.wesleyan.edu/departments/math/grad-math-phd)
- Master of Arts in Mathematics and Computer Science (catalog.wesleyan.edu/departments/math/grad-ma)

COMP112 Introduction to Programming
The course will provide an introduction to a modern, high-level programming language including a discussion of input/output, basic control structures, types, functions, and classes. The lectures will also discuss a variety of algorithms as well as program design issues.

The second meeting time for each section is a computer lab.
Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: None

COMP113 Bioinformatics Programming
This course is an introduction to bioinformatics and programming for students with interest in the life sciences. It introduces problem areas and conceptual frameworks in bioinformatics. The course assumes little or no prior programming experience and will introduce the fundamental concepts and mechanisms of computer programs and examples (e.g., sequence matching and manipulation, database access, output parsing, dynamic programming) frequently encountered in the field of bioinformatics.

Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-BIOL
Identical With: BIOL265, MB&B265, CIS265
Prereq: [MB&B181 or BIOL181]

COMP114 How to Talk to Machines
In this course, students will learn how to program in a number of different styles.
We start with programming state-transition machines, the kind of programming one might use to instruct a robot how to interact with the world around it. We will move on to programming von Neumann machines, which form the core of most computing systems today, and so along the way we will learn what is "in
The goal of the course is to understand not just programming, but how computers are designed, and how those designs are reflected in the way we program them. Along the way, we will pay special attention to the commonalities of the various styles, ultimately learning that much of what a high-level language provides is a way to more easily express computational algorithms that are ultimately implemented on a state transition machine. After passing this course, students will have a working knowledge of basic programming, and COMP 114 satisfies the Mathematics major “elementary knowledge of algorithms and computer programming” requirement.

Offering: Host  
Grading: A-F  
Credits: 1.00  
Gen Ed Area: NSM-MATH  
Prereq: None

COMP115 How to Design Programs
In this course, students will learn to systematically design programs, going from a problem statement to a well-organized solution in a step-by-step fashion. We will apply these program design skills to many applications within computer science and in other disciplines. Students will develop their mathematical skills, because we will use a symbolic view of computation that explains the process of running a program as simple manipulations of its text. Students will also develop their technical reading and writing skills, such as understanding complex problem descriptions and precisely articulating the design of solutions. No prior experience with programming or computer science is expected.

Offering: Host  
Grading: A-F  
Credits: 1.00  
Gen Ed Area: NSM-MATH  
Prereq: None

COMP131 Can Machines Think? (Logic and Computation)
This course will address the question of machine reasoning and its scope through the perspective of computation and logic. We will start by studying the elements of mathematical logic and will learn how to code in the ML programming language so we can approach the issues of automated deduction from both a technical and philosophical perspective. The course will also include extensive readings on consciousness and on the capabilities and limits of computation. Students will be required to write several detailed essays on the issues discussed in class and in the readings.

Offering: Host  
Grading: OPT  
Credits: 1.00  
Gen Ed Area: NSM-MATH  
Prereq: None

COMP132 Computing, Privacy, and Security
This course will discuss both technical and ethical issues related to computing. On the technical side, the material will cover topics such as networking and cryptography. The technical material will be learned in the service of discussing social and ethical issues such as privacy, security, and intellectual property. Neither list is exhaustive, and each list is likely to be modified according to the interests of the instructor, interests of the students, and current events.

Offering: Host  
Grading: A-F  
Credits: 1.00  
Gen Ed Area: NSM-MATH  
Prereq: None

COMP111 Computer Science I
This is the first course in a two-course sequence (COMP111-212) that is the gateway to the computer science major. It is intended for prospective computer science majors and others who want an in-depth understanding of programming and computer science. Topics to be covered in COMP111-212 include an introduction to the fundamental ideas of programming in imperative and functional languages, correctness and cost specifications, and proof techniques for verifying specifications.

Specifics such as choice of programming language, which topics are covered in which semesters, etc., will vary according to the tastes of the faculty offering the courses.

