APPLIED MATHEMATICS, PhD

Introduction
The Department of Mathematical and Statistical Sciences offers a PhD in Applied Mathematics. The degree is designed to give candidates a contemporary, comprehensive education in applied mathematics and to provide research opportunities in the special fields of computational mathematics, discrete mathematics, mathematics of science and engineering, operations research, optimization, probability, and statistics.

These program requirements are subject to periodic revision by the academic department, and the College of Liberal Arts and Sciences reserves the right to make exceptions and substitutions as judged necessary in individual cases. Therefore, the College strongly urges students to consult regularly with their program advisor and CLAS advisor to confirm the best plans of study before finalizing them.

Program Requirements
1. Students must complete a minimum of 72 approved credit hours.
2. Students must complete all credits at the graduate 6000-level and above.
3. Students must earn a minimum grade of B (3.0) or better in all core courses, a B- (2.7) in all other courses taken at CU Denver and must achieve a minimum cumulative program GPA of 3.0. All graded attempts in required and elective courses are calculated in the program GPA. Students cannot complete program or ancillary course requirements as pass/fail.
4. Students must complete 42 credit hours with CU Denver faculty.

Program Restrictions, Allowances and Recommendations
1. There are six phases of the PhD program. A candidate must fulfill course requirements, pass the preliminary examinations, establish a PhD committee, meet the academic residency requirement, pass the comprehensive examination, and write and defend a dissertation.
2. The following MATH courses will NOT count toward a graduate degree: MATH 5000-5009, 5010, 5012-5015, 5017, 5198, 5250 and 5830.
3. Students must complete 42 semester hours of non-thesis course work at the graduate level (up to 30 hours of this course work may be transferred in, including courses taken as part of a master’s degree). In addition, 30 hours of dissertation credit must be taken. Three readings courses (1 semester hour each) are required as part of the formal course work. Students must also satisfy a breadth requirement by completing a total of six graduate math courses from among several areas of mathematics, with no more than three of these courses from any one area.
4. The preliminary examinations are designed to determine that students who intend to pursue the PhD program are qualified to do so. These four-hour written examinations are in the areas of applied analysis and applied linear algebra. Students must pass these exams by the start of their fourth semester.
5. Six semesters of full-time scholarly work are required, as specified in the rules of the Graduate School (http://catalog.ucdenver.edu/cu-denver/graduate/graduate-school-policies-procedures/). All students are strongly advised to spend at least one year doing full-time course work or research with no outside employment.
6. The comprehensive examination is taken after completion of the preliminary exams, completion of at least three semesters of residency, and upon completion of essentially all non-thesis coursework. The exam is designed to determine mastery of graduate-level mathematics and the ability to embark on dissertation research. It consists of a six-hour written examination and an oral follow-up examination. Students must pass the comprehensive exam by the beginning of the 4th year. Within six months after passing the comprehensive examination, the candidate must present a dissertation proposal to their dissertation committee.
7. Each student must write and defend a dissertation containing original contributions and evidence of significant scholarship. The dissertation defense is public and must be given before an examining committee approved by the Graduate School.

For more detailed information about the Applied Mathematics PhD, see department website (https://clas.ucdenver.edu/mathematical-and-statistical-sciences/phd-applied-mathematics/).

Required Courses

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<tr>
<td>MATH 5779</td>
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<td>Take a minimum of three readings courses.</td>
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<td>MATH 7921</td>
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<td>Rdgs:Math Fndts-Cmptn Sc</td>
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<td>MATH 7923</td>
<td>Readings: Discrete Mathematics</td>
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<td>MATH 7924</td>
<td>Rdgs:Comp Mathematics</td>
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<td>MATH 7925</td>
<td>Readings: Optimization</td>
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<td>Rdgs:Applied Prob/Stats</td>
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<td>Rdgs:Comp/Math Biology</td>
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Breadth Requirement

