Mathematics

Mathematics is the study of patterns and the logical connections between them. The patterns can be numerical, algebraic, or geometric. The logical connections are typically computations and proofs. When the patterns come from the real world, we get applied mathematics. The logical connections might then take the form of a differential equation that predicts how a disease outbreak will unfold, a statistical model that allows an actuary to assess risks, or a geometric algorithm that displays a three-dimensional object on a flat computer screen. When the patterns come from our collective imaginations, we get the myriad sub-disciplines of pure mathematics: real analysis, abstract algebra, topology, non-Euclidean geometry, probability, and many others.

Goals

The mathematics program has the following goals:

• To give all students who take mathematics courses a sense of the nature of mathematics and its place in society;
• To give our mathematics majors and minors an understanding of mathematics, its nature and uses; to prepare students to become effective users of mathematics in their careers;
• To prepare future high school teachers of mathematics;
• To give our students interested in continuing to graduate study in mathematics, statistics, or computer science an adequate preparation to succeed in that study.
• To prepare students to excel in their majors. This includes students in distribution courses, mathematics and computer science minors, and students with double majors, who will gain deeper insights into their other majors.

The mathematics major can tailor upper-level courses to his interests (including pure mathematics, applied mathematics and statistics) and career goals (including actuarial science, computer science and secondary education).

Advanced Placement

• A student who gets a 4 or 5 on the AB calculus exam receives immediate credit for MAT-111 Calculus I and is placed into MAT-112 Calculus II.
• Any student starting in MAT-112 Calculus II (by the AP exam or our internal placement) who gets a B- or better will receive retroactive credit for MAT-111 Calculus I.
• A student who gets a 4 or 5 on the BC calculus exam receives immediate credit for MAT-111 Calculus I and MAT-112 Calculus II, and is placed into MAT-223 Elementary Linear Algebra.
• A student who gets a 4 or 5 on the statistics AP exam receives immediate credit for MAT-103 Probability and MAT-104 Statistics.
• A student who gets a 4 or 5 on the computer science A AP exam receives immediate credit for CSC-111 Intro to Programming.
• A student who gets a 4 or 5 on the computer science principles AP exam receives immediate credit for CSC-101 Intro to Computer Science.

Mathematics majors may opt for the Pure Mathematics track, the Computational Mathematics track, or the Financial Mathematics track. There is a great deal of overlap among these choices, and all include the four core courses.

Major in Mathematics

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>MAT-111</td>
<td>Calculus I</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>or MAT-110 Calc I With Pre-Calc Review</td>
<td></td>
</tr>
<tr>
<td>MAT-112</td>
<td>Calculus II</td>
<td>1</td>
</tr>
<tr>
<td>MAT-223</td>
<td>Elementary Linear Algebra</td>
<td>1</td>
</tr>
<tr>
<td>MAT-331</td>
<td>Abstract Algebra I</td>
<td>1</td>
</tr>
</tbody>
</table>

Track

Select one of the following tracks:

• Pure Mathematics
• Computational Mathematics
• Financial Mathematics

Total Credits: 9

Mathematics majors should complete the four core courses by the end of the sophomore year, if possible; they must be completed by the end of the junior year.

Incoming freshmen interested in pursuing mathematics at Wabash College will typically take MAT-111 Calculus I or MAT-112 Calculus II in the fall (depending on placement) and MAT-112 Calculus II or MAT-223 Elementary Linear Algebra in the spring. Course choices in the fall of the sophomore year will usually depend on the direction the student sees himself headed. Students should plan to take MAT-331 Abstract Algebra I in the spring of their sophomore year. Potential mathematics majors should discuss their plans with a member of the department and should read the brochure “How to Major in Mathematics at Wabash College (https://www.wabash.edu/academics/uploads/math/How_to_Be_a_Math_Major.pdf)” and the flow chart describing prerequisites among the courses for the major (https://www.wabash.edu/academics/uploads/math/math_flow_chart_(2010).pdf). Several courses are offered in alternate years; majors must plan accordingly.

