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 for more information.

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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>
</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>
</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>Math 305</td>
<td>Probability and Statistics</td>
<td>3</td>
</tr>
<tr>
<td>or Math 205</td>
<td>Applied Statistics</td>
<td></td>
</tr>
<tr>
<td>Math 309</td>
<td>Matrix Algebra</td>
<td>3</td>
</tr>
<tr>
<td>or Math 301</td>
<td>Differential Equations</td>
<td></td>
</tr>
</tbody>
</table>

Total Units: 21

Courses


U20 Math 1011 Introduction to Statistics
Basic concepts of statistics. Data collection (sampling and designing experiments), data organization (tables, graphs, frequency distributions, numerical summarization of data). Prerequisite: high school algebra. Note: This course is not equivalent to L24 1011 and does not have any A&S attributes. 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. Credit 3 units.

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
Topics in algebra, functions, graphs, and logarithmic and exponential functions. U20 141 serves as preparation for the calculus sequence. Prerequisite: U20 140.
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: OLH

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 will 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 will provide a foundation in descriptive and inferential statistics, and in probability. Students will learn numerical and graphical methods of describing data and will study some of the more common distributions. Topics to be covered 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, and political science. Students must have access to the internet, have an email account, and have some familiarity with Microsoft Excel to take the course. 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 255 Calculus III
Continuation of U20 156. Vectors in the plane and in space, lines and planes in space, calculus of vector-valued functions, parametric equations, arc length, polar coordinates, infinite series, Taylor's theorem. Prerequisite: U20 156 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 301 Independent Study in Mathematics
Credit 3 units.

U20 Math 308 Linear Algebra I
Credit 3 units.

U20 Math 309 Linear Algebra II
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, eigenvectors, orthogonality, symmetric matrices, least square approximation, quadratic forms. Introduction to abstract vector spaces. Prerequisite: Math 132.
Credit 3 units. A&S IQ: NSM, AN 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 435 Statistical Learning: An Introduction to Data Mining
This course is an introduction to applications of statistical learning to big data sets. Topics include assessing model accuracy, linear vs. logistic regression, cross validation and resampling, shrinkage and regularization (lasso) methods, decision trees and other tree-based methods, and clustering methods such as K-means, hierarchical clustering, and support vector machines. We also cover data mining for massive data sets, such as association rule mining. Linear regression will be reviewed. The course provides skills and experience for careers in statistical and machine learning and for positions such as data scientist, data analyst, applied statistician, and data-savvy manager. Prerequisites: U20 Math 594 or permission of instructor and introductory-level programming (R, SAS, or Python).
Same as U20 Math 535
Credit 3 units.

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.
Same as U20 Math 594
Credit 3 units.

U20 Math 495 Stochastic Processes
Content varies with each offering of the course. Past offerings have included such topics as random walks, Markov chains, Gaussian processes, empirical processes, Markov jump processes, and a short introduction to martingales, Brownian motion and stochastic integrals. Prerequisites: Math 318 and 493, or permission of instructor.
Same as L24 Math 495
Credit 3 units. A&S IQ: NSM Arch: NSM