

# Applied Mathematics

## Bachelor of Arts (BA)

The Department of Mathematics offers undergraduate major programs in mathematics and applied mathematics leading to the BA degree. These programs provide excellent preparation for advanced degrees in math, physical sciences, economics, and industrial engineering, as well as graduate study in business, education, law, and medicine. They also prepare students for post-baccalaureate positions in business, technology, industry, teaching, government, and finance.

## Declaring the Major

You are eligible to declare the major in Applied Mathematics if you have met ALL of the following criteria:

1. Completion of MATH 1A Calculus & MATH 1B Calculus (or equivalent) with averages grades of at least "C". For our policy on Advanced Placement scores, please click here (<http://math.berkeley.edu/courses/choosing/ap-exams>).
2. Completion of MATH 53 Multivariable Calculus, MATH 54 Linear Algebra and Differential Equations, and MATH 55 Discrete Mathematics (or equivalent) with minimum grades of "C" in each, or completion of two of those three courses (with minimum grades of "C" in each) and currently enrolled in the third. If declaring while currently enrolled in the final lower-division requirement, that course will need to be completed with a letter grade of at least "C". *Please note that we will accept Computer Science 70 in lieu of MATH 55 Discrete Mathematics if you have a double-major in Computer Science or Electrical Engineering and Computer Science.*

## Major Declaration Procedures

1. Fill out the Math Department application form (available outside 964 Evans).
2. Download and fill out ONE of the following: The Petition to Declare a Major ([http://ls-advise.berkeley.edu/fp/08Declare\\_Maj.pdf](http://ls-advise.berkeley.edu/fp/08Declare_Maj.pdf)) form (for students declaring a Single Major), the Double Major ([http://ls-advise.berkeley.edu/fp/Double\\_Maj\\_Packet.pdf](http://ls-advise.berkeley.edu/fp/Double_Maj_Packet.pdf)) packet (for students declaring two majors within the College of Letters & Science), the Simultaneous Degrees ([http://ls-advise.berkeley.edu/fp/Simult\\_Packet.pdf](http://ls-advise.berkeley.edu/fp/Simult_Packet.pdf)) packet (for students declaring Math or Applied Math as well as a major in another College), or the Change of L&S Major ([http://ls-advise.berkeley.edu/fp/Change\\_of\\_LS\\_Major.pdf](http://ls-advise.berkeley.edu/fp/Change_of_LS_Major.pdf)) form (for students changing to Math or Applied Math from another major within the College of Letters & Science).
3. Print a copy of your Bear Facts transcript showing your completed Math courses. If you completed any math requirements at another institution we will need a copy of that transcript as well.
4. Bring all of the above items to the Undergraduate Adviser in 964 or 965 Evans Hall.

## Honors Program

In addition to completing the requirements for the major in applied mathematics, students in the honors program must:

1. Earn a GPA of *at least* 3.5 in upper division and graduate courses in the major and *at least* 3.3 in all courses taken at the University

2. Complete either MATH 196, in which they will write a senior honors thesis, or pass two graduate mathematics courses with a grade of at least A-
3. Receive the recommendation of the Head Adviser.

Students interested in the honors program should consult with an adviser early in their program, preferably by their junior year.

## Minor Program

There is no minor program in Applied Mathematics.

## Other Majors and Minors Offered by the Department of Mathematics

Mathematics (<http://guide.berkeley.edu/archive/2014-15/undergraduate/degree-programs/mathematics>) (Major and Minor)

In addition to the University, campus, and college requirements, listed on the College Requirements tab, students must fulfill the below requirements specific to their major program.

## General Guidelines

1. All courses taken to fulfill the major requirements below must be taken for graded credit, other than courses listed which are offered on a *Pass/Fail* basis only. Other exceptions to this requirement are noted as applicable.
2. No more than one upper-division course may be used to simultaneously fulfill requirements for a student's major and minor programs, with the exception of minors offered outside of the College of Letters and Science.
3. A minimum grade point average (GPA) of 2.0 must be maintained in both upper- and lower-division courses used to fulfill the major requirements.

For information regarding residence requirements and unit requirements, please see the College Requirements tab.

## Lower-division Requirements (5 courses)

MATH 1A & MATH 1B	Calculus and Calculus	8
MATH 53	Multivariable Calculus	4
MATH 54	Linear Algebra and Differential Equations	4
MATH 55	Discrete Mathematics <sup>1</sup>	4

- <sup>1</sup> For students double-majoring in Computer Science or Electrical Engineering and Computer Sciences, COMPSCI 70 may be substituted.

