

# MATHEMATICS (MATH)

Subject-area course lists indicate courses currently active for offering at the University of Louisville. Not all courses are scheduled in any given academic term. For class offerings in a specific semester, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>).

500-level courses generally are included in both the undergraduate- and graduate-level course listings; however, specific course/section offerings may vary between semesters. Students are responsible for ensuring that they enroll in courses that are applicable to their particular academic programs.

## Course Fees

Some courses may carry fees beyond the standard tuition costs to cover additional support or materials. Program-, subject- and course-specific fee information can be found on the Office of the Bursar website (<http://louisville.edu/bursar/tuitionfee/>).

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### MATH 501. Introduction to Analysis I - CUE 3 Units

**Term Typically Offered:** Fall, Spring

**Prerequisite(s):** MATH 301, MATH 311 and MATH 325.

**Description:** Foundations of the real number system, sequences and series, topology of the line, continuity, differentiation of functions of one variable.

**Course Attribute(s):** CUE - This course fulfills the Culminating Undergraduate Experience (CUE) requirement for certain degree programs. CUE courses are advanced-level courses intended for majors with at least 90 earned credits/senior-level status.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

### MATH 502. Introduction to Analysis II 3 Units

**Term Typically Offered:** Spring Only

**Prerequisite(s):** MATH 501.

**Description:** Riemann integration on the line, sequences and series of functions, uniform convergence, metric spaces.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

### MATH 505. Introduction to Partial Differential Equations 3 Units

**Term Typically Offered:** Fall, Summer

**Prerequisite(s):** MATH 301 and MATH 405 or PHYS 350.

**Description:** Techniques for solving standard heat, wave, and potential equations, including discussion of Fourier analysis techniques.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

### MATH 507. Fourier Analysis 3 Units

**Term Typically Offered:** Spring Only

**Prerequisite(s):** MATH 301 and MATH 405.

**Description:** Introduction to Fourier series and transforms.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

### MATH 511. Complex Analysis I 3 Units

**Term Typically Offered:** Occasionally Offered

**Prerequisite(s):** MATH 301 or ENGR 201; MATH 311; MATH 325 or ENGR 330.

**Description:** Geometry of the complex plane, analytic and meromorphic functions, linear fractional transformations. Cauchy's Theorem and the Residue Theorem. Emphasizes computational aspects of the course topics.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

### MATH 512. Complex Analysis II 3 Units

**Prerequisite(s):** MATH 511.

**Description:** A continuation of MATH 511, including deeper properties of analytic, meromorphic, harmonic functions and conformal mappings. Emphasizes theoretical aspects of the course topics.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

### MATH 520. Theory of Numbers 3 Units

**Prerequisite(s):** MATH 206 or ENGR 102; MATH 311; MATH 325 or consent of instructor.

**Description:** A study of the integers and their divisibility properties. Particular emphasis on the theory of congruencies, partitions, prime numbers, Diophantine analysis and quadratic residues.

**Note:** Credit may be applied towards the MAT but not toward any other graduate degree in mathematics.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

### MATH 521. Modern Algebra I - CUE 3 Units

**Term Typically Offered:** Fall, Spring

**Prerequisite(s):** MATH 206 or ENGR 102; and MATH 311; and MATH 325; or consent of instructor.

**Description:** An introduction to the theory of groups, rings, integral domains, and fields.

**Course Attribute(s):** CUE - This course fulfills the Culminating Undergraduate Experience (CUE) requirement for certain degree programs. CUE courses are advanced-level courses intended for majors with at least 90 earned credits/senior-level status.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

### MATH 522. Modern Algebra II 3 Units

**Term Typically Offered:** Spring Only

**Prerequisite(s):** MATH 521.

**Description:** Continuation in greater depth of topics introduced in MATH 521; introduction to theory of ideals, field extensions, and abstract vector spaces.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

