APPLIED MATHEMATICS - MASTER OF SCIENCE (MS)

The MS degree is only available to current degree-seeking students at CU Boulder who are in the applied mathematics PhD program, another CU Boulder PhD program, or who qualify for the computational science and engineering track, the BS/MS concurrent degree program or the MS/MA in applied mathematics and molecular, cellular and developmental biology dual degree (see details below).

Those who are not currently attending CU Boulder should apply to the Applied Mathematics - Professional Master of Science (MSAM) (catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/applied-mathematics/applied-mathematics-professional-master-science-msam) program.

Students should carefully read the program's Requirements (catalog.colorado.edu/graduate/degree-requirements/masters-degree-requirements) section. For more information, visit the department's Applied Mathematics Graduate Student Supplement (http://www.colorado.edu/amath/prospective-students/graduate/supplement-course-catalog-degree-requirements).

Requirements

Prerequisites

The MS degree is only available to current degree-seeking students at CU Boulder who are in the applied mathematics PhD program, another CU Boulder PhD program, or who qualify for the computational science and engineering track, the BS/MS concurrent degree program or the MS/MA in applied mathematics and molecular, cellular and developmental biology dual degree (see Overview section).

Those who are not currently attending CU Boulder should apply to the Applied Mathematics - Professional Master of Science (MSAM) (catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/applied-mathematics/applied-mathematics-professional-master-science-msam) program.

Prerequisites for graduate study in applied mathematics include three semesters of calculus and a course in differential equations and linear algebra. The overall grade point average for mathematics and applied mathematics must be B or better.

Other strongly recommended courses are:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td></td>
<td><strong>Strongly Recommended Prerequisites</strong></td>
<td></td>
</tr>
<tr>
<td>APPM 4350</td>
<td>Methods in Applied Mathematics: Fourier Series and Boundary Value Problems and Methods in Applied Mathematics: Complex Variables and Applications</td>
<td>6</td>
</tr>
<tr>
<td>&amp; APPM 4360</td>
<td></td>
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<tr>
<td>APPM 4650</td>
<td>Intermediate Numerical Analysis 1</td>
<td>6</td>
</tr>
<tr>
<td>&amp; APPM 4660</td>
<td>and Intermediate Numerical Analysis 2 (or MATH 4650 &amp; MATH 4660)</td>
<td></td>
</tr>
<tr>
<td>APPM 4440</td>
<td>Undergraduate Applied Analysis 1</td>
<td>3</td>
</tr>
<tr>
<td>One of the following:</td>
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<tr>
<td>APPM 3310</td>
<td>Matrix Methods and Applications</td>
<td>3</td>
</tr>
</tbody>
</table>

Course Requirements

The department requires a master's degree candidate to complete an approved program of study consisting of at least 30 credits, at least 18 of which must be applied mathematics courses at the 5000 level or above. A grade of C (2.0) or higher must be attained in each course.

Generally, the following courses do not count toward the 30-credit requirement: APPM 5350, APPM 5360, APPM 5570 and APPM 5720.

NOTE: The APPM 5720 course number is used for a variety of courses that are either run for the first time or on an ad hoc basis. When appropriate, the Graduate Committee may decide that a particular version of this course should count towards graduate credits. If a student would like to count credits from APPM 5720 toward an APPM graduate degree, advice should be sought from the chair of the graduate committee on whether this would be permissible.

All master's degree students must complete two year-long, 5000-level course sequences in applied mathematics:

- APPM 5600 & APPM 5610 (required; may be waived for students who obtain a pass on the numerical analysis preliminary exam) AND
- a sequence listed in the "Graduate Courses" section of the Applied Mathematics Graduate Student Supplement (http://www.colorado.edu/amath/prospective-students/graduate/supplement-course-catalog-degree-requirements) (other sequences require approval from the chair of the graduate committee).

MS candidates must take a yearlong 5000-level graduate sequence outside of applied mathematics in an area where mathematics has significant application. This sequence must be approved by the chair of the graduate committee.

Upon approval by petition to the graduate committee, up to 6 credit hours may be taken in 4000-level courses in other departments, provided members of the graduate faculty teach those courses.

Degree Plans

There are two courses of action for graduate students who are looking to graduate with a master's degree.

Plan I: Thesis Option

A student electing to do a thesis must enroll in 4–6 hours of thesis credit, which count toward the required 30 hours, and must take an oral comprehensive exam (also referred to as a defense) on that thesis work. A student can only enroll in a total of 6 thesis hours for the course of the degree program. This exam will be administered by a committee consisting of the faculty advisor, who serves as committee chair, and two other faculty members. Each committee member must hold a current graduate faculty appointment. The chair must have a regular graduate faculty appointment, and the remaining committee members must hold either regular or special membership. At least one committee member must hold a regular (tenure or tenure-track) faculty appointment in Applied Mathematics.

Plan II: Non-Thesis Option

A student choosing the non-thesis option must pass ("pass" or "PhD research pass") any one of four PhD preliminary exams. Details are provided in the Applied Mathematics Graduate Student Supplement
Required Courses and Credits

Each MS student electing the non-thesis option must submit a completed MS degree audit form to the graduate chair upon submitting the Candidacy Application for an Advanced Degree.

