Department of Mathematical and Statistical Sciences
Graduate Handbook
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Our department's community is committed to creating a supportive culture that welcomes and celebrates all backgrounds, perspectives, and identities, and in which our diverse students, staff, and faculty are valued and respected.

The department recognizes that sustaining such a culture requires continual engagement with, and evaluation of, these policies and guidelines, and encourages all members to communicate possible improvements to this living document. These policies and guidelines are intended to be revisited and edited to create an equitable and inclusive environment that enables students to achieve their desired goals.

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I. Graduate Student Policies and Procedures

This section provides the policies and procedures relevant to the most common situations encountered by graduate students in the department. Further details, including admissions requirements, are listed in the Administrative Policies and Procedures Section of this handbook. Students are directed to the Graduate School Rules and Procedures for any information not provided here.

The department offers a *Graduate Certificate in Applied Statistics, Master of Science (MS) in Applied Mathematics, Master of Science in Statistics,* a *Dual MA/MS degree in Economics and Applied Mathematics (with a focus in Data Science),* a *Dual MA/MS degree in Economics and Statistics,* and a *Doctor of Philosophy (PhD) in Applied Mathematics.* Graduate degrees in the Department of Mathematical & Statistical Sciences at CU Denver are designed to give candidates a contemporary, in-depth education in the Mathematical and Statistical Sciences including research opportunities and other forms of career preparation.

A. Expectations Across all Programs

This section outlines several expectations that apply to students across all certificate and degree programs.

1. Advising and Orientation

Upon acceptance into the graduate program, each student is assigned an initial academic advisor. A student may request and obtain a change in academic advisor by informing the Graduate Program Director and Graduate Program Assistant. Students should note that their initially assigned academic advisor will not necessarily be the faculty member who advises their project, thesis, or doctoral dissertation.

During the first semester of graduate study each student is strongly encouraged to set up a tentative plan of study in consultation with their academic advisor. The plan of study should include a tentative list of courses to be taken each semester. It is also strongly suggested that each student review their plan of study each semester with their current academic advisor and discuss any possible course changes.

Students are encouraged to explore areas of study within the department and to get to know a breadth of departmental faculty, as these efforts will aid in the selection of a project, thesis or dissertation advisor, henceforth referred to as their "research advisor". When a certificate, MS or PhD student selects a research advisor, they should notify the Graduate Program Assistant so that the new advisor is entered in the program records and can assume the duties of their academic advisor as well.

A required orientation for all new graduate students is held in the week before the fall semester begins. The orientation provides information about the department, the faculty, graduate program requirements, expectations and realities, and an opportunity for students to meet with their academic advisor and arrange for advising if not obtained previously.

2. **Grade Requirements**
   Graduate students are required to maintain a GPA of at least 3.0. Courses with grades below a B- do not apply to graduate degrees, but they do contribute to the overall GPA. Students with a GPA less than 3.0 are put on academic probation by the Graduate School and cannot take comprehensive or final (project or thesis) examinations, or graduate. Please see the Graduate School Rules and Procedures. Higher requirements apply to PhD students, as outlined in Section II.C.

3. **Excluded Courses**
   The following courses will not count toward a graduate degree in the Department of Mathematical and Statistical Sciences: MATH 5000-5010, MATH 5012-5015, MATH 5017, MATH 5198, and MATH 5830.

   Courses taken outside the Department of Mathematical and Statistical Sciences while enrolled in the graduate program are not guaranteed to count toward a graduate degree in the Department of Mathematical and Statistical Sciences, and must be approved by the Graduate Studies Committee. Ideally, students should receive this approval prior to enrollment, as course completion is not a guarantee that a course will be accepted by the committee.

4. **Enrollment Requirements**
   The minimum enrollment requirements at CU Denver are as follows:

- For graduate certificate students, all courses in the certificate program must be taken in residency at the University of Colorado Denver.

- For master's students, the minimum enrollment requirement is two (2) semesters of enrollment in a departmental M.S. or PhD program beyond the attainment of the bachelor's degree.

- For doctoral students, the minimum enrollment requirement is six (6) semesters of enrollment in a departmental M.S. or PhD program beyond the attainment of a bachelor's degree. Two (2) semesters of enrollment credit may be allowed for an earned Master's degree from another institution; however, at least four (4) semesters of credit must be earned for work performed while enrolled at CU Denver.

For this purpose, full-time status is defined as enrollment for at least five (5) credit hours.

5. **Announcements and Record Keeping**
   To ensure consistency and proper keeping of student records, all announcements to faculty (thesis, project, or certificate presentations, oral comprehensive exams, and thesis proposal presentations) must be made through the Graduate Program Assistant.

B. Transfer Credit

The following rules apply to transfer credits. Further rules and provisions for number of transfer credits permitted for each graduate program can be found in relevant sections of this document.

- Only courses completed with a grade of B- or better may be considered for transfer credit.
- Credit cannot be transferred into an M.S. or certificate program until the student has established a satisfactory record of at least six hours of graduate credit in MATH at CU Denver with a minimum GPA of 3.0.
- Credit cannot be transferred into the doctoral program until the student has established a satisfactory record of at least 12 graduate credits in MATH at CU Denver with a minimum GPA of 3.0.

Approval of Transfer Credit. All transfer courses must be approved by the Graduate Committee and/or the relevant program director as provided in the rules for each specific program. By Graduate School rules, transfer credit must be completed before the semester of the application to candidacy. Courses taken while registered as a non-degree seeking student are considered transfer credit; per department rules, at most 9 such credits can be transferred into either M.S. program. Per Graduate School rules, coursework accepted for transfer credit must not have been previously applied towards an undergraduate degree or another graduate degree of the same level.

CU Denver Courses Taken Outside of the Department. Courses taken while enrolled as a graduate student at any campus of the University of Colorado system are considered resident coursework. However, all courses taken outside of the Department of Mathematical and Statistical Sciences must be approved by the Graduate Committee and/or the relevant program director as described in the rules for each program in order to be applied toward a graduate degree within the Department of Mathematical and Statistical Sciences. As detailed in Section II.C.6, doctoral students in the College of Engineering, Design, and Computing are permitted to count 12 credits of select engineering coursework towards an M.S. in Applied Mathematics. In addition, courses taken at other campuses prior to enrollment in the graduate program will be counted as part of the credit hour limit on transfer courses.

C. Financial Support for Graduate Students

The Department of Mathematical and Statistical Sciences may, pending the availability of funds, award financial support to graduate students. Types of support and specific policies for funded students are listed in this section.

All applicants interested in a teaching assistantship (TA) are encouraged to apply. Outside of exceptional cases, full assistantships are only awarded to students in the doctoral program. Applicants to the M.S. program with a strong interest in teaching may be considered for partial funding depending on the availability of funds. To be considered for a TA, the application packet must be accompanied by a letter indicating interest in a TA and describing prior teaching or tutoring experience. When the Graduate Committee considers requests for TAs, the primary criterion that is used is academic excellence and likelihood of strong academic outcomes while in the program. Other factors that may be considered include ability to teach

lower division mathematics courses, quality of faculty recommendations, and outside employment.