<p><b>MATH 535. Modeling I</b>  <b>Prerequisite(s):</b> MATH 325 or MATH 405 or equivalent.  <b>Description:</b> Introduction to mathematical modeling of discrete and continuous dynamical systems.                      For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>	<p><b>MATH 562. Mathematical Statistics</b>  <b>Prerequisite(s):</b> MATH 561.  <b>Description:</b> Random samples and statistics, point estimation, sufficiency and completeness, confidence regions, classical theory of hypothesis testing, linear regression, nonclassical procedures.                      For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>
<p><b>MATH 536. Modeling II</b>  <b>Prerequisite(s):</b> MATH 535.  <b>Description:</b> Advanced mathematical modeling of discrete and continuous dynamical systems.                      For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>	<p><b>MATH 564. Probability Models</b>  <b>Prerequisite(s):</b> MATH 561.  <b>Description:</b> Finite probability models, Markov chains, renewal and reliability theory, Brownian motion, stochastic differential equations.                      For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>
<p><b>MATH 545. Introduction to Fractal Geometry</b>  <b>Prerequisite(s):</b> MATH 301 and MATH 325; MATH 501 recommended.  <b>Description:</b> Recursively defined sets and self-similarity; metric spaces and iterated function systems; topological, fractal, and Hausdorff dimensions.                      For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>	<p><b>MATH 568. Mathematical Models in Molecular Biology</b>  <b>Prerequisite(s):</b> MATH 205 or instructor consent.  <b>Description:</b> Introduction to probability models for representations of biochemical networks. Markov Processes. Stochastic simulation. Chemical and biochemical kinetics. Gillespie algorithm. Applications to intra-cellular kinetics.                      For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>
<p><b>MATH 550. Advanced Euclidean Geometry</b>  <b>Term Typically Offered:</b> Occasionally Offered  <b>Prerequisite(s):</b> A year of high school geometry; MATH 206 or ENGR 102; MATH 311; MATH 325 or consent of instructor.  <b>Description:</b> Theory of Euclidean geometry contrasted with non-Euclidean from both the axiomatic and algebraic approach. Of special value to secondary teachers.  <b>Note:</b> Credit may be applied toward the MAT but not toward any other graduate degree in mathematics.                       For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>	<p><b>MATH 570. Foundations of Actuarial Science</b>  <b>Prerequisite(s):</b> MATH 561.  <b>Description:</b> Fundamental mathematical tools for quantitatively assessing risk. Application of these tools to problems encountered in actuarial science is emphasized. Covers the material of Examination 1 of the Society of Actuaries and Casualty Actuarial Society.  <b>Note:</b> Credit may not be applied toward a graduate degree in mathematics.                       For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>
<p><b>MATH 551. Geometry</b>  <b>Term Typically Offered:</b> Spring Only  <b>Prerequisite(s):</b> MATH 206 or ENGR 102; MATH 311; MATH 325 or consent of instructor.  <b>Description:</b> Study of projective spaces, transformations and invariants. Introduction to related geometries, such as affine, elliptic, and hyperbolic.                      For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>	<p><b>MATH 573. Actuarial Models I</b>  <b>Term Typically Offered:</b> Occasionally Offered  <b>Prerequisite(s):</b> MATH 570; MATH 372 or MATH 572.  <b>Description:</b> This course covers the material for the Society of Actuaries Exam MFE, Actuarial Models-Financial Economics (also CAS Exam 3F). The syllabus for Exam MFE develops the student's knowledge of the theoretical basis of financial models and the application of those models to insurance and other financial risks. A thorough knowledge of calculus, probability and interest theory is assumed. In addition, for Exam MFE/3F, students are assumed to be familiar with derivative securities (introductory material).  <b>Note:</b> Knowledge of risk management at the level of MATH 570 is assumed.                       For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>
<p><b>MATH 561. Probability</b>  <b>Term Typically Offered:</b> Fall, Spring  <b>Prerequisite(s):</b> MATH 301.  <b>Description:</b> Probability spaces, probability distributions, moments, moment-generating functions, independence, transformation of variables, sampling distributions, laws of large numbers, central limit theorem, applications.  <b>Note:</b> Credit will not be granted for both MATH 561 and IE 360.                       For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>		

