MATHEMATICS AND COMPUTER SCIENCE

Professors Collins and D. Sutherland
Associate Professors Barel and Campbell (chair)
Assistant Professors Burch and Ferrer
Visiting Assistant Professor Cha

The Department of Mathematics and Computer Science offers a major in Mathematics, a major in Computer Science, and minors in Mathematics and in Computer Science. A student may double major in Mathematics and Computer Science or major in one discipline and minor in the other. Three years of high school mathematics, including two years of algebra and one year of geometry, or equivalent preparation, are necessary for all courses offered in the Department. Trigonometry/Precalculus is strongly recommended. A student who studied calculus before enrolling in Hendrix College may receive course credit for MATH 130 *Calculus I* if he or she takes MATH 140 *Calculus II* with consent of the instructor and passes it with a grade of "C" or better. Alternatively, a student may receive course credit for MATH 140 *Calculus II* if he or she takes MATH 260 *Differential Equations* with consent of the instructor and passes it with a grade of "C" or better.

AP Credit

MATHEMATICS: A student who scores a 4 or higher on the Calculus AB exam or a 3 or higher on the Calculus BC exam will receive course credit for MATH 130 *Calculus I.* In addition, a student scoring 4 or higher on the Calculus BC exam will receive course credit for MATH 140 *Calculus II.*

COMPUTER SCIENCE: A student who scores a 4 or higher on the Computer Science A exam or a 3 or higher on the Computer Science AB exam will receive course credit for CSCI 150 *Foundations of Computer Science I.* In addition, a student scoring 4 or higher on the Computer Science AB exam will receive course credit for CSCI 151 *Foundations of Computer Science II.*

MAJOR IN MATHEMATICS

11 courses distributed as follows:

- MATH 130 *Calculus I*
- MATH 140 *Calculus II*
- MATH 240 *Discrete Mathematics*
- MATH 290 *Introduction to Advanced Mathematics*
- One of the following two-course sequences:
  MATH 320 *Algebra* and MATH 420 *Seminar in Algebra*
  MATH 350 *Real Analysis* and MATH 450 *Seminar in Analysis*
- two courses chosen from the following:
  any mathematics courses listed 200 or above
  CSCI 151 *Foundations of Computer Science II*
  CSCI 380 *Theory of Computation*
  ECON 300 *Intermediate Microeconomics*
  ECON 430/530 *Management Science*
  PHYS 380 *Classical Mechanics*
- three additional courses chosen from the following:
  any mathematics courses listed 300 or above
  CSCI 380 *Theory of Computation*

Each senior major must also enroll in the year-long MATH 497 *Senior Seminar.* A working knowledge of a high-level computer language such as C++ or Java is strongly recommended.

MAJOR IN COMPUTER SCIENCE

12 courses distributed as follows:

- CSCI 150 *Foundations of Computer Science I*
- CSCI 151 *Foundations of Computer Science II*
- MATH 130 *Calculus I*
- MATH 240 *Discrete Mathematics*
- CSCI 230 *Computing Systems Organization*
- CSCI 250 *Programming Practicum*
- CSCI 280 *Algorithms and Problem Solving Paradigms*
- CSCI 330 *Computer Organization*
  OR
  CSCI 420 *Operating Systems and Concurrent Computing*
- CSCI 380 *Theory of Computation*
  OR

MATH 340 *Combinatorics*
- Three additional CSCI courses listed 300 or above

Each senior major must also enroll in the year-long CSCI 497 *Senior Seminar.*

Senior Capstone Experience

The Senior Capstone Experience for the mathematics major and the computer science major consists of an undergraduate research portfolio and participation in two semesters of the Senior Seminar course. MATH 497 *Senior Seminar* and CSCI 497 *Senior Seminar* are non-credit courses that meet weekly to guide students through the process of developing a senior undergraduate research project. The undergraduate research portfolio consists of the senior project and any other research projects completed by the student outside of regular course work. The grade for the Senior Capstone Experience is based on the portfolio and an oral presentation of the senior project.