1. Types of Financial Support

a. Full Teaching Assistantships

Full Teaching Assistantships (Full TAs) consist of remuneration for teaching, an additional stipend, and payment of tuition and fees up to a stated credit limit. Full TAs may not be employed outside of the Department of Mathematical and Statistical Sciences. To ensure students are able to make satisfactory progress toward the degree, full teaching assistants are strongly discouraged from accepting other employment. Other employment must have the written approval of the Graduate Committee.

Minimum Credit Hours. Full TAs are expected to make satisfactory progress toward completion of their degree. Prior to candidacy, Full TAs must enroll in 15 credit hours per academic year applicable toward completion of the degree. After candidacy, Full TAs must enroll in 5 credit hours per semester until 30 thesis credits have been completed. After 30 thesis credit hours have been completed, candidates should enroll in at least one thesis credit per semester.

Application Process. Outside of exceptional cases, Full TAs are typically only awarded to students in the doctoral program. To be considered for a Full TA, applicants should submit a letter indicating interest in a Full TA and describing prior teaching or tutoring experience. For new applicants to the department, this letter should be included with the application packet; otherwise this letter should be submitted directly to the Graduate Committee prior to the application deadline for the student's program, as listed in Section III.A.

Renewal. Full TAs are considered for renewal on an annual basis. Continuation is contingent on (a) satisfactory academic progress within the student's program of study, (b) sufficient quality of instruction and satisfactory performance in all teaching and employment duties, and (c) availability of funds. Provisional students who are offered a TA must reapply for the TA to be continued into a second year of funding. Otherwise,

regular (full-time) TAs in the doctoral program generally do not need to explicitly reapply for funding each year, provided they satisfy conditions (a) and (b).

Full TA positions are generally awarded for a maximum of five years of study within the doctoral program and a maximum of two years of study within the M.S. program. Any student requesting funding beyond these time limits must apply to the graduate committee and should be aware that further funding is not guaranteed.

b. Partial Teaching Assistantships and Student Employment

The department offers opportunities to work as a Partial Teaching Assistant as well as other student employment, which may consist of a mix of duties, generally paid hourly or by class assignment, and are considered for renewal on a semester basis. Such positions typically do not include additional stipend or tuition and fees.

c. Research Assistantships

Research Assistantships may be available by arrangement with individual faculty members who have research funding.

2. Additional Policies for Funded Students

In addition to any policies listed here, department-funded graduate students are expected to make satisfactory progress towards graduation, and to follow all additional guidelines put forth in the relevant letters of offer for their respective positions.

Impact of Academic Probation on Funded Positions. Funded students that are on academic probation or have provisional status will undergo a review by the Graduate Committee and will have a plan of improvement put into place, may have their Full TA funding discontinued, or both.

Qualification for In-State Tuition. All graduate students, and in particular students receiving financial support from the department, should follow the necessary steps to qualify for in-state tuition if they are eligible. A student who is eligible to qualify for in-state residency, but fails to attain it prior to their second year, may be required to pay

the difference between in-state and out-of-state tuition until in-state residency is established.

D. Transitional Rules

All current MS and PhD students have the option of graduating under the current rules or under the rules in effect when they were admitted, unless otherwise noted in this document, except that changes that are the consequence of an external entity (such as accreditation and the Graduate School) apply to all students. See the Graduate Handbook Archive for earlier versions of the rules.

II. Program Requirements

A. Graduate Certificate in Applied Statistics

1. Course Requirements

Four courses are required:

Two Fundamental Courses in Statistics:

- MATH 5320 - Statistical Inference
- MATH 5387 - Applied Regression Analysis

One Advanced Methods Course from:

- MATH 5337 - Introduction to Statistical and Machine Learning
- MATH 5388 - Machine Learning Methods
- MATH 5394 - Experimental Designs
- MATH 6380 - Stochastic Processes
- MATH 6384 - Spatial Data Analysis
- MATH 6388 - Statistical and Machine Learning
- MATH 7393 - Bayesian Statistics
- MATH 7826 - Topics in Probability and Statistics
- Any additional MATH course pre-approved by the Director of Statistical Programs.

One Elective from:

- Any statistics course in the Department of Mathematical and Statistical Sciences at the 5000 level or higher (must be pre-approved by the Director of Statistical Programs). MATH 5830 cannot apply for the certificate.

- ECON 5150 - Economic Forecasting
- ECON 5813 - Econometrics I
- ECON 5823 - Econometrics II
- ENVS 5600 - Applied Statistics for the Natural Sciences
- GEOL 5770 - Applied Statistics for the Natural Sciences
- SOCY 5183 - Seminar: Quantitative Data Analysis
- An equivalent course pre-approved by the Director of Statistical Programs

2. **Additional Requirements**
   Since a certificate is a University of Colorado Denver certification of a student's specialized knowledge in an advanced subject area, all courses in the certificate program must be taken in residency at the University of Colorado Denver. Students must be enrolled in one course per year to maintain their status in the certificate program. Certificates must be completed within 3 years of matriculation.

B. Common Requirement for all M.S. Programs

1. **Thesis, Project, or Coursework Option**
   Every master's student must successfully complete either a final examination (coursework option, MS in Applied Mathematics only) or a thesis or project.

   Coursework option (MS in Applied Mathematics only). For the coursework option, students must complete a final examination during the semester of graduation. The exam has the following objectives: to demonstrate knowledge in a mathematical discipline chosen by the student and commensurate with 5000- and 6000-level mathematics or statistics courses; and to demonstrate proficiency in communicating their mathematics, or the mathematics of others, orally and optionally, at the discretion of the committee, in addition in writing.

   The exam covers material from the student's chosen area of mathematics: options are computational mathematics, discrete mathematics, machine learning and data science, optimization and operations research, and statistics. The exam format and extent of coverage within that area will be determined by the student's examination committee and communicated in writing at least 30 days before the exam. The exam format should include an oral presentation. The

examination committee will prepare and conduct the exam and determine the outcome.

At least two weeks in advance, the examination must be scheduled with the Graduate Program Assistant and the committee and the examination request form approved by the Graduate Program Director and submitted to the Graduate Education office. The student and a majority of members of the committee, including either the committee Chair or Advisor, must be physically present for the oral examination. A minority of committee members may participate by interactive video. In the event of an emergency that prevents one (1) faculty committee member from attending the exam, the exam can proceed with the two (2) or more faculty members who can attend, and the student will schedule a separate meeting with the absent faculty member at an alternate time.

Project or Thesis Option. For these options, students must complete a thesis or project, each with a written component and oral presentation. A thesis or project satisfies the Graduate School's requirement for a final examination, and the advisory committee serves as the examination committee. At least two weeks in advance, the presentation must be scheduled with the Graduate Program Assistant and the committee and the examination request form approved by the Graduate Program Director and submitted to the Graduate School.

The MS thesis or project report must be submitted to the student's committee at least two weeks in advance of the final examination. All members of the committee must be present for the oral examination, although a minority of members, but not both the Chair and Advisor, may participate by interactive video. In the event of an emergency that prevents one (1) faculty committee member from attending the exam, the exam can proceed with the faculty members who can attend, and the student will schedule a separate meeting with the absent faculty member at an alternate time.