<p><b>MATH 574. Actuarial Models II</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 573.  <b>Description:</b> It further develops knowledge of the theoretical basis of actuarial models and the application of those models to insurance and other financial risks.  <b>Note:</b> Continuation of MATH 573.</p> <p>For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 602. Real Analysis II</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 601.  <b>Description:</b> Elementary Hilbert space theory, abstract measure spaces and integration, product spaces. Applications to other areas. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>
<p><b>MATH 581. Introduction to Graph Theory</b> <span style="float: right;"><b>3 Units</b></span>  <b>Term Typically Offered:</b> Fall Only  <b>Prerequisite(s):</b> MATH 206 or ENGR 102; MATH 311; MATH 325 or consent of instructor.  <b>Description:</b> Provides an overview of graph theory. Topics include blocks, trees, connectivity, Hamiltonian and Eulerian graphs; topological problems, matrices and groups.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 605. Functional Equations I</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 601.  <b>Description:</b> Introduction to the theory and application of functional equations in several variables, including Cauchy equations, d'Alembert equation, quadratic functionals.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>
<p><b>MATH 587. Discrete Mathematics for MAT students</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 206 or ENGR 102; MATH 325.  <b>Description:</b> Topics include: Pigeon-hole principle, counting techniques, binomial coefficients, generating functions, stirling and catalan numbers, permutations and graphs.  <b>Note:</b> Does not count towards the mathematics major or minor.  <b>Note:</b> Credit may be applied toward the MAT degree but not towards any other graduate degree in mathematics.  <b>Note:</b> Credit not allowed for both MATH 387 and MATH 587.</p> <p>For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 606. Functional Equations II</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 605 or consent of department.  <b>Description:</b> It extends further the theory of functional equations to applications in various branches of mathematics, information theory, and the natural and social sciences.  <b>Note:</b> Continuation of MATH 605.</p> <p>For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>
<p><b>MATH 590. History of Mathematics - WR</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> 500-level course in math (except MATH 560).  <b>Description:</b> Mathematical history from Mesopotamia to present. Emphasis on doing mathematics, identifying the growth of mathematical concepts and studying prominent mathematicians.  <b>Note:</b> Approved for the Arts and Sciences upper-level requirement in written communication (WR).</p> <p>For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 607. Seminar on Applied Analysis</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 605 or consent of department.  <b>Description:</b> Advanced topics in applied analysis. Topics will be determined by the research interests of the students and those of the instructor.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>
<p><b>MATH 591. Selected Topics in Mathematics</b> <span style="float: right;"><b>1-3 Units</b></span>  <b>Prerequisite(s):</b> Announced in Schedule of Courses.  <b>Description:</b> An examination of one or more topics in mathematics not usually treated in a regularly offered course.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 611. Complex Variables I</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 502.  <b>Description:</b> Geometry of the complex plane and complex analysis. Topics include analytic and meromorphic functions, linear fractional transformations, Cauchy's Theorem and the Residue Theorem.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>
<p><b>MATH 601. Real Analysis I</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 502.  <b>Description:</b> Basic set theory and real topology, Lebesgue measure and integration on the real line, differentiation of integrals, <math>L(p)</math> spaces.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 612. Complex Variables II</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 611.  <b>Description:</b> Including deeper properties of the space of meromorphic functions, harmonic functions and conformal mappings.  <b>Note:</b> Continuation of MATH 611.</p> <p>For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>
<p><b>MATH 621. Algebra I</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 522.  <b>Description:</b> Advanced theory of Groups, Rings, Integral Domains and Fields.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 622. Algebra II</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 621.  <b>Description:</b> Advanced theory of Groups, Rings, Integral Domains and Fields.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>