MINOR IN MATHEMATICS

Six courses distributed as follows:
- MATH 130 *Calculus I*
- MATH 140 *Calculus II*
- MATH 240 *Discrete Mathematics*
- MATH 290 *Introduction to Advanced Mathematics*
- one mathematics course listed 200 or above
- one mathematics course listed 300 or above

MINOR IN COMPUTER SCIENCE

Six courses distributed as follows:
- CSCI 150 *Foundations of Computer Science I*
- CSCI 151 *Foundations of Computer Science II*
- MATH 130 *Calculus I*
- Any CSCI course listed 200 or above
  OR
  MATH 240 *Discrete Mathematics*
- CSCI 385 *Scientific Computing*
  OR
  CSCI 397 *Cross-Disciplinary Project*
- Any additional CSCI course listed 200 or above

Mathematics Courses

MATH 110 *Journey through Mathematics* (HP, QS)
An historical survey of mathematical ideas (arithmetic, geometry, algebra) in various cultural contexts. The emphasis is on the mathematical content. **Note:** This course is not available for credit to students who have had MATH 130 or its equivalent. These students are referred, instead, to MATH 280. *Prerequisite: LBST 100.*

MATH 115 *Mathematics in Contemporary Issues* (CW, QS, SB)
A survey of problems of social conflict, fairness, and uses of mathematics in the modern world, emphasizing mathematical analysis of political and social structures. Topics may include voting methods, power distributions, apportionment, fair division, graph theory, coding theory, and scheduling problems.

MATH 120 *Functions and Models* (QS)
Study of algebraic, trigonometric, exponential and logarithmic functions within the context of mathematical modeling.

MATH 130 *Calculus I* (QS, NS)
Study of limits, differentiation, and integration of functions of one variable. *Prerequisite: MATH 120 or its equivalent.*

MATH 140 *Calculus II* (QS, NS)
Further aspects of integration of functions of one variable. Infinite series. *Prerequisite: MATH 130 or advanced placement.*

MATH 195 *Mathematical Problem Solving* [SP]
Practical sessions in solving challenging problems in mathematics (possible sources: periodicals, problem collection books, or Putnam exams). The class meets biweekly to discuss solutions and receive new assignments. Most problems are solved between sessions, individually or in groups. A student receives one course credit after four semesters of successful problem solving. *Prerequisite: MATH 130 or MATH 140 or consent of instructor.*

MATH 230 *Multivariable Calculus*
Vectors and coordinate systems in two and three dimensions, vector-valued functions, functions of several variables, extrema, multiple

integrals, vector fields, including fundamental theorems of vector calculus. This course will have an emphasis on developing geometric institution. Offered in alternate years. *Prerequisite: MATH 140 or consent of instructor.*

MATH 240 *Discrete Mathematics* (NS)
An introduction to the discrete paradigm in mathematics and computer science. Topics include induction, recursion, logic, algorithmic problem-solving, graph theory, number theory, and counting techniques. *Prerequisite: MATH 130 or consent of instructor.*

MATH 260 *Differential Equations* (NS)
Study of ordinary differential equations and systems of equations, through the use of analytic, qualitative/ geometric, and numerical techniques. Applications from physics, biology, chemistry, engineering, economics, and psychology will be presented. *Prerequisite: MATH 140.*

MATH 270 *Linear Algebra* (NS)
Solving linear systems, matrix algebra, vector spaces and linear transformations, eigenvectors, orthogonality. *Prerequisite: MATH 130.*

MATH 280 *History of Mathematics* (HP, W2)
A survey of mathematical ideas and discoveries in their historical context. The course combines mathematics (proofs and problems) with readings on its development. Offered in alternate years. *Prerequisite: MATH 130 or consent of instructor.*

MATH 290 *Introduction to Advanced Mathematics* (W2)
Fundamentals of set theory, logic, and functions. Emphasis is on developing the students' theorem-proving skills, independent work, written and oral communication skills, and ability to critique others' work. *Prerequisite: MATH 140 and completion of or concurrent enrollment in MATH 240.*

MATH 310 *Mathematical Probability and Statistics*
Theory of probability and mathematical statistics including an introduction to basic concepts of probability theory, discrete and continuous random variables, distribution theory, moment-generating functions, and the Central Limit Theorem. Other topics may include the theory of statistical inference, point estimation, confidence intervals, regression, hypothesis testing, and analysis of variance. Offered in alternate years. *Prerequisite: MATH 140.*