Project (non-thesis) Option. Students choosing the non-thesis option must complete a project, including a written report and oral presentation. The topic should be selected in consultation with the student's research advisor. The project (as reflected in the report and presentation) should demonstrate a level of content mastery commensurate with a 6000-level mathematics or statistics course, delve into mathematics or statistics material not covered in coursework,

and should demonstrate proficiency in communicating mathematics or statistics as well as the ability to synthesize concepts.

The student must deliver an oral presentation on the project. At least two weeks in advance, the presentation must be scheduled and announced to the department faculty through the Graduate Program Assistant, and the committee and the examination request form must be approved by the Graduate Program Director.

After the presentation, a majority of the advisory committee must vote for one of the following outcomes: Pass, Conditional Pass, or Fail. If a student receives a Conditional Pass, the committee will clearly define the requirements for the student to receive an unconditional passing grade and these requirements must be completed to the satisfaction of the examination committee within four (4) months. Failure to satisfy these conditions will result in failure of the examination.

If a student chooses the project (non-thesis) option, the student may register for up to 3 project credits, which count towards the required 30 credit hours.

Thesis Option. Every Master's student has the option to write a thesis. Although original work is encouraged, the thesis may be expository in nature. The topic should be within a relevant area of the mathematical sciences and should be chosen with the approval of the student's research advisor. The written thesis must comply with Graduate School formatting guidelines and meet all relevant deadlines as put forth each semester by the Graduate School and the Registrar.

At least two weeks in advance, the defense must be scheduled, and the committee and the examination request form approved by the Graduate Program Director and submitted to the Graduate School.

After the defense, a majority of the advisory committee must vote for one of the following outcomes: Pass, Conditional Pass, or Fail. If a student receives a Conditional Pass, the committee will clearly define the requirements for the student to receive an unconditional passing grade and these requirements must

be completed to the satisfaction of the examination committee within four (4) months. Failure to satisfy these conditions will result in failure of the examination.

The final version of the thesis must be approved by the student's advisory committee and by the Graduate School format review, and uploaded to ProQuest for publication following the instructions in the Graduate School Format Guide within 60 days of the thesis defense pass or no later than when the requirements of conditional pass are satisfied. The student must provide a final PDF of the thesis to the department with a written statement giving permission to publish the thesis on the department website.

If a student chooses to write a thesis, the student may register for up to 6 thesis credits, which count towards the required 30 credit hours.

Repeated Examination. For all three options, a student who fails the examination is subject to immediate dismissal from the Program on the recommendation of the Graduate Program Director and concurrence of the Dean. At the discretion of the Graduate Committee, a student who fails the examination may be allowed to retake the exam. The re-examination must be completed by the end of the next academic semester (excluding Summer). The original examination form noting the failure is signed by the committee and returned to the Graduate School office. New examination forms will be generated when the examination is rescheduled. The student will be required to meet registration requirements during the semester in which the repeated exam is taken.

2. **Time Limits for Completion of Degree**
   By graduate school rules, Master's students, whether enrolled full-time or part-time, must complete all degree requirements within 7 years of matriculation.

3. **Additional Transfer Guidelines**
   Transfer students will be examined in the same fashion as other applicants, with the exception of transfer credits. At most nine hours of total transfer credit or nine hours earned as a non-degree student, with a grade of B- or better, may be applied toward the MS degree upon approval of the Director of the Statistical Programs and the Graduate Committee. The CLAS Dean's Office must approve

transfer courses and a transfer request form must be submitted. A request for transfer courses may be made after successful completion of one semester at CU Denver. Courses taken at any CU campus are not considered transfer courses; however, these courses must be approved by the Director of the Statistical Programs and the Graduate Committee in order to count toward the MS degree.

C. Master's of Science in Applied Mathematics

1. General Requirements

Students must complete at least 30 semester hours, of which at least 24 hours must be in mathematics and statistics, numbered 5000 or above, and of the remaining, at most six hours may be in courses outside the Department of Mathematical & Statistical Sciences at the 4000 level or above, if approved by the student's academic advisor and by the Graduate Committee in advance.

A maximum of 9 credit hours of coursework may be transferred into the MS program. These transfer credits are subject to the Common Provisions provided in Section I.F.

2. Advisory Committee

By the end of the first year of graduate study, each MS student must choose a research advisor. With this advisor's help, the student will choose at least two additional members of the advisory committee. All three members must be on the CU Denver Graduate Faculty, and at least two must be members of the Department of Mathematical & Statistical Sciences. The Chair of the committee must be a regular member of the graduate faculty and a member of the Department of Mathematical and Statistical Sciences. The Chair may be the same as the student's research advisor.

3. Admission to Candidacy

After completing or registering for all required coursework, students must file an Application for Candidacy with the Graduate School no later than the posted deadline during the semester in which they plan to graduate. The student's academic advisor and Graduate Program Director must approve the completed application before submission to the Graduate School, which certifies that a student's coursework is satisfactory and meets all of the requirements of both the Graduate School as well as the program.

4. **Specific Course Requirements**
   The following course requirements must be satisfied by all students in the MS in Applied Mathematics Program:

   1. (Analysis Core Requirement) One of: MATH 5070 (Applied Analysis) or MATH 6131 (Real Analysis),
   2. (Linear Algebra Core Requirement) MATH 5718 (Applied Linear Algebra), and
   3. At least 24 additional semester hours of coursework, subject to the rule about 4000-level courses in disciplines outside of mathematics outlined above.

   Additionally, a student must either satisfy the course requirements for the MS degree without a concentration area or satisfy the requirements in one of the concentration areas listed below. Unless noted elsewhere, one course cannot be used to fulfill two requirements.

   Substitutions or changes to the requirements may be made with the written approval of a student's academic advisor and the Graduate Committee.

   a. **MS Degree without a Concentration Area**
      Note that MATH 6131 (Real Analysis) can be used to satisfy both the analysis core requirement and may also count as one of the three courses satisfying the requirement below.

      Three of the following courses:
      - MATH 5310 Probability
      - MATH 5320 Statistical Inference
      - MATH 5490 Network Flows
      - MATH 5593 Linear Programming
      - MATH 5660 Numerical Analysis I
      - Any MATH course at the 6000 level or above (with the exception of MATH 6960 Research Methods in Mathematics and Statistics)
      - Additional courses given prior approval by the student's advisor and the Graduate Program Director.

b. Applied Statistics Concentration

- One of the following courses:
  - MATH 5310 Probability
  - MATH 5792 Probabilistic Modeling
  - MATH 6380 Stochastic Processes
- MATH 5320 Statistical Inference
- MATH 5387 Applied Regression Analysis
- MATH 6330 Workshop in Statistical Consulting
- And one of the following courses:
  - MATH 5337 Introduction to Statistical and Machine Learning
  - MATH 5388 Machine Learning Methods
  - MATH 5394 Experimental Designs
  - MATH 6101 Uncertainty Quantification
  - MATH 6380 Stochastic Processes
  - MATH 6384 Spatial Data Analysis
  - MATH 6388 Statistical and Machine Learning
  - MATH 7384 Mathematical Probability
  - MATH 7386 Monte Carlo Methods
  - MATH 7393 Bayesian Statistics
  - MATH 7826 Topics in Probability and Statistics
  - An additional course given prior approval by the student's advisor and the Director of Statistical Programs.