## Upper-division Requirements (8 courses)

MATH 104	Introduction to Analysis	4
MATH 110	Linear Algebra	4
MATH 113	Introduction to Abstract Algebra	4
MATH 128A	Numerical Analysis	4
MATH 185	Introduction to Complex Analysis	4

Select three clustered electives:

A minimum of three upper-division (or graduate) elective courses to form a coherent cluster in an applied area. Courses in other departments may count toward this requirement provided they have substantial mathematical content at an appropriately advanced level and are taken for at least three units.

For sample clusters, please see the department's website.

Undergraduate students in the College of Letters and Science must fulfill the following requirements in addition to those required by their major program.

For detailed lists of courses that fulfill college requirements, please see the College of Letters and Sciences (<http://guide.berkeley.edu/archive/2014-15/undergraduate/colleges-schools/letters-science>) page in this bulletin.

## Entry Level Writing

All students who will enter the University of California as freshmen must demonstrate their command of the English language by fulfilling the Entry Level Writing Requirement. Fulfillment of this requirement is also a prerequisite to enrollment in all reading and composition courses at UC Berkeley.

## American History and American Institutions

The American History and Institutions requirements are based on the principle that a U.S. resident graduated from an American university should have an understanding of the history and governmental institutions of the United States.

## American Cultures

American Cultures is the one requirement that all undergraduate students at Cal need to take and pass in order to graduate. The requirement offers an exciting intellectual environment centered on the study of race, ethnicity and culture of the United States. AC courses offer students opportunities to be part of research-led, highly accomplished teaching environments, grappling with the complexity of American Culture.

## Quantitative Reasoning

The Quantitative Reasoning requirement is designed to ensure that students graduate with basic understanding and competency in math, statistics, or computer science. The requirement may be satisfied by exam or by taking an approved course.

## Foreign Language

The Foreign Language requirement may be satisfied by demonstrating proficiency in reading comprehension, writing, and conversation in a foreign language equivalent to the second semester college level, either by passing an exam or by completing approved course work.

## Reading and Composition

In order to provide a solid foundation in reading, writing and critical thinking the College requires two semesters of lower division work in composition. Students must complete a first-level reading and composition course by the end of their second semester and a second-level course by the end of their fourth semester.

## Breadth Requirements

The undergraduate breadth requirements provide Berkeley students with a rich and varied educational experience outside of their major program. As the foundation of a liberal arts education, breadth courses give students a view into the intellectual life of the University while introducing them to a multitude of perspectives and approaches to research and scholarship. Engaging students in new disciplines and with peers from other majors, the breadth experience strengthens interdisciplinary connections and context that prepares Berkeley graduates to understand and solve the complex issues of their day.

## Unit Requirements

- 120 total units, including at least 60 L&S units
- Of the 120 units, 36 must be upper division units
- Of the 36 upper division units, 6 must be taken in courses offered outside your major department

## Residence Requirements

For units to be considered in "residence," you must be registered in courses on the Berkeley campus as a student in the College of Letters and Science. Most students automatically fulfill the residence requirement by attending classes here for four years. In general, there is no need to be concerned about this requirement, unless you go abroad for a semester or year or want to take courses at another institution or through University Extension during your senior year. In these cases, you should make an appointment to see an adviser to determine how you can meet the Senior Residence Requirement.

Note: Courses taken through UC Extension do not count toward residence.

## Senior Residence Requirement

After you become a senior (with 90 semester units earned toward your B.A. degree), you must complete at least 24 of the remaining 30 units in residence in at least two semesters. To count as residence, a semester must consist of at least 6 passed units. Intercampus Visitor, EAP, and UC Berkeley-Washington Program (UCDC) units are excluded.

You may use a Berkeley summer session to satisfy one semester of the Senior Residence Requirement, provided that you successfully complete 6 units of course work in the Summer Session and that you have been enrolled previously in the College.

## Modified Senior Residence Requirement

Participants in the UC Education Abroad Program (EAP) or the UC Berkeley-Washington Program (UCDC) may meet a Modified Senior Residence Requirement by completing 24 (excluding EAP) of their final 60 semester units in residence. At least 12 of these 24 units must be completed after you have completed 90 units.

## Upper Division Residence Requirement

You must complete in residence a minimum of 18 units of upper division courses (excluding EAP units), 12 of which must satisfy the requirements for your major.