MATH 320 *Algebra*
Introduction to classical algebraic systems and their morphisms. Topics include groups, rings, fields, substructures, ideals, homomorphisms, and quotients. Offered in alternate years. *Prerequisite: MATH 290.*

MATH 340 *Combinatorics*
Continues the ideas of counting, graph theory, and algorithms from Mathematics 240. Topics may include Ramsey Theory, designs, coding theory, generating functions, and optimization. Offered in alternate years. *Prerequisite: MATH 240.*

MATH 350 *Real Analysis*
A rigorous study of the structure of the real line and the properties of real-valued functions. Topics include sequences, limits, continuity, differentiabililty, and integrability. Offered in alternate years. *Prerequisite: MATH 290.*

MATH 420 *Seminar in Algebra*
Algebraic topics that extend the fundamental ideas in MATH 320 will be presented. Offered in alternate years. *Prerequisite: MATH 320.*

MATH 450 *Seminar in Analysis*
Analytic topics that extend the fundamental ideas in Mathematics 350 will be presented. Offered in alternate years. *Prerequisite: MATH 350.*

MATH 490 *Advanced Topics in Mathematics*
Faculty-student seminar. Content will vary according to the interests of the participants and instructor. Past offerings include Great Theorems in Mathematics and Their Proofs, Dynamical Systems, Number Theory, Topology, Wavelets and Wavelet Transforms, Complex Variables, and Introduction to Category Theory. *Prerequisite: consent of instructor.*

MATH 497 *Senior Seminar* [UR]
A required seminar for all senior mathematics majors which meets throughout the academic year. Each student will develop an individual research project under the direction of a faculty member and present the results both orally and in written form.

Computer Science Courses

CSCI 135 *Robotics Exploration Studio* (NS-L)

Introduction to mechanical design and computer programming in the context of building and programming mobile robots. Mechanical design topics will include vectors and forces, Newton's Laws, gears, motors, rotational motion, friction, and the design process. Computer science topics will include an introduction to programming, the programming of sensors and motors, and an introduction to artificial intelligence. Other topics include application of scientific method, teamwork skills, technical writing, and the relationship between the science fiction portrayal of robots and current technological reality. *Cross-listed as PHYS 135.*

CSCI 150 *Foundations of Computer Science I* (QS, NS)
Introduction to computer programming, the process of designing and constructing software. It emphasizes techniques for object oriented design and software development by means of an introduction to the features of the programming language Java, including the notion of classes, and computation due to the interaction between classes. The course also covers some of the most fundamental data structures and algorithms that are useful in Computer Science.

CSCI 151 *Foundations of Computer Science II* (NS)
Builds on the skills acquired in *Foundations of Computer Science I*, placing special emphasis on object oriented software design and data abstraction. Students are introduced to some of the most important and frequently used data structures: lists, stacks, queues, trees, graphs, and programming techniques such as recursion. Other topics covered include analysis of algorithm complexity, program verification, and simulations. Programming assignments focus on the design and implementation of algorithms and data structures. *Prerequisite: CSCI 150 and either completion of or enrollment in MATH 130.*

CSCI 230 *Computing Systems Organization*
A study of the layers of abstraction composing the design of modern computing systems. Topics include numeric representation, digital logic, the memory hierarchy, machine language and assembly language, the program stack, the system call concept, and the compilation process. Students will be introduced to the C programming language. *Prerequisite: CSCI 151.*

CSCI 250 *Programming Practicum* (NS)
Introduction to the computer science concepts necessary for the development of large software systems. Topics will include human-computer interaction, multithreading, network programming, parsing, grammars, testing, and an introduction to databases and software engineering. Programming assignments will emphasize the integration of multiple concepts in the context of realistic software applications. Students will also read and reflect upon case studies in computing ethics, as a way of understanding the societal context in which computer programs are utilized. *Prerequisite: CSCI 151.*