c. Applied Probability and Uncertainty Quantification Concentration

- MATH 5310 Probability
- One of the following courses:
  - MATH 5792 Probabilistic Modeling
  - MATH 6380 Stochastic Processes
- MATH 6101 Uncertainty Quantification
- One of the following courses:
  - MATH 5660 Numerical Analysis I
  - MATH 5733 Partial Differential Equations
  - MATH 6131 Real Analysis
  - MATH 7386 Monte Carlo Methods

d. Data Science Concentration

- MATH 5387 Applied Regression Analysis

- MATH 5388 Machine Learning Methods
- One of the following courses:
  - MATH 5490 Network Flows
  - MATH 5593 Linear Programming
  - MATH 6490 Combinatorial Optimization
  - MATH 6595 Nonlinear Programming
- One of the following courses:
  - MATH 5660 Numerical Analysis I
  - MATH 5733 Partial Differential Equations
  - MATH 6101 Uncertainty Quantification
  - MATH 7386 Monte Carlo Methods
  - MATH 7665 Numerical Linear Algebra
- An additional course from the above lists or the following list:
  - MATH 5779 Math Clinic
  - MATH 6131 Real Analysis
  - MATH 6330 Workshop in Statistical Consulting
  - MATH 6380 Stochastic Processes
  - MATH 6384 Spatial Data Analysis
  - MATH 6388 Statistical and Machine Learning
  - MATH 6404 Applied Graph Theory
  - MATH 7384 Mathematical Probability
  - MATH 7385 Stochastic Differential Equations
  - MATH 7393 Bayesian Statistics
  - MATH 7594 Integer Programming

e. Discrete Mathematics Concentration

Four of the following courses:

- MATH 5490 Network Flows
- MATH 5793 Discrete Math Modeling
- MATH 6404 Applied Graph Theory
- MATH 6490 Combinatorial Optimization
- MATH 7405 Advanced Graph Theory
- MATH 7409 Applied Combinatorics
- MATH 7410 Combinatorial Structures
- MATH 7413 Modern Algebra I
- MATH 7823 Topics in Discrete Math

f. Mathematics of Engineering and Science Concentration

- Three of the following courses:
  - MATH 5387 Applied Regression Analysis
  - MATH 5660 Numerical Analysis I
  - MATH 5733 Partial Differential Equations
  - MATH 5779 Math Clinic
  - MATH 5792 Probabilistic Modeling
  - MATH 5793 Discrete Math Modeling
  - MATH 5794 Optimization Modeling
- Two of the following courses:
  - MATH 5661 Numerical Analysis II
  - MATH 6101 Uncertainty Quantification
  - MATH 6653 Introduction to Finite Element Methods
  - MATH 7386 Monte Carlo Methods
  - MATH 7665 Numerical Linear Algebra

g. Numerical Analysis Concentration

- MATH 5660 Numerical Analysis I
- MATH 5733 Partial Differential Equations
- Three of the following courses:
  - MATH 5593 Linear Programming
  - MATH 5661 Numerical Analysis II
  - MATH 6101 Uncertainty Quantification
  - MATH 6595 Nonlinear Programming
  - MATH 6653 Introduction to Finite Element Methods
  - MATH 7386 Monte Carlo Methods
  - MATH 7665 Numerical Linear Algebra
  - MATH 8660 Math Foundations of Finite Element Methods

h. Operations Research Concentration

- MATH 5593 Linear Programming
- One of the following courses:
  - MATH 5792 Probabilistic Modeling
  - MATH 6380 Stochastic Processes
- Two of the following courses:
  - MATH 5390 Game Theory
  - MATH 5490 Network Flows

- MATH 5779 Math Clinic, with approval
- MATH 5794 Optimization Modeling
- MATH 6490 Combinatorial Optimization
- MATH 6595 Nonlinear Programming
- MATH 7593 Advanced Linear Programming
- MATH 7594 Integer Programming
- MATH 7595 Advanced Nonlinear Programming
- MATH 7825 Topics in Optimization

5. **Special Policy for Engineering PhD students**
   Engineering PhD students can apply 12 credit hours of graduate engineering courses as electives to the MS in Applied Mathematics, with approval by the Graduate Committee.

   The following Engineering classes have been pre-approved to count toward the MS in Applied Mathematics, Mathematics of Engineering and Science Concentration:
   - MECH 5120: Methods Engineering Analysis
   - MECH 5162: Heat Transfer I
   - MECH 5163: Dynamics

D. Master's of Science in Statistics

1. **Program Requirements**
   Students must present 30 hours of course work (which are broken into 4 components as detailed below) and maintain a 3.0 GPA or above for the MS degree. At least 24 of these hours must consist of graduate level (numbered 5000 or higher) courses with the MATH prefix. The remaining 6 hours must be either MATH courses numbered 5000 or above or approved courses outside the department numbered 4000 or above.

   Up to 9 semester hours of prior course work may be transferred in (subject to approval); these must be at the 5000 level or above with a B- or better grade. Courses already applied toward another degree (graduate or undergraduate) cannot be used toward the MS degree in Statistics. Additionally, the following MATH courses will NOT count toward a graduate degree: MATH 5010, 5012-5015, 5017, 5198, and 5830.

Following completion of course work, all students must complete a written project and pass a final oral exam. The project is developed as a student-centered independent research component within MATH 5960 unless they have chosen the thesis option. For students choosing the thesis option, 3 to 6 hours (of the 30 required hours) must be devoted to the writing of a thesis through MATH 5950.

2. **Course Requirements**

The MS degree in Statistics consists of 4 components: 1) core courses, 2) statistics electives, 3) other electives, and 4) MATH 5960 (Master's project) or MATH 5950 (Master's thesis).

Core Courses: The core courses include:

- One of the following courses:
  - MATH 5310 Probability
  - MATH 5792 Probabilistic Modeling
  - MATH 6380 Stochastic Processes
- Math 5320 – Statistical Inference
- Math 5387 – Applied Regression Analysis
- Math 6330 – Workshop in Statistical Consulting

Statistics Electives: Nine hours of statistics electives are required. A running list is given below. Additional courses can be substituted given prior approval by the student's academic advisor and the Director of the Statistical Programs.

- MATH 5337 - Introduction to Statistical and Machine Learning
- MATH 5388 - Machine Learning Methods
- MATH 5394 - Experimental Designs
- MATH 5792 - Probabilistic Modeling
- MATH 6101 - Uncertainty Quantification
- MATH 6380 - Stochastic Processes
- MATH 6384 - Spatial Data Analysis
- MATH 6388 - Statistical and Machine Learning
- MATH 7386 - Monte Carlo Methods
- MATH 7393 - Bayesian Statistics
- MATH 7384 - Mathematical Probability
- MATH 7826 - Topics in Probability and Statistics

Other Electives: Six hours of other electives are required. Any MATH prefix course that can be used for an MS or PhD degree in Applied Mathematics can be used as an elective. While these courses could be additional statistics-focused courses, the added flexibility allows students to direct their coursework into other areas of mathematics and/or science. The following courses will not count toward the MS in Statistics: MATH 5010, MATH 5012-5015, MATH 5017, MATH 5198, and MATH 5830.