<p><b>MATH 622. Algebra II</b>  <b>Prerequisite(s):</b> MATH 621.  <b>Description:</b> Including Polynomial Rings, Modules, Vector Spaces, Structure of Fields, Galois Theory, Advanced Linear Algebra.  <b>Note:</b> A continuation of MATH 621.</p> <p>For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>	<p><b>MATH 663. Theory of Probability I</b>  <b>Prerequisite(s):</b> MATH 501 and MATH 561 or consent of department.  <b>Description:</b> Advanced topics in probability theory such as probability measures, random variables, laws of large numbers, large deviations, expected values, and distributions.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>
<p><b>MATH 631. Group Theory</b>  <b>Prerequisite(s):</b> MATH 522.  <b>Description:</b> Abstract Groups, Homomorphisms, Permutation Groups, Abelian Groups, Simple Groups, Sylow Theory, Series, Extensions.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>	<p><b>MATH 664. Theory of Probability II</b>  <b>Prerequisite(s):</b> MATH 663 or consent of department.  <b>Description:</b> Advanced topics in probability theory such as types of convergence, central limit theorems, conditional probabilities and expectations, stochastic processes, martingales, and Brownian motion.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>
<p><b>MATH 633. Rings and Ideals</b>  <b>Prerequisite(s):</b> MATH 522.  <b>Description:</b> Ideals and Homomorphisms, Prime Ideals and the Prime Radical, Rings of Endomorphisms, the Jacobson Radical.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>	<p><b>MATH 667. Statistical Inference</b>  <b>Prerequisite(s):</b> MATH 561 or consent of department.  <b>Description:</b> Advanced topics in mathematical statistics such as sampling distributions, exponential families, sufficiency, point and interval estimation, likelihood-based inference, hypothesis testing, Bayesian inference, statistical decision theory, and asymptotic theory.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>
<p><b>MATH 635. Mathematical Modeling I</b>  <b>Prerequisite(s):</b> MATH 325, MATH 405 or equivalent.  <b>Description:</b> Introduction to mathematical modeling of continuous and discrete dynamical systems.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>	<p><b>MATH 668. Linear Statistical Modeling</b>  <b>Prerequisite(s):</b> MATH 667 or consent of department.  <b>Description:</b> This course covers linear and related models including a discussion of fixed, mixed, and random effects models as well as regression and ANOVA models. The discussion will include estimation, hypothesis testing, confidence intervals, model fitting, and model diagnostics. Violations of the assumptions of the linear model will be examined. Statistical software will be used frequently. A strong background in linear algebra is needed.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>
<p><b>MATH 636. Mathematical Modeling II</b>  <b>Prerequisite(s):</b> MATH 635.  <b>Description:</b> Advanced mathematical modeling of discrete and continuous dynamical systems.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>	<p><b>MATH 670. Introduction to the Stochastic Calculus</b>  <b>Prerequisite(s):</b> MATH 660 or consent of the department.  <b>Description:</b> Levy Process, local martingale, stochastic integrals, quadratic variation, Ito's formula, existence and uniqueness of stochastic differential equation. Applications to financial engineering, no arbitrage and martingale measure, Black-Scholes model, edging.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>
<p><b>MATH 641. Topology I</b>  <b>Prerequisite(s):</b> MATH 502 or MATH 541.  <b>Description:</b> Continuous functions, connectedness, compactness, countability, separation, metrizability, and completeness in the context of topological spaces.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>	<p><b>MATH 673. Actuarial Models I</b>  <b>Prerequisite(s):</b> MATH 570 and MATH 572.  <b>Description:</b> Theoretical basis of actuarial models and the application of those models to insurance and other financial risks. The following specific models are introduced: Contingent Payment Models, Survival Models, Frequency and Severity Models, Compound Distribution Models, Stochastic Process Models, Ruin Models. Together with its continuation, MATH 674, covers the material on the Examination 3 of the Society of Actuaries and the Casualty Actuarial Society.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>
<p><b>MATH 642. Topology II</b>  <b>Prerequisite(s):</b> MATH 641.  <b>Description:</b> Introduction to algebraic topology, including the Fundamental Group and Covering Spaces.  <b>Note:</b> A continuation of MATH 641.</p> <p>For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>3 Units</b></p>		