Offering: Host  
Grading: A-F  
Credits: 1.00  
Gen Ed Area: NSM-MATH  
Prereq: COMP112 OR COMP113 OR COMP115

COMP212 Computer Science II
This is the second course in a two-course sequence (COMP211-212) that is the gateway to the computer science major. It is intended for prospective computer science majors and others who want an in-depth understanding of programming and computer science. Topics to be covered in COMP211-212 include an introduction to the fundamental ideas of programming in imperative and functional languages, correctness and cost specifications, and proof techniques for verifying specifications.

Specifics such as choice of programming language, which topics are covered in which semesters, etc., will vary according to the tastes of the faculty offering the courses.

Offering: Host  
Grading: A-F  
Credits: 1.00  
Gen Ed Area: NSM-MATH  
Prereq: COMP211

COMP260 Special Topics in Computer Science
This course is designed for nonmajors who wish to pursue some topic in computer science beyond introduction to programming. Topics will vary according to the instructor.

Offering: Host  
Grading: A-F  
Credits: 1.00  
Gen Ed Area: NSM-MATH  
Identical With: QAC260  
Prereq: COMP112

COMP266 Bioinformatics
This course is an introduction to bioinformatics for students with interest in the life sciences. The course is similar to BIOL265 but only meets in the second half of the semester (with BIOL265) and is designed for students with programming background, ideally in Python. The course introduces problem areas and conceptual frameworks in bioinformatics and discusses programming approaches used in bioinformatics such as sequence matching and manipulation algorithms using dynamic programming, clustering analysis of gene expression data, analysis of genetic nets using Object Oriented Programming, and sequence analysis using Hidden Markov Models, Regular Expressions, and information theory.

Offering: CrossListing  
Grading: A-F  
Credits: 0.50  
Gen Ed Area: NSM-BIOL  
Identical With: BIOL266, MB&B266, CIS266  
Prereq: [MB&B181 OR BIOL181]

COMP301 Automata Theory and Formal Languages
This course is an introduction to formalisms studied in computer science and mathematical models of computing machines. The language formalisms
discussed will include regular, context-free, recursive, and recursively enumerable languages. The machine models discussed include finite-state automata, pushdown automata, and Turing machines.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Identical With: COMP500
Prereq: COMP211 AND COMP212 AND MATH228

COMP312 Algorithms and Complexity
The course will cover the design and analysis of efficient algorithms. Basic topics will include greedy algorithms, divide-and-conquer algorithms, dynamic programming, and graph algorithms. Some advanced topics in algorithms may be selected from other areas of computer science.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Identical With: COMP510
Prereq: COMP212 AND MATH228

COMP321 Design of Programming Languages
This course is an introduction to concepts in programming languages. Topics will include parameter passing, type checking and inference, control mechanisms, data abstraction, module systems, and concurrency. Basic ideas in functional, object-oriented, and logic programming languages will be discussed.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Identical With: COMP521
Prereq: COMP212 AND MATH228

COMP327 Evolutionary and Ecological Bioinformatics
Bioinformatic analysis of gene sequences and gene expression patterns has added enormously to our understanding of ecology and evolution. For example, through bioinformatic analysis of gene sequences, we can now reconstruct the evolutionary history of physiology, even though no traces of physiology exist in the fossil record. We can determine the adaptive history of one gene and all the gene’s descendants. We can now construct the evolutionary tree of all of life. Bioinformatics is particularly promising for analysis of the ecology and biodiversity of microbial communities, since well over 99 percent of microorganisms cannot be cultured; our only knowledge of these organisms is through analysis of their gene sequences and gene expression patterns. For example, even when we cannot culture most of a microbial community, we can determine which metabolic pathways are of greatest significance through analysis of community-level gene expression. All these research programs are made accessible not only by breakthroughs in molecular technology but also by innovation in the design of computer algorithms. This course, team-taught by an evolutionary biologist and a computer scientist, will present how bioinformatics is revolutionizing evolutionary and ecological investigation and will present the design and construction of bioinformatic computer algorithms underlying the revolution in biology. Students will learn algorithms for reconstructing phylogeny, for sequence alignment, and for analysis of genomes, and students will have an opportunity to create their own algorithms.

Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-BIOL
Identical With: BIOL327, BIOL527, COMP527, CIS327
Prereq: [BIOL182 or MB&B182] OR [BIOL196 or MB&B196] OR COMP112 OR COMP211

COMP331 Computer Structure and Organization
The purpose of the course is to introduce and discuss the structure and operation of digital computers. Topics will include the logic of circuits, microarchitectures, microprogramming, conventional machine architectures, and an introduction to software/hardware interface issues. Assembly language programming will be used to demonstrate some of the basic concepts.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Identical With: COMP531
Prereq: COMP212

COMP332 Computer Networks
This course will provide an introduction to the fundamentals of computer networks. Computer networks have become embedded in our everyday lives, from the Internet to cellular phones to cloud networking, enabling applications such as email, texting, web browsing, on-demand video, video conferencing, peer-to-peer file sharing, social networking, cloud computing, and more. This course will delve into the infrastructure and protocols that have allowed computer networks to achieve their current ubiquity. While the primary focus of the course will be on the Internet’s architecture, protocols, and applications, we will also touch on other types of computer networks. Programming assignments will be done using Python; prior knowledge of Python is not required.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: COMP212 and MATH228

COMP342 Software Engineering
This course provides an introduction to the processes and tools of software engineering: the design, development, testing, and maintenance of large software systems. The course is based on the Berkeley MOOC "Software Engineering as a Service" and uses on-line material from the MOOC to provide some of the course content.

The first part of the course will cover developing software in teams as well as learning the languages and tools used in the course, including Ruby, Rails, Cucumber, RSpec, Pivotal Tracker, and gitHub.

The second part of the course will continue to present software engineering concepts but will also focus on developing a team service-learning software development project for an external customer.

Offering: Host
Grading: A-F
Credits: 1.50
Gen Ed Area: NSM-MATH
Prereq: COMP211 AND COMP212

COMP350 Computational Media: Videogame Design and Development
This course examines the interplay of art and science in the development of contemporary video games using “game tool” applications to achieve a variety of purposes. It combines a detailed understanding of computational media, including legal and commercial aspects, with hands-on experience in the creative process. There will be discussions with invited industry leaders in various subject areas. Students will have the opportunity to work as part of development teams and create working prototypes to understand the challenges and rewards of producing video games in a professional context.

Offering: Crosslisting
Grading: A-F
Credits: 1.50
Gen Ed Area: NSM-MATH
Identical With: CIS250, FILM250
Mathematics and Computer Science

Prereq: None

COMP352 Topics in Artificial Intelligence
The content of this course will be artificial intelligence and machine learning. The course will cover search strategies and planning and will build up to basic machine learning principles and techniques. Includes some programming.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Identical With: COMP552
Prereq: MATH228 AND COMP212

COMP356 Computer Graphics
This course covers fundamental algorithms in two- and three-dimensional graphics. The theory and application of the algorithms will be studied, and implementation of the algorithms or applications of them will be an integral part of the course. According to the tastes of the instructor, additional topics such as elementary animation or more advanced techniques may be covered.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: COMP212

COMP360A Special Topics in Computer Science
This course covers special topics in computer science. Topics will vary according to the instructor.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: COMP212

COMP360B Special Topics in Computer Science
This course covers special topics in computer science. Topics will vary according to the instructor.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: COMP212 AND MATH228

COMP360C Special Topics in Computer Science
This course covers special topics in computer science. Topics will vary according to the instructor.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: COMP212 AND MATH228

COMP361 Advanced Topics in Computer Science
This course covers advanced topics in Computer Science. The precise topics will vary with the offering, but will typically have prerequisites beyond COMP 211-212. This course may be repeated for credit.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: COMP212 AND MATH228

COMP402 Individual Tutorial, Undergraduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

COMP403 Department/Program Project or Essay
Project to be arranged in consultation with the tutor.
Offering: Host
Grading: A-F

COMP404 Department/Program Project or Essay
Project to be arranged in consultation with the tutor.
Offering: Host
Grading: A-F