E. Dual MA/MS in Economics and Applied Mathematics

A "dual" degree means that students who complete the program earn two master's degrees: an MA in Economics and an MS in Applied Mathematics.

1. Degree Requirements

The requirements for the Dual Degree in Economics and Applied Mathematics include completing 21 credit hours in ECON and 21 credit hours in MATH (42 total credit hours).

Students are expected to meet all course prerequisites. ECON 5803 – Mathematical Economics is a prerequisite for ECON 5073 - Microeconomic Theory and ECON 5813 - Econometrics I. This prerequisite requirement is waived for students who are currently admitted to the MS in Applied Mathematics program. A grade of B- or better is required in all courses, with a cumulative grade point average of B (3.0) or above. No course may be taken more than twice. At most 3 transfer credit hours can be applied towards the MS Applied Mathematics part of the dual degree upon approval.

2. Core Courses

The following 12 courses (36 hours) are required of all dual degree students.

- ECON 5073 - Microeconomic Theory
- ECON 5083 - Macroeconomic Theory
- ECON 5813 - Econometrics I
- ECON 5823 - Econometrics II
- ECON 6053/6054 - Seminar in Applied Economics
- ECON 6073 - Research Seminar
- One of the following courses:

    - MATH 5070 – Applied Analysis
    - MATH 6131 – Real Analysis
- MATH 5387 – Applied Regression Analysis
- MATH 5388 – Machine Learning Methods
- MATH 5718 - Applied Linear Algebra
- One of the following courses:
    - MATH 5490 – Network Flows
    - MATH 5593 – Linear Programming
    - MATH 6490 – Combinatorial Optimization
    - MATH 6595 – Nonlinear Programming
- One of the following courses:
    - MATH 5660 – Numerical Analysis I
    - MATH 5733 – Partial Differential Equations
    - MATH 6101 – Uncertainty Quantification
    - MATH 7386 – Monte Carlo Methods
    - MATH 7665 – Numerical Linear Algebra
    - Any additional course given prior approval by the student's academic advisor and the Director of Graduate Programs.

The "Seminar in Applied Economics" (ECON 6053, 6054) are 8-week 1.5 credit modules, two of which are offered each semester. Students are required to take two of these 8-week modules as part of the core; up to two additional modules can be taken for elective credit.

3. Electives

Dual degree students must also take two elective courses, according to the following guidelines:

- One 5000-level or higher course with a MATH prefix (3 semester hours), except MATH 5000-5010, MATH 5017, MATH 5198, MATH 5250, and MATH 5830.
- One 5000-level or higher course with an ECON prefix (3 semester hours). Contact a graduate advisor in the Economics Department for information about ECON course requirements.

F. Dual MA/MS in Economics and Statistics

A "dual" degree means that students who complete the program earn two master's degrees: an MA in Economics and an MS in Statistics.

1. **Degree Requirements**
   The requirements for the Dual Degree in Economics and Statistics include completing 21 credit hours in ECON and 21 credit hours in MATH (42 total credit hours).

   Students are expected to meet all course prerequisites. ECON 5803 – Mathematical Economics is a prerequisite for ECON 5073 - Microeconomic Theory and ECON 5813 - Econometrics I. This prerequisite requirement is waived for students who are currently admitted to the MS in Statistics program. A grade of B- or better is required in all courses, with a cumulative grade point average of B (3.0) or above. No course may be taken more than twice. At most 3 transfer credit hours can be applied towards the MS in Statistics part of the dual degree upon approval.

2. **Core Courses**
   The following 12 courses (36 hours) are required of all dual degree students.

   - ECON 5073 - Microeconomic Theory
   - ECON 5083 - Macroeconomic Theory
   - ECON 5813 - Econometrics I
   - ECON 5823 - Econometrics II
   - ECON 6053/6054 - Seminar in Applied Economics
   - ECON 6073 - Research Seminar
   - One of the following courses:
     - MATH 5310 – Probability
     - MATH 5792 – Probabilistic Modeling
     - MATH 6380 – Stochastic Processes
   - MATH 5320 – Statistical Inference
   - MATH 5387 – Applied Regression Analysis
   - MATH 6330 – Workshop in Statistical Consulting
   - Two additional courses from the above list or the following list:
     - MATH 5337 – Introduction to Statistical and Machine Learning
     - MATH 5388 – Machine Learning Methods
     - MATH 5394 – Experimental Designs
     - MATH 6101 – Uncertainty Quantification
     - MATH 6384 – Spatial Data Analysis
     - MATH 6388 – Statistical and Machine Learning

- MATH 7384 – Mathematical Probability
- MATH 7386 – Monte Carlo Methods
- MATH 7393 – Bayesian Statistics
- MATH 7826 – Topics in Probability and Statistics
- Any additional course given prior approval by the student's academic advisor and the Director of Statistical Programs.

The "Seminar in Applied Economics" (ECON 6053, 6054) courses are 8-week 1.5 credit modules, two of which are offered each semester. Students are required to take two of these 8-week modules as part of the core; up to two additional modules can be taken for elective credit.

3. **Electives**
   Dual degree students must also take two elective courses, according to the following guidelines:

   - One 5000-level or higher course with a MATH prefix (3 semester hours), except MATH 5000-5010, MATH 5017, MATH 5198, MATH 5250, and MATH 5830.
   - One 5000-level or higher course with an ECON prefix (3 semester hours). Contact a graduate advisor in the Economics Department for information about ECON course requirements.

G. Doctor of Philosophy in Applied Mathematics

1. **Graduation Requirements**
   A candidate must (1) fulfill course requirements, (2) pass the preliminary requirements, (3) meet the academic residency and participation requirements, (4) pass the comprehensive examination, (5) give an oral thesis proposal, and thereafter meet every year with his/her PhD advisory committee and (6) write and defend a thesis.

2. **Course Requirements**
   PhD students must complete 40 credit hours of non-thesis graduate courses; one readings course (MATH 7921-7926) is required as a part of this formal course work. Readings courses are one-hour seminar courses that are announced prior to the start of each semester or can be arranged with a faculty member. As discussed in Section C.3, all courses, including readings courses, should be

chosen in consultation with an academic advisor. Course replacements and equivalencies must be approved by the Graduate Committee.

The core consists of the following seven classes. The first two are required for all Ph.D. students:

- MATH 5070 - Applied Analysis
- MATH 5718 - Applied Linear Algebra

Every student must complete four of the following five classes:

- MATH 5387 - Applied Regression Analysis
- MATH 5388 - Machine Learning Methods
- MATH 5593 - Linear Programming
- MATH 5660 - Numerical Analysis I
- MATH 6404 - Applied Graph Theory

A maximum of 30 credit hours of graduate coursework may be transferred into the PhD program, including coursework previously applied towards a graduate degree. Graduate coursework applied to an undergraduate degree may not be transferred unless it was applied towards a graduate degree at the same time. Equivalencies of transfer credit to core requirements are decided on by the Graduate Director and Graduate Advisor. Up to 6 credit hours of these 30 credit hours may be awarded for a Master's thesis, up to 3 credit hours for a Master's project.

All PhD course work must be completed with at least a 3.25 grade point average. Grades below a B- do not apply towards the degree, though do count toward overall GPA. A student who receives a grade of C+ or lower, or whose overall GPA as a doctoral student falls below 3.25 will be reviewed by the Graduate Committee and may be put on probation or suspended.