<p><b>MATH 674. Actuarial Models II</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 673.  <b>Description:</b> It further develops knowledge of the theoretical basis of actuarial models and the application of those models to insurance and other financial risks. The following specific models are introduced: Contingent Payment Models, Survival Models, Frequency and Severity Models, Compound Distribution Models, Stochastic Process Models, Ruin Models. Together with its predecessor, Mathematics 673, covers material on the Examination 3 of the Society of Actuaries and the Casualty Actuarial Society.  <b>Note:</b> Continuation of Math MATH 673.</p> <p>For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 683. Advanced Combinatorics and Graph Theory I</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 681.  <b>Description:</b> Advanced topics in Combinatorics and Graph Theory, including finite planes, coding theory, combinatorial optimization, groups, graphs, and graphs on manifolds.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>
<p><b>MATH 676. Actuarial Modeling I</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 673 and MATH 674.  <b>Description:</b> Approximately half of the material on the Society of Actuaries/Casualty Actuarial Society examination 4, Actuarial Modeling. Topics include: statistical analysis of simulated data, statistical validation techniques, actuarial credibility, empirical estimation, loss distributions, and introduction to estimation of survival functions.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 684. Advanced Combinatorics and Graph Theory II</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 681 and MATH 682.  <b>Description:</b> Course extends the study of advanced topics in Combinatorics and Graph Theory, including Extremal Graph Theory and Algebraic Combinatoris.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>
<p><b>MATH 677. Actuarial Modeling II</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 676.  <b>Description:</b> The rest of the material on the Society of Actuaries/Casualty Actuarial Society examination 4, Actuarial Modeling. Topics: Estimation of survival and hazard function. Regression analysis. Multiple regression. Regression in actuarial modeling. Time series models. Properties of stochastic time series. Estimating and forecasting with time-series models. Actuarial modeling with time series.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 687. Seminar on Discrete Mathematics</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 683 or consent of department.  <b>Description:</b> Advanced topics in discrete mathematics.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>
<p><b>MATH 681. Combinatorics and Graph Theory I</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 521, or MATH 580, or MATH 581, or consent of department.  <b>Description:</b> Fundamental topics in Graph Theory and Combinatorics through Ramsey theory and Polya's theorem respectively. Motivation will be through appropriate applications.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 690. An Overview of Mathematics</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> Undergraduate mathematics major or at least four mathematics courses in the graduate program or consent of instructor.  <b>Description:</b> History of mathematics, survey of the major content areas of modern mathematics, discernment of current directions in various mathematical fields.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>
<p><b>MATH 682. Combinatorics and Graph Theory II</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 681.  <b>Description:</b> Fundamental topics in Graph Theory and Combinatorics through Ramsey theory and Polya's theorem respectively. Motivation will be through appropriate applications.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 691. Independent Study</b> <span style="float: right;"><b>3 Units</b></span>  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>
<p><b>MATH 683. Advanced Combinatorics and Graph Theory I</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 521, or MATH 580, or MATH 581, or consent of department.  <b>Description:</b> Fundamental topics in Graph Theory and Combinatorics through Ramsey theory and Polya's theorem respectively. Motivation will be through appropriate applications.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 693. Seminar in Teaching Mathematics</b> <span style="float: right;"><b>2 Units</b></span>  <b>Prerequisite(s):</b> Must be admitted to a graduate program in the Department of Mathematics and consent of instructor.  <b>Description:</b> Topics in teaching mathematics to college students.  <b>Note:</b> Does not count as part of the 18-hour minimum in mathematics for the MA in Mathematics.   For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>
<p><b>MATH 684. Advanced Combinatorics and Graph Theory II</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite(s):</b> MATH 681 and MATH 682.  <b>Description:</b> Course extends the study of advanced topics in Combinatorics and Graph Theory, including Extremal Graph Theory and Algebraic Combinatoris.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 694. Graduate Internship</b> <span style="float: right;"><b>1-6 Units</b></span>  <b>Description:</b> Students participating in a graduate internship must be registered for this course.  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>
<p><b>MATH 685. Thesis Guidance</b> <span style="float: right;"><b>1-6 Units</b></span>  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>	<p><b>MATH 695. Thesis Guidance</b> <span style="float: right;"><b>1-6 Units</b></span>  For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</p>

**MATH 696. Computer in Teaching Science and Mathematics 3 Units**

**Prerequisite(s):** One year of teaching experience or consent of instructor (no previous computer experience needed).

**Description:** Introductory programming and use of computers in a wide range of topics in secondary school science and mathematics.

**Note:** Does not count as part of 15-hour minimum in 600-level mathematics courses for the MA in Mathematics.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

**MATH 699. Seminar 1-12 Units**

**Description:** Topics vary.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

**MATH 700. Doctoral Research 1-6 Units**

**Grading Basis:** Pass/Fail

**Prerequisite(s):** Student must have passed all qualifying examinations and have a dissertation committee.

**Description:** Research while enrolled for a doctoral degree under the direction of faculty members.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

**MATH 710. Doctoral Dissertation 1-6 Units**

**Grading Basis:** Pass/Fail

**Prerequisite(s):** Previous enrollment in MATH 700.

**Description:** Dissertation writing under the direction of the major professor.

**Note:** Grade to be deferred until evaluation of the dissertation by the student's committee.

**Note:** Graded pass-fail, depending on the evaluation by the student's committee.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)