Mathematics or Applied Mathematics

A degree in mathematics is useful for those seeking careers in teaching, research, the sciences, or business and government. The traditional mathematics major is particularly appropriate if students plan to teach or enter professional school or if they seek an interesting major within the liberal arts. The applied mathematics major is suggested if a student plans a career in actuarial work, industrial mathematics or statistics.

The minor in mathematics consists of 21 units of required course work. Please refer to the Degree Requirements section (p. 1) for more information.

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Website: http://ucollege.wustl.edu/programs/undergraduate/bachelors-math

Degree Requirements

Bachelor of Science in Mathematics or Applied Mathematics

All University College undergraduate students must satisfy the same general-education requirements (http://bulletin.wustl.edu/undergrad/ucollege/bachelors/#degreerequirements).

Required for all mathematics majors: 12 units

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 155</td>
<td>Calculus I</td>
<td>3</td>
</tr>
<tr>
<td>Math 156</td>
<td>Calculus II</td>
<td>3</td>
</tr>
<tr>
<td>Math 255</td>
<td>Calculus III</td>
<td>3</td>
</tr>
<tr>
<td>Math 256</td>
<td>Calculus IV</td>
<td>3</td>
</tr>
<tr>
<td>Total Units</td>
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<td>12</td>
</tr>
</tbody>
</table>

Students in the applied math major are also required to take Math 133 Programming with Python.

Plus an additional 18 units of 300- and 400-level Mathematics courses

Students in the traditional math major are encouraged to take Math 3101 Foundations for Higher Mathematics. This is a day-school course designed to introduce students to the language and conventions of mathematical discourse. University College math majors may enroll in this course at the University College tuition rate. In addition, students should select relevant courses in the social and physical sciences to complement and augment the major.

A sample of available 300- and 400-level courses is given here:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 301</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>Math 305</td>
<td>Probability and Statistics</td>
<td>3</td>
</tr>
<tr>
<td>Math 3091</td>
<td>Matrix Algebra</td>
<td>3</td>
</tr>
<tr>
<td>Math 493</td>
<td>Probability</td>
<td>3</td>
</tr>
<tr>
<td>Math 494</td>
<td>Mathematical Statistics</td>
<td>3</td>
</tr>
</tbody>
</table>

The Minor in Mathematics

To earn a minor in mathematics, 21 credits of mathematics courses must be completed, of which at least 9 units must be advanced course work (300 level or above). Suggested course work includes the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 133</td>
<td>Programming with Python</td>
<td>3</td>
</tr>
<tr>
<td>Math 155</td>
<td>Calculus I</td>
<td>3</td>
</tr>
<tr>
<td>Math 156</td>
<td>Calculus II</td>
<td>3</td>
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<tr>
<td>Math 255</td>
<td>Calculus III</td>
<td>3</td>
</tr>
<tr>
<td>Math 256</td>
<td>Calculus IV</td>
<td>3</td>
</tr>
<tr>
<td>Math 305</td>
<td>Probability and Statistics</td>
<td>3</td>
</tr>
<tr>
<td>Math 133</td>
<td>Applied Statistics</td>
<td>3</td>
</tr>
<tr>
<td>Math 309</td>
<td>Matrix Algebra</td>
<td>3</td>
</tr>
<tr>
<td>Math 301</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>Total Units</td>
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<td>21</td>
</tr>
</tbody>
</table>

Courses


U20 Math 1011 Introduction to Statistics

This course covers basic concepts of statistics, including data collection (sampling and designing experiments), data organization (tables, graphs, frequency distributions, numerical summarization of data), and statistical inference (elementary probability and hypothesis testing). Prerequisite: high school algebra. This course is not equivalent to L24 1011. Credit 3 units.

U20 Math 133 Programming with Python

An introductory course for students with little or no programming experience. Topics include the software development process, documentation, debugging, and testing within the commonly used Python environment. At the end of the course students should be able to write and debug basic programs to display and interpret data using accepted programming conventions and styles.
Beyond standard mathematics, and discover exciting ideas and applications. Students will learn effective thinking techniques with applications that are typically not discussed in standard math courses. Mathematics plays an important role in society, from engineering to architecture to the social and behavioral sciences. This course will expose non-math majors to fascinating sides of mathematics. Mathematics or Applied Mathematics (08/03/20) Bulletin 2020-21 Mathematics or Applied Mathematics (08/03/20)

**U20 Math 140 Algebra**
The basic rules for operation within the real number system, polynomials, linear and quadratic equations, and inequalities. Prerequisite: one year of high school algebra or equivalent. Credit 3 units.

**U20 Math 141 Topics in Precalculus**
A study of the properties of algebraic and trigonometric functions in preparation for further coursework in calculus. Topics covered include the continuation of the study of polynomial, exponential, and logarithmic functions and a foundation in trigonometry, including analytic trigonometry and application and polar coordinates. U20-140 and 141 serve as preparation for the calculus sequence. Prerequisite: high school or college algebra. Credit 3 units.

**U20 Math 155 Calculus I**
First course in differential calculus covering functions, limits, continuity, derivatives, techniques of differentiation, and applications including maxima and minima of functions, curve sketching, related rates and rectilinear motion, mean value theorem. Prerequisite: U20-141 or equivalent, including trigonometry. Credit 3 units. UColl: OLI

**U20 Math 156 Calculus II**
Continuation of U20 155, starting with a brief review of definitions and formulas. The concept of the integral; the Fundamental Theorem of Calculus; techniques of integration; application of the integral including areas, volume, and work; differential and integral calculus with elementary transcendental functions. Prerequisite: U20 155 or equivalent. Credit 3 units.