COMP407 Senior Tutorial (downgraded thesis)
Downgraded Senior Thesis Tutorial - Project to be arranged in consultation with the tutor. Only enrolled in through the Honors Coordinator.
Offering: Host
Grading: A-F

COMP408 Senior Tutorial (downgraded thesis)
Downgraded Senior Thesis Tutorial - Project to be arranged in consultation with the tutor. Only enrolled in through the Honors Coordinator.
Offering: Host
Grading: A-F

COMP409 Senior Thesis Tutorial
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

COMP410 Senior Thesis Tutorial
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

COMP411 Group Tutorial, Undergraduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

COMP412 Group Tutorial, Undergraduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

COMP419 Student Forum
Student-run group tutorial, sponsored by a faculty member and approved by the chair of a department or program.
Offering: Host
Grading: Cr/U

COMP420 Student Forum
Student-run group tutorial, sponsored by a faculty member and approved by the chair of a department or program.
Offering: Host
Grading: Cr/U

COMP421 Undergraduate Research, Sciences
Individual research projects for undergraduate students supervised by faculty members.
Offering: Host
Grading: A-F
and required of graduate students.

COMPS423 Advanced Research Seminar, Undergraduate
Advanced research tutorial; project to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

COMPS424 Advanced Research Seminar, Undergraduate
Advanced research tutorial; project to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

COMPS469 Education in the Field, Undergraduate
Students must consult with the department and class dean in advance of undertaking education in the field for approval of the nature of the responsibilities and method of evaluation.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: None

COMPS491 Teaching Apprentice Tutorial
The teaching apprentice program offers undergraduate students the opportunity to assist in teaching a faculty member's course for academic credit.
Offering: Host
Grading: OPT

COMPS492 Teaching Apprentice Tutorial
The teaching apprentice program offers undergraduate students the opportunity to assist in teaching a faculty member's course for academic credit.
Offering: Host
Grading: OPT

COMPS500 Automata Theory and Formal Languages
This course is an introduction to formalisms studied in computer science and mathematical models of computing machines. The language formalisms discussed will include regular, context-free, recursive, and recursively enumerable languages. The machine models discussed include finite-state automata, pushdown automata, and Turing machines.
Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Identical With: COMP301
Prereq: COMP211 AND COMP212 AND MATH228

COMPS501 Individual Tutorial, Graduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

COMPS502 Individual Tutorial, Graduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

COMPS503 Selected Topics, Graduate Sciences
Topic to be arranged in consultation with the tutor. A seminar primarily concerned with papers taken from current research publications designed for, and required of, graduate students.
Offering: Host
Grading: A-F

COMPS504 Selected Topics, Graduate Sciences
Topic to be arranged in consultation with the tutor. A seminar primarily concerned with papers taken from current research publications designed for, and required of, graduate students.
Offering: Host
Grading: A-F

COMPS510 Algorithms and Complexity
The course will cover the design and analysis of efficient algorithms. Basic topics will include greedy algorithms, divide-and-conquer algorithms, dynamic programming, and graph algorithms. Some advanced topics in algorithms may be selected from other areas of computer science.
Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Identical With: COMP312
Prereq: COMP212 AND MATH228

COMPS511 Group Tutorial, Graduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

COMPS512 Group Tutorial, Graduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

COMPS521 Design of Programming Languages
This course is an introduction to concepts in programming languages. Topics include parameter passing, type checking and inference, control mechanisms, data abstraction, module systems, and concurrency. Basic ideas in functional, object-oriented, and logic programming languages will be discussed.
Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Identical With: COMP321
Prereq: COMP212 AND MATH228