Pure Mathematics Track

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT-333</td>
<td>Funct Real Variable I</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>or MAT-341 Topology</td>
<td></td>
</tr>
<tr>
<td>Mathematics Electives</td>
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</tr>
</tbody>
</table>

Total Credits: 5

Computational Mathematics Track

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>CSC-111</td>
<td>Intro to Programming¹</td>
<td>1</td>
</tr>
<tr>
<td>MAT-337</td>
<td>Numerical Analysis</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>or MAT-338 Topics Computational Math</td>
<td></td>
</tr>
<tr>
<td>Mathematics Electives</td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

Total Credits: 5

¹ This does not count toward the major, but it is a prerequisite for MAT-337 Numerical Analysis and MAT-338 Topics Computational Math, and should be taken by the sophomore year, if possible.
Financial Mathematics Track

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>MAT-251</td>
<td>Mathematical Finance</td>
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</tr>
<tr>
<td>MAT-252</td>
<td>Math Interest Theory</td>
<td>0.5</td>
</tr>
<tr>
<td>MAT-253</td>
<td>Probability Models</td>
<td>0.5</td>
</tr>
<tr>
<td>MAT-254</td>
<td>Statistical Models</td>
<td>0.5</td>
</tr>
<tr>
<td>MAT-255</td>
<td>Mathematical Statistics</td>
<td>0.5</td>
</tr>
<tr>
<td>or MAT-256</td>
<td>Regression Models</td>
<td></td>
</tr>
</tbody>
</table>

Mathematics Electives: 2

Total Credits: 5

The requirements for the financial mathematics major are good preparation for the initial actuarial exams.

Electives may not include MAT-010 Pre-Calc With Intro to Calc, MAT-103 Probability, MAT-104 Statistics, MAT-106 Topics in Contemporary Math, or MAT-108 Intro to Discrete Structures.

Additional Courses

Additional courses to consider, especially for students who are considering graduate school:

Pure Mathematics

<table>
<thead>
<tr>
<th>Code</th>
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</thead>
<tbody>
<tr>
<td>MAT-219</td>
<td>Combinatorics</td>
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</tr>
<tr>
<td>MAT-221</td>
<td>Found of Geometry</td>
<td>1</td>
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<tr>
<td>MAT-222</td>
<td>Theory of Numbers</td>
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</tr>
<tr>
<td>MAT-224</td>
<td>Elem Differential Equations</td>
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<tr>
<td>MAT-225</td>
<td>Multivariable Calculus</td>
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<tr>
<td>MAT-323</td>
<td>Topics in Linear Algebra</td>
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<tr>
<td>MAT-324</td>
<td>Topics in Differential Equations</td>
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<tr>
<td>MAT-332</td>
<td>Abstract Algebra II</td>
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<tr>
<td>MAT-334</td>
<td>Funct Real Variable II</td>
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</tr>
<tr>
<td>MAT-344</td>
<td>Complex Analysis</td>
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Computational Mathematics

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<td>MAT-219</td>
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<tr>
<td>MAT-222</td>
<td>Theory of Numbers</td>
<td>1</td>
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<tr>
<td>MAT-224</td>
<td>Elem Differential Equations</td>
<td>1</td>
</tr>
<tr>
<td>MAT-226</td>
<td>Operations Research</td>
<td>1</td>
</tr>
<tr>
<td>MAT-314</td>
<td>Modeling With Differential Equations</td>
<td>1</td>
</tr>
<tr>
<td>MAT-323</td>
<td>Topics in Linear Algebra</td>
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</tr>
<tr>
<td>MAT-332</td>
<td>Abstract Algebra II</td>
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Financial Mathematics

<table>
<thead>
<tr>
<th>Code</th>
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<th>Credits</th>
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<tbody>
<tr>
<td>MAT-224</td>
<td>Elem Differential Equations</td>
<td>1</td>
</tr>
<tr>
<td>MAT-324</td>
<td>Topics in Differential Equations</td>
<td>1</td>
</tr>
<tr>
<td>MAT-333</td>
<td>Funct Real Variable I</td>
<td>1</td>
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</table>

Mathematics Minor

<table>
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<tr>
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<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>MAT-110</td>
<td>Calc I With Pre-Calc Review</td>
<td>1</td>
</tr>
<tr>
<td>or MAT-111</td>
<td>Calculus I</td>
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</tr>
<tr>
<td>MAT-112</td>
<td>Calculus II</td>
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</tr>
<tr>
<td>MAT-223</td>
<td>Elementary Linear Algebra</td>
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</tr>
<tr>
<td>Mathematics Electives</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
| Total Credits: 5

Potential mathematics minors should read the brochure "How to Minor in Mathematics or Computer Science at Wabash College (https://www.wabash.edu/academics/uploads/math/How_to_Minor_in_Mathematics_or_Computer_Science_at_Wabash_College.pdf),"

MAT-003 Pre-Calculus

This course is intended solely for those students who wish to take calculus, but whose preparation makes a refresher course in pre-calculus advisable. Topics covered include a review of algebra (solving equations and inequalities, simplification of algebraic expressions) and properties of elementary functions (polynomial, rational, exponential, logarithmic, and trigonometric functions) with special emphasis on graphing these functions. MAT 003 cannot be used for any distribution credit or any area of concentration. (For students who desire a distribution credit in mathematics but do not wish to take calculus, MAT 103, 104, 106, and 108 are recommended.)

