INTRODUCTION

The Department of Applied Mathematics of the University of Colorado at Boulder offers a range of courses and research opportunities in several areas including:

Applied Probability and Statistics
Computational Mathematics
Dynamical Systems and Mathematical Biosciences
Nonlinear Phenomena
Physical Applied Mathematics

For more information on these areas and research specialties of the department and affiliated faculty, please refer to our website: http://amath.colorado.edu.

This document provides information on a variety of topics, ranging from admission procedures to degree requirements. If you have questions that are not answered in this document, please do not hesitate to contact us.

ADMISSION REQUIREMENTS

The admission requirements spelled out below apply equally to the M.S. and Ph.D. programs. The program that the applicant applies for is *not*, in and of itself, a factor in decisions regarding admission or financial support. Applicants should be aware, however, that both programs are competitive, and meeting the requirements does not guarantee admission. Successful applicants will, in general, have records considerably stronger in breadth and quality than these minimum standards suggest.

equivalent from an institution comparable to the University of Colorado in applied mathematics, engineering, mathematics, or a natural science. Those with significant backgrounds in the physical sciences are encouraged to apply. Applicants should have strong foundations in mathematical course work and the mathematical maturity to understand basic concepts in pure and applied mathematics.

mathematical nature beyond calculus, including advanced calculus and linear algebra. Additional recommended courses include partial differential equations, complex analysis, numerical analysis, and perhaps probability and statistics. These courses need not be in a mathematics department; however, they should require the mathematical maturity expected of a strong upper-level mathematics undergraduate.

It is also recommended that applicants have some computing experience. For example, a working knowledge of a scientific programming language such as FORTRAN, C, C++, or MATLAB is recommended, and experience with UNIX can be very helpful.

An exceptional student who has some deficiencies in his/her mathematics background also may be considered for admission. However, such students likely will need to take some upper-division undergraduate mathematics courses during their first year of graduate study. For details, see the **PROVISIONAL ADMISSION** section of this supplement.

APPLICATION DEADLINES

Graduate applications for a given academic year (fall semester admission) should be received from domestic applicants by December 15 of the preceding year and from foreign applicants by December 1 of the

M.S. DEGREE REQUIREMENTS

ACADEMIC ADVISING

Each new student will be assigned a faculty advisor (usually the chair of the graduate committee) for consultation in planning a sound program of study. Advising includes the courses to be taken and the

M.S. 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 graduate chair. Upon approval by petition to the graduate committee,

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 his/her thesis work. 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.

The M.S. student on the thesis option must be registered for a minimum of 1 credit hour during the academic term (including summer session) the defense is passed.

At least two weeks before the defense, the M.S. student on the thesis option must submit for approval, a completed M.S. degree audit form, t form (available on the Graduate School website), and the dissertation title and abstract (in electronic format) to the graduate program assistant.

A student who fails the oral thesis defense may, in a later semester, make one and only one more attempt to satisfy this requirement. In doing so, the student may switch from the thesis to the non-thesis option.

An electronic copy of the thesis (in PostScript or PDF format), as well as an unbound copy, printed single-sided on 8.5 x 11 watermarked bond paper of at least 25 percent cotton content and 20-pound weight, should be submitted

Otherwise, the graduate committee may remove an inactive student from the degree program.

TRANSFER CREDIT

Master's degree students may request a maximum of 9 semester hours to be transferred from another institution. All transfer requests ***must*** have approval of the graduate committee and the Graduate School.

PH.D. DEGREE REQUIREMENTS

ACADEMIC ADVISING

Each new student will be assigned a faculty advisor (usually the chair of the graduate committee) for consultation in planning a sound program of study. Advising includes the courses to be taken and the areas in which to take the preliminary exams. Incoming students will be prevented from registering until they ob
will assume the duties of the faculty advisor when the committee is formed.

ADEQUATE PROGRESS

Doctoral students must demonstrate adequate progress toward the degree by:

Maintaining a grade point average of the Graduate School minimum of 3.0 or better in all course work

The Graduate School will not accept any grade below B- (2.7) toward the Ph.D. degree.