**U20 Math 205 Applied Statistics**
This is a first course in statistics with examples and applications from a variety of disciplines, and emphasis on the social, behavioral, and natural sciences. Students learn about key topics and statistical methods that may be applied to areas such as economics, mathematics, psychology, business, and health sciences, to name a few. The course provides a foundation in descriptive and inferential statistics, and in probability. Students learn numerical and graphical methods of describing data and study some of the more common distributions. Topics include hypothesis testing, confidence-interval estimation, correlation, regression, analysis of variance, contingency tables, quality control, and nonparametric statistics. This course may be applied to University College majors in economics, managerial economics, mathematics, and political science. This course is entirely web-based, with all course components online. U20 Math 205 and 305 may not BOTH be taken for credit. Prerequisite: college algebra. Credit 3 units. UColl: OLI

**U20 Math 210 The Art of Mathematical Thinking**
Mathematics plays an important role in society, from engineering to architecture to the social and behavioral sciences. This course will expose non-math majors to fascinating sides of mathematics that are typically not discussed in standard math courses. Students will learn effective thinking techniques with applications beyond standard mathematics, and discover exciting ideas and new perspectives about the world. We will look at questions like: What do rabbits, piano keyboards, and pine cones have to do with the Parthenon? What do secret codes and bar codes have to do with number systems and prime numbers? What are some uses and misuses of mathematics in everyday life? Why are coincidences not so amazing after all? Prerequisite: proficiency in high school algebra. Credit 3 units. UColl: OLI

**U20 Math 230 Introduction to Data Science with Python**
In this continuation of Programming with Python, students apply their skills to data science examples. The course will start with a brief review of Python and then shift to technical topics such as working with the numerical library NumPy; data manipulation with pandas; and creating graphics with matplotlib, Seaborn and other data visualization libraries. The final project will be an application of machine learning using the scikit-learn library. Prerequisite: U20 133 or permission of the instructor. Credit 3 units. UColl: NSC

**U20 Math 255 Calculus IV**
Continuation of U20 256. Functions of several variables, partial derivatives, tangent planes, directional derivatives, total differential, multiple integrals, line integrals, and an introduction to elementary differential equations. Prerequisite: U20 255 or equivalent. Credit 3 units.

**U20 Math 256 Calculus IV**
Continuation of U20 255. Functions of several variables, partial derivatives, tangent planes, directional derivatives, total differential, multiple integrals, line integrals, and an introduction to elementary differential equations. Prerequisite: U20 255 or equivalent. Credit 3 units.

**U20 Math 3001 Independent Study in Mathematics**
Credit 3 units.

**U20 Math 301 Differential Equations**
First course in differential equations with emphasis on linear equations and their applications. Prerequisite: U20 256 or equivalent. Credit 3 units.

**U20 Math 305 Probability and Statistics**
Discrete and continuous random variables, mean and variance, hypothesis testing and confidence limits, nonparametric methods. Students' t-methods, regression, correlation. Prerequisite: U20 156 or consent of department. Credit 3 units.

**U20 Math 309 Linear Algebra I**
Detailed treatment of the algebra of matrices. Rank and equivalence of matrices. Matrices over a number field. Linear equations and linear dependence. Determinants. Prerequisite: U20 256 or equivalent. Credit 3 units.
U20 Math 3091 Matrix Algebra
An introductory course in linear algebra that focuses on Euclidean n-space, matrices and related computations. Topics include: systems of linear equations, row reduction, matrix operations, determinants, linear independence, dimension, rank, change of basis, diagonalization, eigenvalues, eigenvectors, orthogonality, symmetric matrices, least square approximation, quadratic forms. Introduction to abstract vector spaces. Prerequisite: Math 132. Credit 3 units. A&S IQ: AN Arch: NSM Art: NSM

U20 Math 3101 Foundations for Higher Mathematics
This course provides an introduction to the rigorous techniques used in more advanced mathematics. Topics include propositional logic, the use of quantifiers, set theory, methods of proof and disproof (counterexamples), and foundations of mathematics. The use of these tools in the construction of number systems and in other areas such as elementary number theory, combinatorial arguments, and elementary proofs in analysis is also covered. Prerequisite: Math 233. Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM

U20 Math 400 Independent Study
Credit variable, maximum 3 units.

U20 Math 420 Experimental Design
A first course in the design and analysis of experiments, from the point of view of regression. Factorial, randomized block, split-plot, Latin square, and similar design. Prerequisite: CSE 131 or 200, Math 3200, or permission of instructor. Same as U20 Math 520 Credit 3 units. Art: NSM

U20 Math 493 Probability
Mathematical theory and application of probability at the advanced undergraduate level; a calculus-based introduction to probability theory. Topics include the computational basics of probability theory, combinatorial methods, conditional probability including Bayes’ theorem, random variables and distributions, expectations and moments, the classical distributions, and the central limit theorem. Same as U20 Math 593 Credit 3 units.

U20 Math 494 Mathematical Statistics
Theory of estimation, minimum variance and unbiased estimators, maximum likelihood theory, Bayesian estimation, prior and posterior distributions, confidence intervals for general estimators, standard estimators and distributions such as the Student-t and F-distribution from a more advanced viewpoint, hypothesis testing, the Neymann-Pearson Lemma (about best possible tests), linear models, and other topics as time permits. Prereq: Math 305 and U20 593, or permission of the instructor. Same as U20 Math 594 Credit 3 units.