**Prerequisites:** none

**Credits:** 0.5

MAT-010 Pre-Calc With Intro to Calc

This course is intended solely for those students who wish to take calculus, but whose preparation makes a slower-paced course in calculus advisable. Topics covered include a review of algebra (solving equations and inequalities, simplification of algebraic expressions), properties of polynomials and rational functions, limits, continuity, an introduction to derivatives via polynomials and rational functions, and applications of the derivative. MAT 010 cannot be used for any distribution credit or any area of concentration. (For students who desire a distribution credit in mathematics but do not wish to take calculus, MAT 103, 104, 106, and 108 are recommended.) This course is offered in the fall semester.

**Prerequisites:** none

**Corequisites:** Prerequisite: MAT-010 placement

**Credit:** 1

MAT-103 Probability

Topics include a brief introduction to probability, conditional probability, expected values as well as the application of probabilistic reasoning to interesting problems in the areas of medical testing, investing, insurance, retirement annuities, and the analysis of rare events. MAT 103 does not count toward the mathematics major or minor.

**Prerequisites:** none

**Credits:** 0.5

**Distribution:** Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills
MAT-104 Statistics
In this course, we present the classical approach to statistical reasoning, both the p-value argument to testing claims and the confidence interval approach to estimation. Other topics include correlation, prediction, and paradoxes involving averages. MAT 104 does not count toward the mathematics major or minor. (MAT 103 is not a prerequisite for MAT 104)
Prerequisites: none
Credits: 0.5
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills

MAT-106 Topics in Contemporary Math
A reflective examination of basic mathematical ideas. Through participation and discovery, students will consider an articulation of mathematics that focuses on patterns, abstraction, and inquiry. Topics will vary, but could include logic, Euclidean geometry, algorithms, etc. This course does not count toward the major or minor in mathematics. Please refer to the Registrar’s page for course description.
Prerequisites: none
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills

MAT-108 Intro to Discrete Structures
An introduction to discrete mathematics for students not planning to major in mathematics. Topics include sets and logic, proof methods, counting arguments, recurrence relations, graphs, and trees. This course may be used to meet the mathematics requirement for the computer science minor. However, it does not count toward the mathematics major or minor. Students may not present both MAT 108 and 219 for credit toward graduation.
Prerequisites: none
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills

MAT-110 Calc I With Pre-Calc Review
This course is intended solely for those students who took and passed MAT 010 and desire to complete a course in calculus. Successful completion of this course is equivalent to completion of MAT 111. Topics covered include an introduction to integration via polynomials and rational functions, applications of the integral, Fundamental Theorem of Calculus, and introduction to exponential, logarithmic and trigonometric functions, and the application of the derivative and integral to these families of functions. The focus is on understanding basic concepts and gaining basic computational skills. This course counts as a distribution credit in mathematics. Credit cannot be given for both MAT 110 and MAT 111. This course is offered in the spring semester.
Prerequisites: MAT-010 with a grade of C- or better.
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills
Equated Courses: MAT-111

MAT-111 Calculus I
Basic calculus of one variable from an intuitive point of view. Topics include limits, continuity, derivatives and integrals of the elementary functions, Fundamental Theorem of Calculus, and applications. The focus is on understanding basic concepts and gaining basic computational skills.
Prerequisites: none
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy
Equated Courses: MAT-110

MAT-112 Calculus II
A continuation of MAT 111. Numerical and symbolic techniques of integration, applications of integration, an introduction to partial derivatives and multiple integrals, sequences and series, and Taylor’s Theorem.
Prerequisites: Prerequisite: MAT-110 or MAT-111 with a minimum grade of C-, or MAT-112 placement
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills
Equated Courses: APCR

MAT-178 Special Topics
This course is designed for the treatment of material outside the regular offerings of the department. For a given semester, the course content and other particulars will be announced before advance registration for that semester. Please refer to the Registrar’s page for course description.
Prerequisites: none
Credits: 0.5-1
Distribution: Natural Science/Mathematics, Quantitative Literacy

MAT-219 Combinatorics
This course is an introduction to combinatorial reasoning. Topics include graphs, circuits in graphs, graph coloring, trees, counting principles, generating functions, and recurrence relations. Students may not present both MAT 108 and 219 for credit towards graduation. This course is offered in the spring semester.
Prerequisites: MAT-223
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy

MAT-221 Found of Geometry
A development of Euclidean and non-Euclidean geometries from a modern viewpoint.
Prerequisites: MAT-112
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy

MAT-222 Theory of Numbers
A study of elementary number theory. Topics include divisibility, congruences, properties of prime numbers, number theoretic functions, diophantine equations, and additional selected topics. This course is offered in the spring semester.
Prerequisites: MAT-112
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy
MAT-223 Elementary Linear Algebra
An introduction to linear mathematics. Linear systems of equations, matrices, determinants, vector spaces, bases and dimension, function spaces, linear transformations, eigenvalues and eigenvectors, inner products, and applications. An important aspect of the course is to introduce the student to abstract thinking and proofs.
Prerequisites: Prerequisite: MAT-112 with a minimum grade of C-, or MAT-223 placement.
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy
Equated Courses: CR
MAT-224 Elem Differential Equations
Introduction to ordinary differential equations. Special solution techniques and some theory for first-order and linear equations including integrating factors, constant coefficients, undetermined coefficients, variation of parameters, power series solutions, Laplace transforms, and systems of differential equations applications. This course is offered in the spring semester.
Prerequisites: Prereq MAT-112 with a minimum grade of C- and 223.
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy
Equated Courses: CR
MAT-225 Multivariable Calculus
Calculus in higher dimensions. Limits, continuity, differentiability, directional derivatives, constrained coefficients, undetermined optimization, geometry of curves, multiple integrals, general coordinate systems, path and surface integrals, vector calculus, theorems of Green and Stokes applications. This course is offered in the fall semester.
Prerequisites: Prerequisites: MAT-112 with a minimum grade of C-, and MAT-223
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy
MAT-226 Operations Research
Linear and nonlinear optimization, linear programming, integer programming, duality, combinatorics, the simplex method and related algorithms, game theory, Markov chains, queuing theory.
Prerequisites: MAT-223
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy
MAT-235 Stochastic Simulation
Interesting real world phenomena often involve randomness at some level, and this course develops mathematical and computational tools for studying these systems. In particular, students will study and implement computer simulation models of continuous and discrete stochastic processes with potential applications in physics, economics, epidemiology, networks, sports, elections, and industrial engineering. Specific topics for study include: basic probability models, pseudo-random number generation, queueing models, discrete event simulations, Poisson processes, random walks, Markov chains, Monte Carlo methods, and statistical analysis of simulated data.
Prerequisites: Prereq of MAT 112 and CSC 111
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy
MAT-251 Mathematical Finance
The course gives an overview of the mathematical reasoning behind the pricing of options. Topics include binomial models, put-call parity, a probabilistic derivation of the Black-Scholes pricing formula for call options, and delta hedging. We will also look at Asian, gap, and barrier options. This course is offered in the fall semester.
Prerequisites: Prerequisite: MAT-112
Credits: 0.5
Distribution: Natural Science/Mathematics, Quantitative Literacy
MAT-252 Math Interest Theory
This course will involve a thorough treatment of the mathematical theory of interest, with special attention paid to calculating present and accumulation values for annuities (series of payments made at regular time intervals). Some topics include nominal and effective rates of interest and discount, force of interest, amortization schedules, sinking funds, and bonds. This course is offered in the fall semester.
Prerequisites: Prerequisite: MAT-112
Credits: 0.5
Distribution: Natural Science/Mathematics, Quantitative Literacy
MAT-253 Probability Models
This course is an introduction to discrete and continuous random variables. Distributions considered include the hypergeometric, binomial, geometric, Poisson, uniform, normal, gamma, chi-square, t and F. We will cover the Central Limit Theorem, multivariate distributions, and transformations of random variables.
Prerequisites: Prerequisite: MAT-112
Credits: 0.5
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills
MAT-254 Statistical Models
This course gives an overview of confidence intervals, classical hypothesis testing procedures: z-tests, t-tests, F-tests, Chi-square tests, Latin square designs, and regression. An intuitive but mathematical treatment is given for all the distributions and procedures involved. This course is offered in the spring semester.
Prerequisites: MAT-112
Credits: 0.5
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills
MAT-277 Special Topics
This course is designed for the treatment of material outside the regular offerings of the department. For a given semester, the course content and other particulars will be announced before advance registration for that semester. Please refer to the Registrar's page for course description.
Prerequisites: none
Credit: 1
Distribution: Quantitative Literacy
MAT-287 Independent Study
Enrollment through Instructor and Department Chair approval.
Prerequisites: none
Credits: 0.5-1
Distribution: Natural Science/Mathematics
MAT-314 Modeling With Differential Equations
A course to develop the basic skills of formulation, simplification, and analysis of mathematical models for describing and predicting phenomena in the natural and social sciences, with special emphasis in modeling with differential equations. Topics may be taken from fields such as physics, chemistry, biology, psychology, economics, and political science. This course is offered in the fall semester of even-numbered years.
Prerequisites: MAT-224
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy

MAT-323 Topics in Linear Algebra
An in-depth study of some of the topics covered in MAT 223, including the theory of vector spaces, linear transformations, and Euclidean spaces, together with some additional topics, which may include isomorphisms, duality, canonical forms, and applications of linear algebra. Please refer to the Registrar’s page for course description.
Prerequisites: MAT-223
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy

MAT-324 Topics in Differential Equations
A second course in differential equations offering study of special topics in more depth or beyond those covered in MAT 224. Topics may include existence and uniqueness theory, stability theory, Green’s functions, dynamical systems, partial differential equations, and applications of differential equations. Please refer to the Registrar’s page for course description.
Prerequisites: MAT-224
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy

MAT-331 Abstract Algebra I
A first course in higher abstract mathematics. Emphasis is placed on writing proofs. Topics include groups and rings. This course is offered in the spring semester.
Prerequisites: Prereq MAT-223 with a minimum grade of C-
Credit: 1
Distribution: Natural Science/Mathematics

MAT-332 Abstract Algebra II
A continuation of MAT 331. Topics will depend on the instructor but may include fields, modules, Galois theory, or advanced topics in groups and rings.
Prerequisites: Prerequisite: MAT-331
Credit: 1
Distribution: Natural Science/Mathematics

MAT-333 Funct Real Variable I
A first course in the foundations of modern analysis. Topics include set theory, topology of the real numbers, sequences, series, differentiation, integration, and rigorous proofs of the major theorems of single-variable calculus. This course is offered in the fall semester.
Prerequisites: Prerequisite: MAT-223
Credit: 1
Distribution: Natural Science/Mathematics

MAT-334 Funct Real Variable II
A continuation of MAT 333. Topics will depend on the instructor but may include sequences and series of functions, Fourier analysis, elementary functional analysis, advanced multivariable calculus or metric spaces.
Prerequisites: MAT-333
Credit: 1
Distribution: Natural Science/Mathematics

MAT-337 Numerical Analysis
This course will address topics such as numerical solution of non-linear equations in one variable, interpolation, approximation, differentiation, integration, difference equations, differential equations and their applications, boundary value problems, linear systems, matrices, and optimization. This course is offered in the fall semester of even-numbered years.
Prerequisites: Prerequisites: CSC-111 and MAT-223
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy

MAT-338 Topics Computational Math
A course to develop mathematical and computational techniques in areas of mathematics or interdisciplinary study in which computation plays a central and essential role. Topics vary by semester but may include computational geometry, computer algebra, scientific computing, and symbolic computation. This course is offered in the fall semester of odd-numbered years. Please refer to the Registrar’s page for course description.
Prerequisites: CSC-111 and MAT-112
Credit: 1
Distribution: Natural Science/Mathematics

MAT-341 Topology
A study of elementary topology. Topics discussed will include topologies, separation axioms, connectedness, compactness, continuity, and metric spaces.
Prerequisites: MAT-223
Credit: 1
Distribution: Natural Science/Mathematics

MAT-344 Complex Analysis
Analytic functions, mapping of elementary functions, integrals, residue theory, conformal mapping. This course is offered in the spring semester of odd-numbered years.
Prerequisites: MAT-223
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy

MAT-353 Probability Models II
This course is a continuation of MAT 253 (Probability Models). Topics include survival functions, hazard functions, order statistics, continuous and discrete distributions not considered in MAT 253, mixed random variables. Brownian motion and stochastic calculus. We will look at a wide variety of probability problems associated with insurance.
Prerequisites: Prerequisite: MAT-253
Credits: 0.5
Distribution: Natural Science/Mathematics, Quantitative Literacy

MAT-354 Mathematical Statistics
This course takes a more theoretical look at estimation and hypothesis testing than MAT 254 (Statistical Models). Topics include maximum likelihood estimators (MLE’s), the information inequality, asymptotic theory of MLE’s, likelihood ratio tests, most powerful tests, uniformly most powerful tests, and Bayesian statistics. This course is offered in the spring semester.
Prerequisites: MAT-253 and 254
Credits: 0.5
Distribution: Natural Science/Mathematics, Quantitative Literacy
**MAT-355 Regression Models**
This course takes a matrix-based look at regression (introduced in MAT 254, Statistical Models). We focus on the probabilistic reasoning behind regression, in particular the inferences we can make using linear combinations of normal random variables. We also look briefly at some time series models.
**Prerequisites:** MAT-223, 253, 254
**Credits:** 0.5
**Distribution:** Natural Science/Mathematics, Quantitative Literacy