Attaining either a pass or a research pass on at least one preliminary exam by the conclusion of the first year in the graduate program and passing three prelims, including applied analysis and numerical analysis (attaining at least two research passes), before starting the third year

(See the

Finally, each student must take a yearlong graduate sequence outside of applied mathematics in an area where mathematics has significant application. Faculty advisor approval of this sequence is required.

DISSERTATION CREDIT-HOUR REQUIREMENT

Doctoral students are required to enroll in a minimum of 30 dissertation credit hours to complete the requirements for the Ph.D.

As a rule, no more than 10 dissertation credit hours taken in the semesters prior to the academic term during which the comp

upon meeting this requirement. Extenuating circumstances will be considered by petition to the graduate committee.

Preliminary

At the same time, the Ph.D. student must forward a completed Doctoral Examination Report form, available

The Graduate School will allow Ph.D. students to transfer up to 21 semester hours of course work from another institution toward the doctoral degree. All transfer requests must have the approval of the graduate committee in Applied Mathematics.

Course work already applied toward a graduate degree received from CU-Boulder or another institution cannot be accepted for transfer toward another graduate degree of the same level at CU-Boulder. For
arned by a student cannot be

Credit may not be transferred until the student has completed 6 credits of graduate-level course work as a regular, degree-seeking student on the CU-Boulder campus with a GPA of 3.0 or above.

B.S./M.S. (CONCURRENT) DEGREE PROGRAM

PURPOSE OF THE PROGRAM

This is a five-year degree program leading to both a Bachelor of Science and a Master of Science degree in Applied Mathematics at the conclusion of the fifth year. It enables well-qualified and motivated students to experience graduate-level course work earlier in their education and to obtain an M.S. degree in a reduced time period.

For more information about the B.S./M.S program, consult the Department of Applied Mathematics Undergraduate Curriculum Guide.

COMBINED M.S. AND M.A. PROGRAM WITH MCD BIOLOGY

PURPOSE OF THE PROGRAM

This three-year interdisciplinary program offers two degrees, an M.S. in Applied Mathematics and an M.A. in MCD Biology.

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 TO THE PROGRAM

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 MCD Biology.

Adequate undergraduate preparation consists of successful completion of basic courses on cell and molecular biology. Any student deemed deficient in either of these areas will be required to take Molecular Cell Biology I and II (MCDB 3135 and MCDB 3145) after enrollment.

Students will be required to apply to both programs, with Applied Mathematics designated as the primary program. Subject to joint recommendation and approval by both programs, incoming students will be admitted to this dual degree program as a regular part of the Applied Mathematics recruitment process.

Interested students should apply to the Applied Mathematics program and indicate their interest in the concurrent degree on their application.

The student will be expected to start both programs simultaneously, except in unusual cases when clearly nothing would be compromised. Continuation of the student beyond the first year is subject to approval by both programs.

CURRICULUM

The required curriculum in Applied Mathematics includes the following seven 3-credit courses: Methods of Applied Mathematics: Partial Differential and Integral Equations (APPM 5470), Numerical Analysis 1 and 2 (APPM 5600 and APPM 5610), Introduction to Mathematical Statistics (APPM 5520), Statistical

Applications: Software and Methods (APPM 5580), Numerical Methods for Unconstrained Optimization (CSCI 6676), and two semesters of Independent Study in Applied Mathematics (APPM 6900).

One semester of APPM 6900 (2 credits) for this program will focus on a basic study of the principles of genetics. The second semester of APPM 6900 (1 credit) will focus on oral student presentations on thesis research, including fielding questions, responding to critiques, and presenting background information. Both sections of APPM 6900 will be arranged in consultation with the student s faculty advisor, who will nominally serve as the course instructor.

This package of 21 credits provides the necessary background in general applied mathematics, computational mathematics, and statistics/probability for students to address challenging problems at the interface of applied mathematics and biology. This preparation is appropriate for either an academic or a commercial setting, especially in the emerging area of bioinformatics.

In MCD Biology, the core curriculum consists of 21 credits as follows. A student takes three 3-credit courses, usually during the second year: Cell Structure and Function (MCDB 5210), Gene Expression (MCDB 5230), and Topics in Developmental Genetics (MCDB 5250). In the third year, a student takes either Molecular Genetics (MCDB 5220) or Cell Signaling and Developmental Regulation (MCDB 5426). In addition, the student takes one 3-credit graduate elective in MCDB and 6 credits of Master s Thesis

APPM 5460 (3 credits)

SOME SAMPLE PROGRAMS

A. Computational Physics, non-

IQ BIO CURRICULUM IN APPLIED MATHEMATICS

IQ Biology students pre-approved by Applied Mathematics may count the IQ Biology Core courses as 12 of the 30 credits required outside Applied Mathematics for the successful completion of the Ph.D.