## Learning Goals for the Major

Mathematics is the language of science. In Galileo's words:

Philosophy is written in this grand book, the universe, which stands continually open to our gaze. But the book cannot be understood unless one first learns to comprehend the language and read the characters in which it is written. It is written in the language of mathematics, and its characters are triangles, circles, and other geometric figures, without which it is impossible to understand a single word of it. Without those, one is wandering in a dark labyrinth.

Mathematics majors learn the internal workings of this language, its central concepts and their interconnections. These involve structures going far beyond the geometric figures to which Galileo refers. Majors also learn to use mathematical concepts to formulate, analyze, and solve real-world problems. Their training in rigorous thought and creative problem-solving is valuable not just in science, but in all walks of life.

## Skills

By the time of graduation, majors should have acquired the following knowledge and skills:

1. Analytical skills
  - An understanding of the basic rules of logic
  - The ability to distinguish a coherent argument from a fallacious one, both in mathematical reasoning and in everyday life
  - An understanding of the role of axioms or assumptions
  - The ability to abstract general principles from examples
2. Problem-solving and modeling skills (important for all, but especially for majors in Applied Mathematics)
  - The ability to recognize which real-world problems are subject to mathematical reasoning
  - The ability to make vague ideas precise by representing them in mathematical notation, when appropriate
  - Techniques for solving problems expressed in mathematical notation
3. Communication skills
  - The ability to formulate a mathematical statement precisely
  - The ability to write a coherent proof
  - The ability to present a mathematical argument verbally
  - Majors in Mathematics with a Teaching Concentration should acquire familiarity with techniques for explaining K-12 mathematics in an accessible and mathematically correct manner.
4. Reading and research skills
  - Sufficient experience in mathematical language and foundational material to be well-prepared to extend one's mathematical knowledge further through independent reading
  - Exposure to and successful experience in solving mathematical problems presenting substantial intellectual challenge

The Undergraduate Adviser provides information on requirements, policies, procedures, resources, opportunities, untying bureaucratic knots, developing study plans, attending commencement, certifying degrees and minors. The student is strongly encouraged to see the Undergraduate Adviser as soon as problems arise.

The individually assigned Faculty Adviser counsels students on the academic content of their mathematics major. The Faculty Adviser's signature is required on program forms (a) when a student first declares the major; and (b) confirming approval of courses that are not already pre-approved to be used for the major electives. Appropriate questions for the faculty adviser include selection of electives and preparation for graduate-level courses in a specific mathematical area to be used for Honors in the major. Be sure and let him/her know if you are considering graduate work in or related to mathematics, and solicit help in how best to prepare.

Occasionally, the student's adviser goes on sabbatical or is taken off the major advising list and a new official adviser will be appointed by the Head Major Adviser. Requests to change advisers will be accommodated to the extent possible on an individual basis. Please make requests well in advance of the Tele-BEARS period in which the change is to become effective.

## Tele-BEARS and Adviser Codes

Adviser Codes are required for enrollment in the next semester's courses during Tele-BEARS. Mathematics majors must consult with their Faculty Adviser when they first declare. In subsequent semesters, they may meet with the Staff Advisers. Meeting the Faculty or Staff Advisers should take place prior to the beginning of the Tele-BEARS period to ensure obtaining the Adviser Code in a timely manner. Before meeting with the Adviser, the student should plan a tentative program for the coming semester, and have an overall plan for completing the major. Tele-BEARS packets consisting of a Course Approval Form (green) and a Major Checklist (white) which shows your completed courses and grades will be available in the Main Office (970 Evans) two weeks prior to the start of Tele-BEARS. Faculty Advisers hold regular office hours during the academic year. These hours are posted on the bulletin board across from 965 Evans. It is best to allow time for more than one meeting in case decisions depend on information not available at the first visit.

When the Adviser and the student have agreed on a program of study, the Adviser will sign the Course Approval Form (green). Approved alternatives and electives should be indicated on the bottom of the program form and initialed by the Adviser. Adviser Codes are released by the Staff Advisers in 964 and 965 Evans Hall. Adviser Codes are not given over the phone.

Admitted transfer students should attend CalSO orientation programs during the semester preceding their first semester at Cal. Returning students should see their faculty adviser or the Undergraduate Adviser during the semester prior to their readmitted term.

Although students are formally required to see their Faculty Advisers only when they first declare the major, they are strongly encouraged to consult with them, or seek the advice of any faculty member, at any time. If the Adviser's office hours conflict with the student's classes, the student should schedule an appointment with via email.