A student who fails a written preliminary exam may, in a later semester, make one and only one more attempt to satisfy this requirement. In doing so, the student may switch between the thesis and the non-thesis option of the program, or between one preliminary exam area and another. Students who fail two preliminary exams are subject to dismissal from the program.

Computational Science and Engineering Track

Purpose of the Program
The purpose of this program is to meet the needs of students who want to learn the basic concepts and skills of computational science and engineering and then continue toward a PhD in a discipline outside applied mathematics. A student who completes this program successfully will obtain a master’s degree in applied mathematics, in the computational science and engineering track.

The program is designed to provide interested students with a foundation in computational mathematics and, at the same time, to allow sufficient latitude for students to become proficient in an outside discipline. Approximately half of the credits for the master’s degree will be taken from a department other than applied mathematics.

Admission to the Program
A student in the computational science and engineering track will be enrolled simultaneously in two graduate programs, one in applied mathematics and one in the department from which the student wishes to receive a PhD.

An interested student may apply for admission to this track either when applying for graduate study at CU or at any time during the first two years of graduate study. First-year and second-year graduate students in any of the participating departments may apply for admission to this program.

Curriculum
The curriculum is flexible in that a student may choose from a set of courses most useful to the discipline in which the PhD is sought. Each participating department will have a specific set of appropriate courses that will be specified between that department and the department of applied mathematics.

Required Courses and Credits

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>APPM</td>
<td>Numerical Analysis 1</td>
<td>3</td>
</tr>
<tr>
<td>APPM</td>
<td>Numerical Analysis 2</td>
<td>3</td>
</tr>
<tr>
<td>APPM</td>
<td>Applied Analysis 1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>One of the following courses, to be approved by the outside advisor</td>
<td>3</td>
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<tr>
<td></td>
<td>APPM 5470 Methods of Applied Mathematics: Partial Differential and Integral Equations</td>
<td>3</td>
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<tr>
<td></td>
<td>APPM 5460 Methods in Applied Mathematics: Dynamical Systems and Differential Equations</td>
<td>3</td>
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</tbody>
</table>

APPM 5600 Markov Processes, Queues, and Monte Carlo Simulations

Other approved applied mathematics courses

Thesis Option

APPM 6950 Master’s Thesis 4-6

Non-thesis option

Graduate electives, at least 3 credits in applied mathematics. (A student choosing this option must pass one of the four APPM preliminary exams.)

CSCI Courses (minimum of 3 credits)

CSCI 5576 High-Performance Scientific Computing (or other approved CSCI course) 4

Credits in second department (12 credits approved by outside advisor)

Thesis option: must include 3 credits of MS thesis in outside department.

Other Recommended Courses

APPM 5430 Methods in Applied Mathematics: Applications of Complex Variables 3
APPM 5480 Methods of Applied Mathematics: Approximation Methods 3
APPM 6610 Introduction to Numerical Partial Differential Equations 3
APPM 7400 Topics in Applied Mathematics 1-3

1 Students who have not had the equivalent of APPM 4440 and APPM 4450 may need to take these or comparable courses before taking APPM 5440.

Additional Course Requirements
The Graduate School requires at least 30 graduate credits. Students working as teaching assistants in APPM also must take APPM 7400.

To waive any of the course requirements:

- A student can waive the requirement for APPM 5600 and APPM 5610 by passing the APPM preliminary exam in Numerical Analysis.
- A student can waive the requirement for APPM 5440 by passing the APPM preliminary exam in Applied Analysis, or by passing the final exam in APPM 5440 given that year.
- A student can waive the requirement for APPM 5470 by passing the APPM preliminary exam in PDEs.

Plan(s) of Study
The following plan of study is an example track for students looking to study partial differential equations.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>Year One</td>
<td>APPM 5600 Numerical Analysis 1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>APPM 5610 Numerical Analysis 2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Part 1 Out of Department Sequence</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>APPM 5470 Methods of Applied Mathematics: Partial Differential and Integral Equations</td>
<td>3</td>
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<tr>
<td></td>
<td>APPM 5620 Numerical Linear Algebra</td>
<td>3</td>
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Dual Degree Program

MS/MA in Applied Mathematics and MCDB

This three-year interdisciplinary program offers two master's degrees: an MS in applied mathematics and an MA in molecular, cellular and developmental biology (MCDB). The goal of the program is to produce well-trained applied mathematics students who are capable of making serious contributions leading to advancements in molecular biology. Such students will be well educated in computational sciences, statistics, probability and molecular biology.

Admission Requirements

Students are required to apply to both programs, with APPM as the primary one. Subject to joint recommendation and approval by APPM and MCDB, incoming students will be admitted to this dual degree program as a regular part of the applied mathematics recruitment process.

Program Requirements

Students are expected to meet all requirements for admission to the graduate program in the Department of Applied Mathematics and to possess a basic science background suitable for pursuit of this dual degree. Students also are expected to meet minimum requirements for admission to the graduate program in MCDB. Adequate undergraduate preparation consists of successful completion of basic courses on cell and molecular biology. Any student deemed deficient in either area will be required to take Molecular Cell Biology I and II (MCDB 3135 and MCDB 3145) after enrollment.