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<td>Students must also satisfy a breadth requirement by completing a total of 18 hours of six graduate math courses from among several areas of mathematics, with no more than three of these courses from any one area.</td>
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Computational Mathematics

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<tr>
<td>MATH 5791</td>
<td>Continuous Modeling</td>
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**Discrete Mathematics**

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<td>Discrete Math Modeling</td>
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<td>MATH 6023</td>
<td>Topics in Discrete Math</td>
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**Operations Research (including Probability)**

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<td>MATH 7595</td>
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**Statistics**

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<tr>
<td>MATH 5387</td>
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<tr>
<td>MATH 5394</td>
<td>Experimental Designs</td>
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<tr>
<td>MATH 6330</td>
<td>Workshop in Statistical Consulting</td>
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<tr>
<td>MATH 6384</td>
<td>Spatial Data Analysis</td>
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<td>MATH 6388</td>
<td>Statistical and Machine Learning</td>
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<td>Mathematical Statistics I</td>
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<td>Mathematical Statistics II</td>
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<tr>
<td>MATH 7393</td>
<td>Bayesian Statistics</td>
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<td>MATH 7397</td>
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**General**

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<tr>
<td>MATH 5733</td>
<td>Partial Differential Equations</td>
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<td>MATH 6131</td>
<td>Real Analysis</td>
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**Additional Electives**

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<td>Functions of a Complex Variable</td>
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<td>Probability</td>
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<td>MATH 5337</td>
<td>Intro to Statistical and Machine Learning</td>
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<td>MATH 5350</td>
<td>Mathematical Theory of Interest</td>
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<td>MATH 5351</td>
<td>Actuarial Models</td>
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<td>MATH 5387</td>
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Complete an additional 18 credit hours of graduate level coursework, in consultation with the program director.

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<td>Experimental Designs</td>
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<td>MATH 5446</td>
<td>Theory of Automata</td>
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<td>Network Flows</td>
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<td>Mathematical Foundations of Artificial Intelligence</td>
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<td>Linear Programming</td>
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<td>Computational Biology</td>
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MATH 7405  Advanced Graph Theory  3
MATH 7409  Applied Combinatorics  3
MATH 7410  Combinatorial Structures  3
MATH 7413  Modern Algebra I  3
MATH 7414  Modern Algebra II  3
MATH 7419  Mathematical Coding Theory  3
MATH 7421  Projective Geometry  3
MATH 7593  Advanced Linear Programming  3
MATH 7594  Integer Programming  3
MATH 7595  Advanced Nonlinear Programming  3
MATH 7663  Finite Difference Methods for Partial Differential Equations  3
MATH 7665  Numerical Linear Algebra  3
MATH 7667  Introduction to Approximation Theory  3
MATH 7821  Topics in Projective Geometry  3
MATH 7822  Topics in Linear Algebra  3
MATH 7823  Topics in Discrete Math  3
MATH 7824  Topics in Computational Mathematics  3
MATH 7825  Topics in Optimization  3
MATH 7826  Topics in Probability and Statistics  3
MATH 7827  Topics in Applied Mathematics  3
MATH 7840  Independent Study  1-3
MATH 7921  Readings in Mathematics  1
MATH 7922  Rdgs:Math Fndts-Cmpr Sc  1
MATH 7923  Readings: Discrete Mathematics  1
MATH 7924  Rdgs:Comp Mathematics  1
MATH 7925  Readings: Optimization  1
MATH 7926  Rdgs:Applied Prob/Stats  1
MATH 7927  Rdgs:Comp/Math Biology  1
MATH 8660  Mathematical Foundations of Finite Element Methods  3
MATH 8664  Iterative Methods in Numerical Linear Algebra  3

**Dissertation**

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To learn more about the Student Learning Outcomes for this program, please visit our website (https://clas.ucdenver.edu/mathematical-and-statistical-sciences/phd-program-goals-objectives/).