CSCI 280 *Algorithms & Problem Solving Paradigms* (W2)
Introduction to algorithm design stategies that build upon data structures and programming techniques introduced in the first two computer science courses. Strategies discussed will include brute-force, divide-and-conquer, dynamic programming, problem reduction, and greedy algorithms. Particular topics to be covered will include graph traversal and shortest paths, string matching, searching, sorting, and advanced data structures such as balanced search trees, heaps, hash tables, state machines, and union-find structures. In addition, the course will include an introduction to complexity theory and the complexity classes P and NP. *Prerequisites: CSCI 151 and MATH 240.*

CSCI 330 *Computer Architecture and Organization*
A study of the design concepts of major importance in modern computers. Topics will include microprogramming, language-directed computers, parallel processors, and pipeline computers. Emphasis will be placed on the relationship of architecture to programming issues. *Prerequisite: CSCI 230.*

CSCI 335 *Artificial Intelligence*
An introduction to the design, analysis, implementation, and application of classical and contemporary algorithms in artificial intelligence, with an emphasis on the development of complete, embodied intelligent agents. Topics will include symbolic planning, robot programming under both subsumption and hybrid paradigms, automated theorem proving, intelligent game-playing programs, rule-based systems, genetic algorithms, neural networks, and machine learning. *Prerequisite: Any CSCI course listed 200 or above.*

CSCI 340 *Database Systems*

Introduction to the theoretical and practical aspects of database management systems. Emphasis is on the relational data model. Topics covered include query languages, relational design theory, file structures, and query optimization. Students will implement a database application using Oracle or MySQL, Java Applets, and Servlets. *Prerequisite: Any CSCI course listed 200 or above.*

CSCI 350 *Software Engineering* (W2)

In this course, students learn and gain practical experience with software engineering principles and techniques. The practical experience centers on a semester-long team project which is carried through all of the stages of the software lifecycle. Topics in this course include requirements analysis, specification, design, and verification. Emphasis will be placed on writing precise requirements, using formal and semiformal methods to assist in design and verification of software, and the incremental software development. *Prerequisite: CSCI 250.*

CSCI 360 *Survey of Programming Languages* (W2)

Concepts and structures governing the design and implementation of modern programming languages. Introduction to concepts of compilers and run-time representations of programming languages. Features of programming languages supporting abstraction. Programming language paradigms including procedural, functional programming, object-oriented programming, logic programming, polymorphism, and concurrency will be covered. *Prerequisite: CSCI 230.*

CSCI 380 *Theory of Computation*

Covers basic topics in automata, computability, and complexity theory, including: models of computation (finite automata, Turing machines and RAMs); regular sets and expressions; recursive, r.e., and non-r.e. sets and their basic closure properties; complexity classes; determinism vs. non-determinism, with and without resource bounds; reductions and completeness; practice with NP- and P-completeness proofs; and the complexity of optimization and approximation problems. *Prerequisite: MATH 240.*

CSCI 385 *Scientific Computing*

Students will study problems arising from the physical, biological, and/or social sciences and the algorithms and theory used to solve them computationally. Included among the problems will be numerical methods for maximizing a function and solving a differential equation. *Prerequisites: MATH 130 and CSCI 150.*

CSCI 397 *Cross-Disciplinary Project* [SP]
In this course intended for computer science minors, the student will complete a semester-long project investigating the relationship of the student's major with computing. Typically, this will involve developing software to solve a computational problem in the major discipline. This course must be taken as an independent study, supervised by a computer science faculty member in consultation with a faculty member in the student's major discipline. *Prerequisite: CSCI 151.*

CSCI 420 *Operating Systems and Concurrent Computing*
Basic principles of modern operating systems design: emphasis on concurrency including problems (nondeterminism), goals (synchronization, exclusion) and methods (semaphores, monitors); resource management including memory management and processor scheduling; file systems; interrupt processing; multithreaded programming. *Prerequisite: CSCI 230.*

CSCI 490 *Advanced Topics in Computer Science*
Faculty-student seminar. Content will vary according to the interests of the participants and instructor. *Prerequisite: consent of instructor.*

CSCI 497 *Senior Seminar* [UR]
A required seminar for all senior computer science majors which meets throughout the academic year. Each student will develop an individual research project under the direction of a faculty member and present the results both orally and in written form.