COMPS527 Evolutionary and Ecological Bioinformatics
Bioinformatic analysis of gene sequences and gene expression patterns has added enormously to our understanding of ecology and evolution. For example, through bioinformatic analysis of gene sequences, we can now reconstruct the evolutionary history of physiology, even though no traces of physiology exist in the fossil record. We can determine the adaptive history of one gene and all the gene's descendants. We can now construct the evolutionary tree of all life. Bioinformatics is particularly promising for analysis of the ecology and biodiversity of microbial communities, since well over 99 percent of microorganisms cannot be cultured; our only knowledge of these organisms is through analysis of their gene sequences and gene expression patterns. For example, even when we cannot culture most of a microbial community, we can determine which metabolic pathways are of greatest significance through analysis of community-level gene expression. All these research programs are made accessible not only by breakthroughs in molecular technology but also by innovation in the design of computer algorithms. This course, team-taught by an evolutionary biologist and a computer scientist, will present how bioinformatics is revolutionizing evolutionary and ecological investigation and will present the design and construction of bioinformatic computer algorithms underlying the revolution in biology. Students will learn algorithms for reconstructing phylogeny, for sequence alignment, and for analysis of genomes, and students will have an opportunity to create their own algorithms.
Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-BIOL
Identical With: BIOL327, COMP327, BIOL527, CIS327
MATH117 Introductory Calculus
This course is designed to introduce basic ideas and techniques of differential calculus. Students should enter with sound precalculus skills but with very limited or no prior study of calculus. Topics to be considered include differential calculus of algebraic, exponential, and logarithmic functions. (Integral calculus will be introduced in MATH118.)
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: None

MATH118 Introductory Calculus II: Integration and Its Applications
This course continues MATH117 and is designed to introduce basic ideas and techniques of calculus. Students should enter MATH118 with sound precalculus skills and with very limited or no prior study of integral calculus. Topics to be considered include differential and integral calculus of algebraic, exponential, and logarithmic functions.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: None

MATH119 Elements of Calculus, Part 1
This course is the first half of a two-semester calculus sequence (MATH119 & MATH120). This sequence is designed for students who have not previously studied calculus. The course, together with MATH120, will cover limits, derivatives, and integrals. Exponential, logarithmic, and trigonometric functions will be introduced and their calculus will be studied. Applications of calculus to biology, economics, physics, and/or other fields will be emphasized. Completion of both semesters (MATH119 and MATH120) is required to receive credit for MATH119.
Offering: Host
Grading: Amp Graded
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: None

MATH120 Elements of Calculus, Part II
This course is the second half of a two-semester calculus sequence (an ampersand (&) course). This sequence is designed for students who have not previously studied calculus. The course, together with MATH119, will cover limits, derivatives, and integrals. Exponential, logarithmic, and trigonometric functions will be introduced and their calculus will be studied. Applications of calculus to biology, economics, physics, and/or other fields will be emphasized. Completion of both semesters (MATH119 and MATH120) is required to receive credit for MATH119.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: MATH119

MATH121 Calculus I, Part I
MATH121 is designed for students who have completed a high school calculus course and who might pursue study in an area for which calculus is an essential tool but who are not prepared to place out of calculus. This course is a deeper and broader study of calculus than MATH117; theoretical aspects are not the main focus but will not be avoided. The course will, together with MATH122, treat limits, derivatives, and integrals; the calculus of exponential, logarithmic, trigonometric, and inverse trigonometric functions; techniques of integration; plane analytic geometry; various applications of calculus; and sequences and series, including power series and intervals of convergence.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: None
MATH122 Calculus I, Part II
The continuation of MATH121. Topics covered include techniques and applications of integration and an introduction to sequences and series.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: None

MATH132 Elementary Statistics
Topics included in this course are organizing data, central measures, measures of variation, distributions, sampling, estimation, conditional probability (Bayes' theorem), hypothesis testing, simple regression and correlation, and analysis of variation.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: None

MATH163 An Invitation to Mathematics
This course aims to introduce students to some of the great ideas of mathematics. We will investigate a variety of topics in number theory, set theory, probability, game theory, topology, and geometry. One major goal is to give students a chance to "think like a mathematician." Thus, students will be encouraged to explore and to discover mathematical patterns and ideas for themselves. We will also gain an understanding of what constitutes a mathematical proof and why mathematicians are so insistent about them.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: None

MATH211 Problem Solving for the Putnam
This course will explore the problems and problem-solving techniques of the annual William Lowell Putnam mathematical competition. Particular emphasis will be placed on learning to write clear and complete solutions to problems. The competition is open to all undergraduate students.
Offering: Host
Grading: Cr/U
Credits: 0.25
Gen Ed Area: NSM-MATH
Prereq: None