3. **Preliminary Points Requirements**
   Each PhD student must earn three preliminary points. One preliminary point may be earned in each of the seven core classes by passing the class and an additional exam in the summer or winter directly following the class. These additional exams are only offered for classes running in the Fall and Spring semesters, and not for classes running in Summer. At least one preliminary point must be in MATH 5070 - Applied Analysis or MATH 5718 - Applied Linear Algebra.

A student wishing to earn a preliminary point must sign up with the Graduate Program Assistant at least one month prior to the end of the class. Students who cannot take the exam as planned should give notice of withdrawal at least one week prior to the exam.

The exam committee for each preliminary point consists of the faculty member teaching the class and another member of the graduate faculty. At the beginning of each core class, a syllabus for the preliminary point is supplied to all students. This syllabus may contain some material not covered in class. The exam is summative, but may take different forms. Possible formats include a written exam of 2-4h, a hybrid exam with a preparation period of 1-2h followed by a 1h oral exam, and a student presentation followed by a 1h oral exam covering the whole syllabus. Other formats are possible with approval by the graduate committee, but they must include a time-restricted, supervised component outside the original class.

To earn a preliminary point, students may substitute a transfer course for equivalent coursework instead of passing the class, but they have to additionally pass the preliminary exam for that class. In this case, the exam committee may require additional work by the student on a case-by-case basis.

PhD students must earn at least two preliminary points by the beginning of their fourth semester in the PhD program, and the third point by the beginning of their fifth semester in the PhD program. For the purposes of this rule, a winter preliminary examination offered in the first weeks of a student's fourth semester of the PhD program is considered as being offered prior to the start of their fourth semester. If a student fails to meet either deadline, they may petition the Graduate Committee in writing for a one semester extension. The petition will be successful only if the student's overall record indicates their having skills and potential for completing the PhD. If a student fails to meet the deadline and is denied another attempt, the student will be dismissed from the PhD program at the conclusion of their next semester, but may remain in the MS program.

An MS student, non-degree seeking student, or an applicant to the PhD program may attempt three times to earn preliminary points prior to matriculating into the PhD program, given that they have passed the class or an equivalent class.

4. **PhD Advisory Committee**

Each PhD student must choose a research advisor and, with this advisor's help, select other members of the PhD advisory committee. The advisor assumes the duties of academic advisor as well and the committee assumes the dual responsibility for advising and testing the student. In particular, under the direction of their research advisor, the committee will:

1. Design and evaluate the Comprehensive Exam; and
2. Advise on research and serve as the examining committee for the student's dissertation defense.

The PhD advisory committee consists of five Regular or Special members of the CU Denver Graduate Faculty, one of whom is the student's research advisor. At least one committee member must have their primary and prior affiliations outside of the Department of Mathematical and Statistical Sciences. At least three committee members, including the Chair, must be Regular Members of the CU Denver Graduate School and faculty members of the Department of Mathematical and Statistical Sciences. Committee members may be from outside the CU system, but must be granted special membership on the CU Denver graduate faculty for this purpose. The research advisor cannot be the chair of the committee. The research advisor must be a Regular Member of the CU Denver Graduate School.

The research advisor must seek and have received approval from the Graduate Committee for the composition of the advisory committee at least 30 days before the student takes the comprehensive exam. After formation of the committee, the chair, advisor or student may petition for changes to the committee membership; however, approval must be provided by the Graduate Committee at least 30 days before the date of the thesis defense. No changes to the PhD advisory committee will be allowed during the 30 days prior to the comprehensive exam and until the conclusion of the comprehensive exam. Similarly, no changes to the PhD advisory committee will be allowed during the 30 days prior to the thesis proposal and thesis defense. Applications for graduate school membership for committee members, if required, must be initiated at least 45 days before the date of the comprehensive exam.

After the student has been admitted to candidacy and has presented the research proposal, the advisory committee will meet with the student at least once per year to assess progress. Written records of the advisory committee meetings and the student's progress must be kept in the student's file. If progress is unsatisfactory, the committee will write a written report to the student and the graduate program director specifying steps to be taken to rectify the situation. If the student does not achieve an acceptable level of progress within six months after receipt of this report, the student will be terminated from the program. A thesis defense is scheduled upon recommendation of the PhD advisory committee.

5. **Participation**

   PhD students are required to participate in advising weeks, and are expected to participate in the life of the department by attending colloquia, seminars, orientations and other department activities and by spending time on campus interacting with other students and faculty outside of normal class hours. Students should discuss with their academic advisors how to fulfill this requirement.

6. **Comprehensive Examination and Candidacy**

   Timeline and Requirements: Students must complete their comprehensive examination prior to the start of their fourth year in the PhD program. Students must have completed at least 36 credits of non-thesis coursework before the semester in which they attempt their comprehensive exam.

   Applying for Candidacy: Application for candidacy to the PhD program must be made at least two weeks before the comprehensive examination is taken and approved by the student's advisor and the Graduate Director. Candidacy will be granted after at least three semesters have been completed in the program, an advisory committee has been selected, all preliminary examinations have been passed, and all non-thesis course requirements (including the breadth requirement) have been satisfied. Any student who has not completed the required 40 credits of non-thesis coursework at the time of their application for candidacy should list all intended coursework on their application for candidacy as "to be completed".

Objectives and Format: The comprehensive exam has the following objectives: to determine mastery of graduate level mathematics, capacity to synthesize mathematical concepts, and ability to embark upon doctoral thesis research. The comprehensive exam has two parts:

a. The first part consists of a written exam of roughly (but not limited to) six hours. The exam may take place on a single day or be split into two parts on consecutive days. The written exam covers material from the student's intended area of research. The choice of area and the extent of coverage within that area will be determined by the student's advisory committee. The advisory committee will prepare and conduct the exam and determine the outcome.

b. The second part of the exam consists of an oral follow-up, not to exceed two hours in length. The student will be given a copy of the scored written exam, no later than seven days after that exam, and a list of topics in which the committee found the student deficient. The oral follow-up will cover but need not be limited to questions on the written exam and topics on the list provided to the student. The oral exam is open to the faculty of the Department of Mathematical and Statistical Sciences, after which the student shall meet with the examination committee in a closed session. The Graduate School must be notified on the appropriate forms and the oral examination announced to faculty through the Graduate Program Assistant at least two (2) weeks before the oral exam. The oral should be given within four weeks of returning the graded exam to the student.

All members of the committee must be present for the examination, although a minority of members, but not the student nor both the Chair and Advisor, may participate by interactive video. In the event of an emergency that prevents one (1) faculty committee member from attending the exam, the exam may proceed with the faculty members who can attend and the student will schedule a separate meeting with the absent faculty member at an alternate time. The examination form must be signed by the committee and returned to the Graduate School Office. The student must receive votes from the majority of the examination committee for one of the following outcomes: a) Pass; b) Conditional Pass; or c) Fail.

If a student receives a Conditional Pass, the examining committee will clearly define the requirements for the student to receive an unconditional passing grade and these requirements must be completed to the satisfaction of the examination committee within four (4) months. The committee Chair is responsible for monitoring the conditions and reporting their outcome to the Graduate School. Failure to satisfy these conditions will result in failure of the examination.