In addition to Applied Mathematics Ph.D. requirements, the following courses and requirements are mandatory for the Applied Mathematics Ph.D. with a Certificate in IQ Biology:

Year 1:
Quantitative Biology Foundations (IQ Biology Core course, 6 credits)
Statistics and Computations for Genomes and Meta-Genomes (IQ Biology Core course, 3 credits)
Forces in Biology (IQ Biology Core course, 3 credits)
One or two other graduate courses to fill gaps in background related to quantitative biology and pre-approved by the IQ Biology Mentoring Committee
Three 10-week lab rotations with IQ Biology faculty

Years 1-5:
Attend the IQ Biology Seminar and Workshop Series

Year 2:
Start thesis research with IQ Biology faculty in Applied Mathematics (co-advising with mentors outside Applied Mathematics is encouraged), and present at the IQ Biology Symposium. For information about IQ Biology faculty, visit http://iqbiology.colorado.edu/faculty.

Years 2-3:
Applied Analysis series (APPM 5440, APPM 5450; 6 credits)
Numerical Analysis series (APPM 5600, APPM 5610; 6 credits)
Probability and Statistics series (APPM 5520, APPM 5560; 6 credits)
One Science Ethics Course (e.g., CHEM 5776; 1 credit)

Years 2-5:
Attend Applied Mathematics colloquia.

Years 3-5:
Participate on the IQ Biology Symposium Organization Committee.

Preliminary Exams:
Pass at least three of the following preliminary exams in Applied Math, with a Ph.D. Research Pass in at least two of them: Applied Analysis, Numerical Analysis, and Probability & Statistics

Comprehensive Exam:
The comprehensive examination must be completed by the end of Year 3.

Dissertation:
Thesis research needs to be carried out with a faculty advisor in Applied Mathematics, and the Ph.D. thesis committee must include at least one other IQ Biology faculty member.

For details on IQ Biology curriculum, visit: http://iqbiology.colorado.edu/programs/curriculum-overview.

APPM TEACHER LICENSURE OPTION

Every graduate student in the Department of Applied Mathematics takes a yearlong sequence of courses in some area of application of mathematics. One option is to take this sequence in the School of Education, and ultimately, to both obtain
mathematics in a secondary school (i.e., middle through high school). This option is not simple, and pursuing it will delay graduation from the department.

Nevertheless, for graduate students in Applied Mathematics who also seek a teaching license, here are some guidelines.

The Teacher Education Program (TEP) in the School of Education for Secondary Mathematics Teacher Licensure consists of seven courses: (EDUC 3013, EDUC 4023, EDUC 4050, EDUC 4060, EDUC 4232, EDUC 5317, and EDUC 5375), plus one semester of student teaching (which includes EDUC 4513 and EDUC 4712, and is a full-time, full-semester, in-school commitment), and a passing score on the PRAXIS II or PLACE licensure exam in mathematics. Students not yet admitted to TEP are eligible to enroll in EDUC 3013 and EDUC 4050 but must be admitted to take any of the other courses listed above.

Before being admitted to TEP, a student must have met requirements that include a minimum of 56 hours of college work, grade point average minimums (2.75 in several areas, including mathematics courses), 25 hours of youth experience, and a passing score on the PRAXIS II or PLACE licensure exam in mathematics. Prior to student teaching, the student must have completed all but the student teaching semester courses, a series of mathematics s a passiexam ssiw(a),50(e)400000912 69(hin)-11(g)69oliPLsug ex12sixAki(nt)9(fo7(e)ssa)4

work in Applied Mathematics. In fact, each graduate student must take a yearlong sequence outside the department. Consult a faculty advisor for more information and approval.

BASIC COURSES

Acceptable 5000-level APPM sequences include the following (others require faculty advisor approval): 5430-5470, 5440-5450, 5460-5470, 5470-5480, 5520-5540, 5520-5560, 5600-5610, 5590-5380, 5590-5520, 5590-5540, 5590-5560, and 5590-5580.