MATH221 Vectors and Matrices
This is a course in the algebra of matrices and Euclidean spaces that emphasize the concrete and geometric. Topics to be developed include solving systems of linear equations; matrix addition, scalar multiplication, and multiplication; properties of invertible matrices; determinants; elements of the theory of abstract finite dimensional real vector spaces; dimension of vector spaces; and the rank of a matrix. These ideas are used to develop basic ideas of Euclidean geometry and to illustrate the behavior of linear systems. We conclude with a discussion of eigenvalues and the diagonalization of matrices.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: None

MATH222 Multivariable Calculus
This course treats the basic aspects of differential and integral calculus of functions of several real variables, with emphasis on the development of calculational skills. The areas covered include scalar- and vector-valued functions of several variables, their derivatives, and their integrals; the nature of extremal values of such functions and methods for calculating these values; and the theorems of Green and Stokes.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: None

MATH223 Linear Algebra
An alternative to MATH221, this course will cover vector spaces, inner-product spaces, dimension theory, linear transformations and matrices, determinants, eigenvalues and eigenvectors, Hermitian and unitary transformations, and elementary spectral theory. It will present applications to analytic geometry, quadratic forms, and differential equations as time permits. The approach here is more abstract than that in MATH221, though many topics appear in both.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: None

MATH225 Fundamentals of Analysis: An Introduction to Real Analysis
In this rigorous treatment of calculus, topics will include, but are not limited to, real numbers, limits, sequences and series, continuity and uniform continuity, differentiation, the Riemann integral, sequences and series of functions, pointwise and uniform convergence of functions, and interchange of limiting processes. MATH228 or comparable experience in writing mathematical proofs is strongly recommended for success in this course.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: (MATH222 AND MATH221) OR (MATH222 AND MATH223)

MATH226 Complex Analysis
This course will present the basic properties of complex analytic functions. We begin with the complex numbers themselves and elementary functions and their mapping properties, then discuss Cauchy's integral theorem and Cauchy's integral formula and applications, Taylor and Laurent series, zeros and poles and residue theorems, the argument principle, and Rouche's theorem. In addition to a rigorous introduction to complex analysis, students will gain experience in communicating mathematical ideas and proofs effectively.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: (MATH222 AND MATH221) OR (MATH222 AND MATH223)

MATH228 Discrete Mathematics
This course is a survey of discrete mathematical processes. Students will be introduced to the process of writing formal mathematical proofs, including mathematical induction. Topics may include set theory, logic, number theory, finite fields, permutations, elementary combinatorics, or graph theory.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: None

MATH229 Differential Equations
This course is an introduction to the theory of ordinary differential equations. Many aspects of mathematics and computer science are important in this discipline, and a broad view will be presented, in agreement with modern theory and practice. The only prerequisite for the course is multivariable calculus; all other necessary tools will be developed as the course proceeds.
MATH211 An Introduction to Probability
This course teaches the basic theory of probability. Although the notions are simple and the mathematics involved require only a basic knowledge of the ideas of differential and integral calculus, a certain degree of mathematical maturity is necessary. The fundamental concepts to be studied are probability spaces and random variables, the most important ideas being conditional probability and independence. The main theorems we will study are the law of large numbers and the central limit theorem.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: MATH222

MATH231 Mathematical Statistics
This course covers the basic notions of estimation, hypothesis testing, regression, analysis of variance, experimental design, and other topics in statistics from a rigorous mathematical perspective. This material will be supplemented by various case studies.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: MATH222

MATH241 Set Theory
This course covers ordinal and cardinal numbers, cardinal arithmetic, theorems of Cantor and Schroeder-Bernstein, introduction to Zermelo-Fraenkel set theory, Axiom of Choice, and some infinitary combinatorics.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: MATH221 or MATH223

MATH242 Mathematical Logic
This course is an introduction to mathematical logic, including first-order logic and model theory, axiomatic set theory, and, as time permits, Goedel’s incompleteness theorem.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: MATH225