A student who fails the examination is subject to immediate dismissal from the Graduate School upon the recommendation of the Program and concurrence of the Dean. At the Program's discretion, a student who fails the examination may retake it once. The re-examination will be in the form designated by the committee and must be completed within twelve (12) months. The original examination form noting the failure is signed by the committee and returned to the Graduate School office. The student will be required to meet registration requirements and be registered during the term in which the repeated exam is taken.

Following the comprehensive exam, students must be continuously registered in each fall and spring semester to maintain an active status until a successful thesis defense. After students have satisfied their course and thesis credit hours requirements, they may register for only one (1) thesis hour each fall and spring semester, which is considered sufficient for full-time status.

7. Thesis Proposal

Timeline: Within six months of successful completion of the written exam and/or oral follow-up, the student must give an oral research proposal before the advisory committee. At least two weeks prior to the oral proposal, the student must submit a written proposal as outlined below.

Format: The goal of the thesis proposal is for the student to articulate their intended dissertation research, both in writing and orally, and to receive guidance from the advisory committee on the feasibility and impact of the proposed research.

The thesis proposal has two parts:

a. A written research proposal of at most 15 pages that addresses the following:
    i. A description of the student's proposed research problems.
    ii. A thorough review of the relevant literature.
    iii. A detailed description of possible methodologies that could be used to approach the proposed research.
    iv. A discussion of how the student plans to approach each of their proposed research problems in light of the literature review and methodologies discussed above.

b. An oral research proposal that covers the main parts of the written proposal: The purpose of this presentation is to determine the feasibility of the student's proposed thesis topic. The research proposal is open to the public and must be scheduled and advertised through the Graduate Program Assistant at least two weeks prior to the presentation. The student will be provided a detailed summary of the committee's assessment and recommendations, which (as above) should be incorporated into a revised version of the student's written proposal. At the discretion of the advisory committee, a student may be asked to give a subsequent oral proposal at a later date.

After completing the oral research proposal, the student will be asked to submit a final version of the written proposal that reflects any recommendations made by the advisory committee.

8. Thesis

Each student must complete at least 30 hours of thesis credit. No more than 10 of these hours may be taken in any one semester without approval of the Dean of the Graduate School. No more than 10 thesis hours may be taken prior to the semester of the comprehensive examination.

Candidates for the PhD degree are required to write a dissertation containing original contributions and evidence of significant scholarship. Substantive contributions to research and writing by other persons should be explicitly acknowledged, either in an Acknowledgements section or in the appropriate chapters.

The thesis is written under the guidance of the student's research advisor, or a secondary research advisor. The thesis must comply in format with the specifications of the Graduate School and must be prepared in TeX, LaTeX, AMSTeX or MSWord following the Graduate School Format Guide. Thirty days before the final thesis defense, the student must submit a finalized draft of the thesis to the advisory committee and make it available electronically to department faculty. The Graduate School must be notified on the appropriate forms and the examination announced to faculty through the Graduate Program Assistant at least two (2) weeks before the defense.

The candidate must present and defend the dissertation before the student's advisory committee. The defense is open to the public and must be scheduled and announced at least two weeks prior to the exam to the graduate school and on the department website. All members of the advisory committee must be present for the defense; however, a minority of members, but not the student nor both the Chair and Advisor, may participate by interactive video. In the event of an emergency that prevents one committee member from attending the exam, the exam can proceed with the faculty who can attend. However, the student will need to meet with the absent committee member at an alternate time. The outcome of the defense can be "pass", "conditional pass", or "fail", as determined by a strict majority vote of the committee. If the student receives a conditional pass, the examining committee will define requirements that the student must satisfy to pass the defense. These requirements must be completed to the satisfaction of the committee within 60 days. Any extensions to this deadline require a recommendation from the Graduate Committee and approval by the graduate school.

The committee may declare the thesis defense successful but may request further minor changes in the thesis. The final version of the thesis must be approved by the student's advisory committee and by the Graduate School format review, submitted to the Graduate School, with the appropriate supporting documentation, and uploaded to ProQuest for publication following the instructions in the Graduate School Format Guide within sixty (60) days of the thesis defense. The student must provide a final PDF of the thesis to the department with a written statement giving permission to publish the thesis on the department website.

In the event of failure, the student will be dismissed from the program. Any exceptions to this will require approval from the Dean of the Graduate School.

9. **Time Limits**
   Students should begin the process of selecting a research advisor and a PhD advisory committee by the end of the semester in which all preliminary exams have been passed and must select a research advisor and form a PhD advisory committee prior to the start of their third year in the program.

   Students must pass the comprehensive examination no later than by the end of their third (3rd) year in the PhD program (including summer). All requirements for the PhD degree must be satisfied within eight (8) years of matriculation in the PhD program.

III. Administrative Policies and Procedures

A. Admissions

1. **Application Deadlines**
   A complete application packet (including unofficial transcripts and at least three letters of recommendation) must be submitted to the CU Denver Graduate School by the relevant application deadline, which is

   - July 15 for Fall semesters for MS and PhD programs,
   - November 1 for the following spring semester (MS admissions only)
   - March 1 for the following summer semester (MS admissions only).

   The target date for purposes of funding for Fall semester is January 15 for the PhD Program and April 1 for MS programs.

   Applications received after the deadlines and target dates may still be considered for admission, and possible TA funding, depending on availability. Outside of exceptional cases, students may only apply to start the PhD program in Applied Mathematics in the Fall Semester.

2. **International Admissions**

International students must provide financial documentation and certified English translations of all records and references not in English and apply at least two months before the application deadline to allow for visa processing. Applicants must satisfy the English Language Proficiency (ELP) Requirement as set by the Graduate School. The Graduate School and the Office of International Education may have additional requirements for international students.

3. **Program-Specific Rules**
   This section outlines the admissions criteria for specific programs within the department.

   a. **Graduate Certificate in Applied Statistics**
      The minimum admission requirements for students applying to the Applied Statistics Graduate Certificate are:

      - A bachelor's degree (not necessarily in mathematics or statistics) from an accredited college or university
      - A grade point average (GPA) of 3.0 or above during their bachelor's degree.
      - Students must have taken three semesters of calculus (through multivariate calculus), linear algebra, and a calculus-based statistics course that covers basic probability and statistical distributions.

   Subject to approval by the Director of Statistical Programs and the Graduate Committee, students with prerequisite deficiencies may be admitted with the understanding that those deficiencies must be removed after admission. Courses taken to fulfill admission deficiencies may not be counted toward the graduate certificate.

   b. **Master's of Science in Applied Mathematics**
      All applicants must establish adequate preparation for graduate studies in Applied Mathematics as demonstrated by at least one of the following:

      - A baccalaureate or master's degree (not necessarily in mathematics) from an accredited college or university, or completion of work equivalent to the baccalaureate or master's degree given at CU Denver with at least a 3.0 grade point average (GPA)

or

- Sufficiently high performance on the GRE subject test in mathematics, or completion of at least 12 credit hours of graduate-level mathematical coursework.