**MAT-377 Special Topics**
This course is designed for the treatment of material outside the regular offerings of the department. For a given semester, the course content and other particulars will be announced before advance registration for that semester. Please refer to the Registrar’s page for course description.
**Prerequisites:** none
**Credits:** 0.5-1
**Distribution:** Natural Science/Mathematics, Quantitative Literacy

**MAT-378 Special Topics**
This course is designed for the treatment of material outside the regular offerings of the department. For a given semester, the course content and other particulars will be announced before advance registration for that semester. Please refer to the Registrar’s page for course description.
**Prerequisites:** none
**Credits:** 0.5-1
**Distribution:** Natural Science/Mathematics, Quantitative Literacy

**MAT-387 Independent Study**
Directed reading and research on special topics for qualified students. May be repeated for credit. Level varies (intermediate or advanced); determined in consultation with instructor. Enrollment through Instructor and Department Chair approval.
**Prerequisites:** none
**Credits:** 0.5-1
**Distribution:** Natural Science/Mathematics

**MAT-388 Independent Study**
Directed reading and research on special topics for qualified students. May be repeated for credit. Level varies (intermediate or advanced); determined in consultation with instructor. Enrollment through Instructor and Department Chair approval.
**Prerequisites:** none
**Credits:** 0.5-1
**Distribution:** Natural Science/Mathematics

**MAT-400 Seminar**
Topics in the history and foundations of mathematics, the special emphasis varying from year to year. Every student will be expected to write a term paper. Please refer to the Registrar’s page for course description.
**Prerequisites:** none
**Credits:** 0.5
**Distribution:** Natural Science/Mathematics, Quantitative Literacy

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**Computer Science (CSC)**

**CSC-101 Intro to Computer Science**
An introduction to the field of computer science: the study of algorithmic processes and the machines that implement them. Students will study the history of computing as well as ethical issues raised by computing and automation. Students will study fundamental areas of the discipline, including basic digital circuits, computer hardware and architecture, data representation, issues of computability, and algorithm design and analysis. Students will also engage in hands-on activities involving basic digital circuits, hardware and programming.
**Prerequisites:** none
**Credit:** 1
**Distribution:** Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills

**Equate Courses:** APCR

**CSC-111 Intro to Programming**
This course provides an introduction to programming and problem solving in a higher-level, general-purpose language. Programming topics include primitive data types, simple data types such as arrays, program constructs such as conditionals, loops, and functions, and the fundamentals of object-oriented programming. (Note: CSC-111 does not count as a laboratory science.)
**Prerequisites:** Prerequisite: CSC-101 or MAT 112; or permission of the instructor
**Credit:** 1
**Distribution:** Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills

**CSC-112 Advanced Programming**
A variety of topics that are important in developing large-scale software. Object oriented programming in a language such as C++. Dynamic data structures such as lists, queues, and stacks. An introduction to a rigorous analysis of the efficiency of an algorithm. Advanced algorithms such as Quicksort, mergesort, and the use of hash tables. An introduction to using the Unix operating system and Unix tools for software development such as Make.
**Prerequisites:** CSC-111
**Credit:** 1
**Distribution:** Natural Science/Mathematics, Quantitative Literacy

**CSC-121 Intro to Additional Program Language**
An introduction to one or more additional programming languages. Students will build on their previous knowledge of a programming language to learn one or more additional languages. Languages vary by semester but may include any programming paradigm. For a given semester the course content and other particulars will be announced before registration for that semester. This course may be taken multiple times, for credit for each different language.
**Prerequisites:** CSC-111 with a grade of C- or better
**Credits:** 0.5
**Distribution:** Natural Science/Mathematics, Quantitative Literacy

**CSC-171 Special Topics in Comp. Sci.**
This course is designed for the treatment of material outside the regular offerings of the department. For a given semester, the course content and other particulars will be announced before registration for that semester. Refer to the Course Descriptions document on the Registrar’s webpage for topics and descriptions of current offerings. This course is offered irregularly.
**Prerequisites:** none
**Credit:** 1
**Distribution:** Natural Science/Mathematics, Quantitative Literacy
CSC-187 Independent Study
Enrollment through Instructor and Department Chair approval.
Prerequisites: none
Credits: 0.5-1
Distribution: Natural Science/Mathematics

CSC-188 Independent Study
Enrollment through Instructor and Department Chair approval.
Prerequisites: none
Credits: 0.5-1
Distribution: Natural Science/Mathematics

CSC-211 Intro to Data Structures
This course studies structured ways of storing and organizing data and algorithms designed for these structures. Attention is given to both theory and practical implementation of data structures and algorithms. Analytical techniques will be developed to study algorithm complexity, comparisons between iterative and recursive algorithms, and theory for searching, sorting, and traversing data. Computational studies will provide practical validation of analytical results and will develop an intuition for understanding tradeoffs between competing methods. Data structures covered include lists, stacks, queues, trees, hash tables, graphs, and related data types.
Prerequisites: Prerequisite: CSC-111 with a minimum grade of C-.
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy

CSC-235 Stochastic Simulation
Interesting real world phenomena often involve randomness at some level, and this course develops mathematical and computational tools for studying these systems. In particular, students will study and implement computer simulation models of continuous and discrete stochastic processes with potential applications in physics, economics, epidemiology, networks, sports, elections, and industrial engineering. Specific topics for study include: basic probability models, pseudo-random number generation, queueing models, discrete event simulations, Poisson processes, random walks, Markov chains, Monte Carlo methods, and statistical analysis of simulated data.
Prerequisites: Prereq of MAT-112 and CSC-111
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy

CSC-241 Introduction to Machine Organization
This course studies the various levels at which a computer can be studied, both in hardware and software. These levels include transistor level digital circuits, higher-level architectural circuits, and the hierarchy of machine code, assembly code, and high-level programming languages. Students will comparatively study different modern and historical computer architectures, including examples of both RISC and CISC architectures. Students will become proficient in programming in a modern assembly language (e.g. ARM64 or x86-64). This course is offered in the fall semester.
Prerequisites: Prerequisite: CSC-211, or permission of the instructor
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills
Equated Courses: CSC-311

CSC-242 Theory of Programming Languages
A study of the paradigms of programming languages, including procedural languages such as Pascal or ‘C’, object-oriented languages such as C++ or Smalltalk, functional languages such as ML or Scheme, logic-oriented languages such as Prolog, and concurrency such as in Ada. Consideration of how concepts are implemented, such as modules, parameter passing, function evaluation, data types and type checking, memory management, exception handling, and threads. This course is offered in the spring semester.
Prerequisites: CSC-121
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills
Equated Courses: CSC-321

CSC-243 Algorithm Design and Analysis
This course studies how algorithms are designed, analyzed, implemented and proven to work correctly. Common algorithmic design paradigms will be examined -- divide and conquer, dynamic programming, greedy, as well as the strategy of reducing from one type of problem to another. Standard techniques for studying algorithmic efficiency will be utilized throughout the course, including asymptotic analysis and recurrence relations. Additional specialized topics may be surveyed such as graph algorithms, linear programming, parallel algorithms, approximation algorithms, randomized algorithms, computational geometry and lower bound analysis. This course is offered in the spring semester.
Prerequisites: CSC-211 and MAT-108 or 219
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills
Equated Courses: CSC-331

CSC-244 Theory of Computing
How do we know if a problem is computationally hard to solve? In this course, computational problems will be studied as formal languages and classified according to their solvability under various theoretical computation models and resource constraints. The models to be studied will include finite-state automata, pushdown automata, linear-bounded automata and Turing Machines. Alternative characterizations of these models will also be examined, such as those of grammars, circuits, restricted programming languages and Church’s ?-calculus. Complexity classes (e.g., L, P, NP, Co-NP and PSPACE) will be introduced to study time and space constraints, along with the notions of complete problems, efficient reductions and hierarchy theorems. Along the way, many difficult open problems that continue to vex theoretical computer scientists will be explored, such as the infamous P versus NP problem. This course is offered in the fall semester.
Prerequisites: Prerequisite: CSC-111 with a minimum grade of C-; either MAT-108 or MAT-219 with a minimum grade of C-
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills
Equated Courses: CSC-341
CSC-271 Special Topics in Computer Science
This course is designed for the treatment of material outside the regular offerings of the department. For a given semester, the course content and other particulars will be announced before registration for that semester. This course is offered irregularly. Refer to the Course Descriptions document on the Registrar’s webpage for Topics and Descriptions of current offerings.
Prerequisites: CSC-111 or permission of the instructor.
Credits: 0.5-1
Distribution: Natural Science/Mathematics, Quantitative Literacy

CSC-287 Independent Study
Enrollment through Instructor and Department Chair approval.
Prerequisites: none
Credits: 0.5-1
Distribution: Natural Science/Mathematics

CSC-288 Independent Study
Enrollment through Instructor and Department Chair approval.
Prerequisites: none
Credits: 0.5-1
Distribution: Natural Science/Mathematics

CSC-311 Intro Machine Organ
A study of the various layers at which a machine can be studied, including higher-level languages, assembly language, machine language, and digital circuits. Data representation. A comparison of RISC and CISC architectures. Some programming in a representative assembly language. Issues of cross-language programming. This course is offered irregularly.
Prerequisites: CSC-211
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy
Equated Courses: CSC-241