MATH243 Abstract Algebra: Groups, Rings, and Fields
This course is an introduction to abstract algebra, a core area of mathematics: the study of the basic properties of structures, with emphasis on fundamental results about groups and rings. MATH228, or comparable experience in writing proofs and in abstract reasoning, is strongly recommended.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: MATH225

MATH244 Topology: Point Set
This is an introduction to general topology, the study of topological spaces. We will begin with the most natural examples, metric spaces, and then move on to more general spaces. This subject, fundamental to mathematics, enables us to discuss notions of continuity and approximation in their broadest sense. We will illustrate topology's power by seeing important applications to other areas of mathematics.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: None

MATH245 Algebraic Topology
This course will use linear algebra to learn about interesting general properties of shapes. The major goal will be the classification of closed, bounded surfaces such as the sphere, the torus, the Klein bottle, and the projective plane. We will introduce the point-set topology and the new linear algebra that we need, but MATH221 or 223 is essential for this course.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: (MATH221 AND MATH222) OR (MATH223 AND MATH222)

MATH252 Differential Forms
This class will be an introduction to differential forms, a central tool in modern topology, geometry, and physics. The course begins where MATH222 ends, with Green’s theorem, the divergence theorem, and Stokes’ theorem. All of these theorems are special cases of one theorem, known as the general Stokes’ theorem, about integration of differential forms. The objective of the first part of the course will be to understand and prove this theorem. We will then discuss manifolds and what can be learned about them using differential forms, concentrating on de Rham cohomology.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: MATH225

MATH255 Fundamentals of Analysis II
Topics to be addressed include the topology of metric spaces (continuity, connectedness, and compactness), convergence of sequences and series of functions, spaces of functions and their topologies, the Lebesgue integral (on the line) and its basic convergence theorems, and Fourier series.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: MATH225

MATH261 Abstract Algebra: Groups, Rings, and Fields
This course is an introduction to abstract algebra, a core area of mathematics: the study of the basic properties of structures, with emphasis on fundamental results about groups and rings. MATH228, or comparable experience in writing proofs and in abstract reasoning, is strongly recommended.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: MATH225

MATH262 Abstract Algebra
This continuation of MATH261 will discuss fields and Galois theory. Additional topics will be covered as time permits.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: MATH261

MATH271 Elementary Number Theory
This is a course in the elements of the theory of numbers. Topics covered include divisibility, congruences, quadratic reciprocity, Diophantine equations, and a brief introduction to algebraic numbers.
Offering: Host
Grading: A-F
Credits: 1.00
Mathematics and Computer Science

Gen Ed Area: NSM-MATH
Prereq: MATH228

MATH273 Combinatorics
This course will present a broad, comprehensive survey of combinatorics. Topics may include partitions, the topic of inclusion-exclusion, generating functions, recurrence relations, partially ordered sets, trees, graphs, and minimax theorems.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: MATH228

MATH274 Graph Theory
A graph is a set V of elements called vertices and a set E of pairs of elements of V called edges. From this simple definition, many elegant models have been developed. Indeed, graph theory is essential to applications of computer science to network analysis and planar mapping. This course will be an introduction to graph theory with an emphasis on the connections between graph theory and linear algebra.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: MATH222

MATH275 Probabilistic Graphical Models
Graphical models are used to represent complex, uncertain relationships among several, possibly very many, variables. They are fundamental in many domains of application, including medical diagnosis and prognosis, vision and image processing, robotics, and computational biology. This course will familiarize students with the graph theory and probability theory needed to discuss graphical models. After that, students will investigate exact and approximate statistical inference for graphical models, learning/inference of parameters, and possibly learning of graph structure.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: MATH221 OR MATH223

MATH283 Differential Geometry
This course is an introduction to the classical differential geometry of curves and surfaces in Euclidean 3-space. Topics from global differential geometry and extensions to higher dimensions will be considered as time and the background of the students permit.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MATH
Prereq: (MATH222 AND MATH221) OR (MATH222 AND MATH223)

MATH401 Individual Tutorial, Undergraduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

MATH402 Individual Tutorial, Undergraduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