In addition, students must have taken a minimum of 30 semester hours of undergraduate mathematics, at least 24 of which are upper division courses with a grade of B– or better. These courses must include:

- one semester of linear algebra;
- one semester of one of the following: abstract algebra, differential equations, discrete mathematics, or probability
- one semester of advanced calculus or real analysis (or equivalent).

Subject to approval by the Graduate Committee, students who do not satisfy all of the above admission requirements may be admitted with course deficiencies with the understanding that deficiencies must be removed within one year of entry into the program. Undergraduate credits earned for deficiency coursework cannot be applied to a graduate degree.

c. Master's of Science in Statistics

The minimum admission requirements for students applying to the MS in Statistics program are:

- A bachelor's degree (not necessarily in mathematics or statistics) from an accredited college or university;
- A grade point average (GPA) of 3.0 or above during their bachelor's degree;
- Students must have taken three semesters of calculus (through multivariate calculus), linear algebra, and a calculus-based statistics course that covers basic probability and statistical distributions.

Admitted students are generally expected to have completed several additional upper-division mathematics courses on top of the minimum requirements, though students from non-mathematics backgrounds who meet the minimum requirements and have exceptional track records will be considered on a case-by-case basis. Subject to approval by the Director of

Statistical Programs and the Graduate Committee, students with prerequisite deficiencies may be admitted with the understanding that those deficiencies must be removed after admission. In such cases, credits earned for deficiency coursework cannot be applied to a graduate degree.

Admission to the 5-year BS/MS in Statistics. The requirements for admission into the University of Colorado Denver's undergraduate mathematics program are the same as the university requirements. Once a student has progressed beyond three semesters of calculus (through multivariate calculus), linear algebra, Introduction to Abstract Mathematics, and Statistical Theory, they may apply for entry into the 5-year BS in Mathematics/MS in Statistics degree program. A 3.0 grade point average (GPA) is required over all mathematics courses. Determination of whether applicants for the 5-year BS in Mathematics/MS in Statistics degree program are accepted into the program will be determined by the Director of the Program in Statistics and the Graduate Committee.

d. Dual MA/MS in Economics and Applied Mathematics

Students interested in completing the Dual degree in Economics and Applied Mathematics must apply separately to each program, meet the admission requirements of each program, and be accepted by each program. If one program accepts a student for the dual degree, but the other program does not, then the student may not graduate under the dual degree program. Students may apply to both programs at the same time or apply to the economics program first, and then to the applied mathematics program after their first semester, or vice versa. Both programs must be completed in the same semester to take advantage of the dual degree graduation requirements.

e. Dual MA/MS in Economics and Statistics

Students interested in completing the Dual degree in Economics and Statistics must apply separately to each program, meet the admission requirements of each program, and be accepted by each program. If one program accepts a student for the dual degree, but the other program does not, then the student may not graduate under the dual degree program. Students may apply to both programs at the same time or apply to the economics program first, and then to the statistics program after their first semester, or vice versa. Both

programs must be completed in the same semester to take advantage of the dual degree graduation requirements.

f. Doctor of Philosophy in Applied Mathematics

All applicants must establish adequate preparation for graduate studies in Applied Mathematics as demonstrated by at least one of the following:

- A baccalaureate or master's degree (not necessarily in mathematics) from an accredited college or university, or completion of work equivalent to the baccalaureate or master's degree given at CU Denver with at least a 3.0 grade point average (GPA)

or

- Sufficiently high performance on the GRE subject test in mathematics, or completion of at least 12 credit hours of graduate-level mathematical coursework.

In addition, students must have taken a minimum of 30 semester hours of undergraduate mathematics, at least 24 of which are upper division courses with a grade of B– or better. These courses must include:

- one semester of linear algebra;
- one semester of one of the following: abstract algebra, differential equations, discrete mathematics, or probability
- one semester of advanced calculus or real analysis (or equivalent).

Subject to approval by the Graduate Committee, students who do not satisfy all of the above admission requirements may be admitted with course deficiencies with the understanding that deficiencies must be removed within one year of entry into the program. Undergraduate credits earned for deficiency coursework cannot be applied to a graduate degree.

Additional Factors. Additional factors that can strengthen the application include:

- Strong performance within an MS degree program in Mathematics or related area;

- Research activities and experience, including publications in reputable, refereed venues, conference presentations, and/or software development expertise;
- A strong showing on the GRE subject test in Mathematics;
- A minor or second major or MS in an area related to the student's intended focus.

B. Courses Taken More Than 5 Years Prior to Candidacy

By graduate school rules, courses taken more than five years prior to applying for candidacy (including transfer courses) must be validated by the graduate program director to ensure their content is still current. However, it is the policy of the Department of Mathematical and Statistical Sciences that the content of all mathematics courses taken at an accredited University is considered current for at least ten years. For courses taken more than ten years prior to applying for candidacy, the validation process will require an assessment of the student's knowledge of the subject matter.

C. Leave of Absence

A student may request up to a one-year leave of absence from either the M.S. program or the PhD program. The student must be in good standing, indicate the return date, give justification for the leave of absence, and agree to contact his/her academic advisor and the Graduate Committee at least once per semester. Each petition must be approved by the Graduate Program Director.

A leave of absence does not extend deadlines automatically or guarantee resumption of any departmental funding awarded to the student at the time of the leave. An extension of deadlines requires a separate petition to the Graduate Committee. Students who leave a graduate program for more than one year will be removed from that program and must reapply for readmission through the Graduate School.

D. Exceptions

Unless otherwise stated, exceptions to these rules must be approved by the Graduate Committee. In cases where an exception can be made while still satisfying all requirements of the graduate school, the Graduate Committee may approve the request with consultation of the student's advisory committee. In cases involving exceptions to graduate school rules, the Graduate Committee, if it approves the

exception, will submit a petition to the graduate school, which will then either approve or deny the exception.

E. Procedures for Graduate Faculty Appointment

The following describes the departmental procedure for nominating individuals for appointment as special members of the graduate faculty.

Required Materials. To request an appointment to the graduate faculty, email the following to the Graduate Program Director:

- An updated CV of the individual to be appointed;
- Justification for why the appointment is needed;
- If the individual does not have a terminal degree, provide an explanation of how the individual satisfies the qualifications required by the graduate school (see below).

The Graduate Program Director will announce the nomination on the faculty mailing list, including the justification for the request and the CV of the individual.

Approval. The nomination can be approved in one of two ways:

- If no faculty member objects to the nomination within two weeks following the announcement, the nomination is approved.
- Alternatively, the nomination will be discussed and voted on at a faculty meeting. The nomination is approved by a simple majority vote of the graduate faculty. This method is required if any faculty member objects to the nomination within two weeks following the announcement. This method may also be used if the announcement is made less than two weeks prior to a faculty meeting.

Qualifications Required by the Graduate School. Special members of the Graduate Faculty shall hold a doctoral degree or the terminal degree appropriate to their discipline or shall have made other academic contributions that qualify them for membership. Nominees for special faculty appointments shall present evidence of their research and scholarly activity and/or teaching activities. The quality of the nominee's research and discovery or creative work, teaching at the graduate level,

mentoring of graduate students and scholarship shall be central to receiving a graduate faculty appointment.

Deadline. The special graduate faculty appointment should be requested at least three weeks before the date of the examination the faculty member is to serve on.