The following courses, which are cross-listed as graduate/undergraduate courses, generally **do not** count toward the 30-credit-hour M.S. or Ph.D. requirement:

APPM 5350 (3) Methods in Applied Mathematics: Fourier Series and Boundary Value Problems
APPM 5360 (3) Methods in Applied Mathematics: Complex Variables and Applications
APPM 5570 (3) Statistical Methods
APPM 5720 (3) Open Topics in Applied Mathematics

All of the remaining courses listed below **do** count toward the 30-credit-hour M.S. or Ph.D. requirement:

*APPM 5120 (3). Introduction to Operations Research***.** Studies linear and nonlinear programming, the simplex method, duality, sensitivity, transportation and network flow problems, some constrained and unconstrained optimization theory, and the Kuhn-Tucker conditions, as time permits. Prereqs.: APPM 3310 3963( )-159(pr)-6(oblems,)-160(someMAeW*z5 0 0 i(in]TJET3o8.27 T1eW*n)]TJ(0.00000912 0 612 792 r4e2

equivalent to APPM 2360, 3310, and MATH 3001 and MATH 4001. (Normally offered spring semesters of even-numbered years)

APPM 5470 (3). Methods of Applied Mathematics: Partial Differential and Integral Equations. Studies properties and solutions of partial differential equations. Covers methods of characteristics, well-posedness, Prereqs.: APPM 4350 and 4360, or MATH 4430, or equivalent. (Normally offered fall semester)

APPM 5480 (3). Methods of Applied Mathematics: Approximation Methods. Covers asymptotic evaluation of integrals (stationary phase and steepest descent), perturbation methods (regular and singular methods, and inner and outer expansions), multiple scale methods, and applications to differential and integral equations. Prereq.: APPM 5470 or instructor consent. (Normally offered spring semesters of odd-numbered years)

APPM 5520 (3). Introduction to Mathematical Statistics. Examines point and confidence interval estimation. Principles of maximum likelihood sufficiency and completeness; tests of simple and composite hypotheses, linear models, and multiple regression analysis. Analyzes variance distribution-free methods. Prereq.: one semester calculus-based probability such as MATH 4510 or APPM 3570. Same as APPM 4520 and MATH 4520/5520. (Normally offered spring and fall semesters)

APPM 5540 (3). Introduction to Time Series. Single and multivariable regression, forecasting using regression models, time series models, and modeling with MA, AR, ARMA, and ARIMA models, forecasting with time series models, and spectral analysis. Prereqs.: APPM 3570 or MATH 4510, and APPM 5520/MATH 5520. Same as APPM 4540 and MATH 4540/5540. (Normally offered spring semester)

APPM 5560 (3). Markov Processes, Queues and Monte Carlo Simulations. Brief review of conditional probability and expectation followed by a study of Markov chains, both discrete and continuous time. Queuing theory, terminology, and single queue systems are studied with some introduction to networks of queues. Uses Monte Carlo simulation of random variables throughout the semester to gain insight into the processes under study. Prereq.: APPM 3570 or equivalent. Same as APPM 4560. (Normally offered fall semester)

APPM 5570 (3). Statistical Methods. Covers discrete and continuous probability laws, random variables; expectations; laws of large numbers and central limit theorem; estimation, testing hypotheses, analysis of variance, regression analysis, and nonparametric methods. Emphasizes applications with an introduction to packaged computer programs. Prereq.: APPM 1360 or equivalent Calculus 2 course. Same as APPM 4570. (Normally offered fall and spring semesters)

APPM 5580 (3). Statistical Applications: Software and Methods. Continuation of APPM 5570. Combines statistical methods with practical applications and computer software. Develops commonly used statistical models such as analysis of variance as well as linear and logistic regression. The statistical models are implemented and interpreted in the context of actual data sets using available statistical software. Prereq.: one semester of statistics. Same as APPM 4580. (Normally offered spring semester)

APPM 5590 (3), Statistical Modeling. Introduces methods, theory and applications of statistical models, from linear models (simple and multiple linear regression), to hierarchical linear models. Topics such as estimation, residual diagnostics, goodness of fit, transformations, and various strategies for variable