MATH407 Senior Tutorial (downgraded thesis)
Downgraded Senior Thesis Tutorial - Project to be arranged in consultation with the tutor. Only enrolled in through the Honors Coordinator.
Offering: Host
Grading: A-F

MATH408 Senior Tutorial (downgraded thesis)
Downgraded Senior Thesis Tutorial - Project to be arranged in consultation with the tutor. Only enrolled in through the Honors Coordinator.
Offering: Host
Grading: A-F

MATH409 Senior Thesis Tutorial
Topics to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

MATH410 Senior Thesis Tutorial
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

MATH411 Group Tutorial, Undergraduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

MATH412 Group Tutorial, Undergraduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

MATH419 Student Forum
Student-run group tutorial, sponsored by a faculty member and approved by the chair of a department or program.
Offering: Host
Grading: Cr/U

MATH421 Undergraduate Research, Science
Individual research projects for undergraduate students supervised by faculty members.
Offering: Host
Grading: OPT

MATH422 Undergraduate Research, Science
Individual research projects for undergraduate students supervised by faculty members.
Offering: Host
Grading: OPT

MATH423 Advanced Research Seminar, Undergraduate
Advanced research tutorial; project to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

MATH424 Advanced Research Seminar, Undergraduate
Advanced research tutorial; project to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT

MATH465 Education in the Field, Undergraduate
Students must consult with the department and class dean in advance of undertaking education in the field for approval of the nature of the responsibilities and method of evaluation.
Offering: Host
Grading: OPT

MATH466 Education in the Field, Undergraduate
Students must consult with the department and class dean in advance of undertaking education in the field for approval of the nature of the responsibilities and method of evaluation.
Offering: Host
Grading: OPT
MATH514 Analysis I
MATH513 and MATH514 constitute the first-year graduate course in real and complex analysis. One semester will be devoted to real analysis, covering such topics as Lebesgue measure and integration on the line, abstract measure spaces and integrals, product measures, decomposition and differentiation of measures, and elementary functional analysis. One semester will be devoted to complex analysis, covering such topics as analytic functions, power series, Mobius transformations, Cauchy's integral theorem and formula in its general form, classification of singularities, residues, argument principle, maximum modulus principle, Schwarz's lemma, and the Riemann mapping theorem.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: None

MATH515 Analysis II
This is a topics course in analysis and varies from year to year. It may be repeated for credit.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: None

MATH516 Analysis II
This is a topics course in analysis and varies from year to year. It may be repeated for credit.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: None

MATH523 Topology I
This course is an introduction to topological spaces and the fundamental group; topological spaces, continuous maps, metric spaces; product and quotient spaces; compactness, connectedness, and separation axioms; and introduction to homotopy and the fundamental group.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: None

MATH524 Topology I
A continuation of MATH523, this course will be an introduction to algebraic topology, concentrating on the fundamental group and homology.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: None

MATH525 Topology II: Topics in Topology
This is a topics course in topology that varies from year to year. This course may be repeated for credit. Recent topics have included knot theory, homotopy theory, Lie groups, and topological graph theory.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: None

MATH526 Topology II
This is a topics course in topology that varies from year to year. It may be repeated for credit.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: None

MATH543 Algebra I
This course covers group theory including Sylow theorems, and basic ring and module theory, including structure of finitely generated modules over principal-ideal domains.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: None

MATH544 Algebra I
This course studies Galois theory, finitely generated modules over principal-ideal domains, and other topics as time permits.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: None

MATH545 Algebra II: Topics in Algebra
This is a topics course in algebra that varies from year to year. This course may be repeated for credit.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: None

MATH546 Algebra II
This is a topics course in algebra that varies from year to year. It may be repeated for credit.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: None

MATH549 Advanced Research Seminar, Graduate
Advanced research tutorial; project to be arranged in consultation with the tutor.

Offering: Host
Grading: OPT

MATH550 Advanced Research Seminar, Graduate
Advanced research tutorial; project to be arranged in consultation with the tutor.

Offering: Host
Grading: OPT

MATH572 Special Topics in Mathematics
This is a supervised reading course on advanced topics in number theory. This course may be repeated for credit.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: None