CSC-321 Programming Lang
A study of the paradigms of programming languages, including procedural languages such as Pascal or ‘C’, object-oriented languages such as C++ or Smalltalk, functional languages such as ML or Scheme, logic-oriented languages such as Prolog, and concurrency such as in Ada. Consideration of how concepts are implemented, such as modules, parameter passing, function evaluation, data types and type checking, memory management, exception handling, and threads. This course is offered irregularly.
Prerequisites: CSC-121
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy
Equated Courses: CSC-242

CSC-331 Analysis Algorithms
Advanced topics and problems in analyzing algorithms. Algorithms involving structures such as sequences, sets, and graphs, and topics such as geometric and numeric algorithms. An introduction to the question of P=NP and NP-Complete problems. Parallel algorithms. This course is offered irregularly.
Prerequisites: CSC-211 and MAT-108 or 219
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy
Equated Courses: CSC-243

CSC-337 Introduction to Numerical Analysis
Advanced-This course will address topics such as numerical solution of non-linear equations in one variable, interpolation, approximation, differentiation, integration, difference equations, differential equations and their applications, boundary value problems, linear systems, matrices, and optimization. This course is offered in the fall semester of even-numbered years.
Prerequisites: Prerequisites: CSC-111 and MAT-223
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy

CSC-338 Topics in Computational Math
An advanced course to develop mathematical and computational techniques in areas of mathematics or interdisciplinary study in which computation plays a central and essential role. Topics vary by semester but may include computational geometry, computer algebra, scientific computing, and symbolic computation. This course is typically offered in the fall semesters of odd-numbered years.
Prerequisites: CSC-111 and MAT-112
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy
Equated Courses: CSC-244

CSC-361 Database System Design
CSC 361 - Database System Design. Database management is a central component of a modern computing environment. This course introduces the fundamental concepts of database design and database languages. Topics include relational databases, SQL, formal relational query languages, the E-R model, relational database design, storage and file structures, indexing and hashing, query processing, transactions, and data warehousing and mining.
Prerequisites: Take CSC-211 with a minimum grade of C-
Corequisites: Take CSC-211 with a minimum grade of C-
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills

CSC-362 Operating Systems
This course explores the design and implementation of computer operating systems. Topics include historical aspects of operating systems development, systems programming, process scheduling, synchronization of concurrent processes, virtual machines, memory management and virtual memory, I/O and file systems, system security, OS/architecture interaction, and distributed operating systems.
Prerequisites: Take CSC-211 with a minimum grade of C-
Corequisites: Take CSC-211 with a minimum grade of C-
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills
CSC-363 Compiler Design
This course explores principles and practices used for designing and implementing compilers and interpreters. Students will build a compiler for a programming language designed for the course. The major stages of compilation will be studied in-depth – lexical analysis, syntax analysis, semantic analysis, and code generation. Additional topics such as advanced parsing techniques and specific compiler-construction tools may be covered at the instructor’s discretion.
Prerequisites: Take CSC-211 with a minimum grade of C-
Corequisites: Take CSC-211 with a minimum grade of C-
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills

CSC-364 Parallel Programming
This course provides an introduction to high-performance computing through the study of different ways that a large problem can be divided into separate tasks which are solved simultaneously by parallel processing elements. Topics include the study of different types of parallel computing, the design and implementation of parallel algorithms, hardware that supports parallelism, and analysis of scalability.
Prerequisites: Take CSC-211 with a minimum grade of C-
Corequisites: Take CSC-211 with a minimum grade of C-
Credit: 1
Distribution: Natural Science/Mathematics, Quantitative Literacy, Quantitative Skills

CSC-387 Independent Study
Directed study on special topics for qualified students. May be repeated for credit.
Prerequisites: none
Credits: 0.5-1
Distribution: Natural Science/Mathematics

CSC-388 Independent Study
Directed study on special topics for qualified students. May be repeated for credit.
Prerequisites: none
Credits: 0.5-1
Distribution: Natural Science/Mathematics

CSC-400 Senior Capstone
This course is a senior capstone course, which all computer science majors should take in their senior year. This is a project-based course that develops skills in individual and team software development, including reading, documenting, presenting, and critiquing software systems.
Prerequisites: Prerequisite: CSC-211 with a minimum grade of C-
Credit: 1

CSC-487 Independent Study
Enrollment through Instructor and Department Chair approval.
Prerequisites: none
Credits: 0.5-1
Distribution: Natural Science/Mathematics

CSC-488 Independent Study
Enrollment through Instructor and Department Chair approval.
Prerequisites: none
Credits: 0.5-1
Distribution: Natural Science/Mathematics

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Mark McCartin-Lim
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