

# Undergraduate Mathematics Mission Statement, Objectives, and Assessment

The mission of the undergraduate program in the Department of Mathematics at Duke University is to provide students with an understanding of mathematical thought and knowledge; the ability to use this understanding to produce and communicate mathematics; and the preparation to apply these skills in advanced degree programs and/or careers requiring expertise in mathematics.

## 1 Objectives

The objectives for undergraduate education in Mathematics at Duke are consistent with those outlined in the *Curriculum Guide 2004* of the Committee on the Undergraduate Program in Mathematics, from the Mathematical Association of America, which can be found at <http://www.maa.org/sites/default/files/pdf/CUPM/cupm2004.pdf>

The objectives for students in the Department of Mathematics fall into five categories:

- I. **Logical Skills:** Students should be proficient in the application of the laws of logic to mathematical statements. Students encounter this rigorous mathematical thinking in the pre-requisite linear algebra course, and expand and sharpen those skills in the required courses in analysis (Math 139 or 203) and algebra (Math 121 or 200). Many other courses require students to write proofs and/or construct algorithms, such as Math 123S, 128S, 160S, 181, 187, 188, 201, 204, 205, 206, and graduate level courses.
- II. **Accumulation of Knowledge:** Students should have a detailed understanding of a broad subset of known mathematical notions and results. Our major courses cover a broad set of fields: analysis, algebra, geometry, topology, probability and statistics, ordinary and partial differential equations, number theory, and linear programming. Our requirements force students to learn material in several of these areas.
- III. **Analytical Skills:** Students should have the ability to see connections between mathematical notions and applications, to formulate precise and relevant mathematical statements and questions, and to find valid means of resolving those questions. All major courses require extensive problem solving on the part of the student.
- IV. **Writing:** Students should be able to communicate mathematical concepts and reasoning effectively, and should be able to write rigorous proofs. All of our courses require problem solving, and they require writing to communicate their solutions. Many courses, including the required Math 139 or 203 and Math 121 or 200, require writing proofs; this is the most demanding of all technical writing. Students are expected to be able to communicate their solutions and proofs effectively and concisely.
- V. **External Performance:** Students should be able to perform and compete successfully outside of the classroom environment and outside of the University.

## 2 Assessment

1. **Math 121 and 200.** While writing proofs is a skill that is required in many courses for our majors, a special emphasis is given in the Algebra courses, Math 121 and 200. All math majors are required to take one of these courses.

Currently, to assess this Student Learning Objective, students are given a short quiz near the beginning of the term in which they are asked to provide rigorous proofs of relatively simple statements. For example, they may be asked to show that the square root of 2 is irrational or to prove a statement by mathematical induction. A copy of the students' solutions are kept and the same question is asked again on the final exam. A comparison of their proofs provides a measure of how much progress in this area the students have made.

This is a direct measure of the success of the department in achieving Objective IV.

2. **Math 139/203.** Currently, the instructor for these courses assigns each student one or more long (proof-)writing assignments. Each consists of a difficult theorem, broken down into small steps, requiring arguments ranging from simple to quite challenging. Students meet with the instructor to make sure they know in principle how to do the problems; their challenge is to give well-organized completely correct epsilon-delta proofs. After the initial meeting, students write out their arguments, the instructor criticizes them and they re-write them if necessary.

This is a measure of the success of the department in achieving Objectives I, III, and IV.

3. **PRUV.**

For several years we have conducted summer research programs for our undergraduates. The participants in these programs typically

- \* Participate in a 6 weeks research mentorship in mathematics;
- \* Collaborate with graduate students and postdocs in the field of interest;
- \* Share the experiences of undergraduates with similar goals and interests.
- \* Continue their project in their senior year in independent studies courses with the goal of Graduation with Distinction.
- \* Develop contacts with potential employers.

Here are the numbers of participants in this program for the last eight years.

Year	Number
2007	10
2006	9
2005	6
2004	5
2003	8
2002	8
2001	5
2000	4

See <http://math.duke.edu/vigre/pruv/index.html> for further details.

The success of this program is a measure of the success of the Department in achieving Objectives III and V.

4. **Competitions.** Duke mathematics students' performance in the William Lowell Putnam Mathematics Competition has been consistently outstanding. In the last ten years the team has finished, on the average, in position 3.5. Nineteen Duke students competed in the most recent Putnam competition.

In addition, Duke mathematics students have an outstanding record in the Mathematical Contest in Modeling. Indeed, since 1998, thirteen teams from Duke have been rated "Outstanding" which is to say they finished in the top 1-2%. Twenty-one Duke students participated in the most recent Putnam competition.

Duke mathematics majors have an outstanding record of success in obtaining prestigious scholarships like the Rhodes, Churchill, Goldwater as well as the Duke Faculty Scholarship.

See <http://math.duke.edu/news/awards/> for further details.

These are direct measures of the success of the Department in achieving Objectives II and V.

5. **Graduation With Distinction**

Mathematics majors who have strong academic records are eligible for graduation with distinction in mathematics. The requirements are:

- (a) An overall GPA of at least 3.3 and a mathematics GPA of at least 3.5, maintained until graduation;

- (b) A paper demonstrating significant independent work in mathematics, normally written under the supervision of a tenured or tenure-track faculty member of the Department of Mathematics. Usually the paper will be written as part of an independent study taken in the senior year (Mathematics 194);
- (c) An oral presentation of the paper, open to the public.

The student's committee chooses from three levels: Distinction, High Distinction and Highest Distinction. We rarely award Highest Distinction.

Class	Number
2003	6
2004	9
2005	2
2006	5
2007	4

## 6. Independent Study and Publications

In the Fall semester of 2007, there were 21 students enrolled in Independent Study courses in the Mathematics Department. In the current Spring semester of 2008 there are 35 undergraduate student enrollments in graduate level courses.

We have records of twenty-two papers published by Duke undergraduates in research journals, including *Topology*, *Journal of Number Theory* and *Journal of Theoretical Biology*. Since 1990, Duke undergraduates have presented 20 papers at national meetings of the American Mathematical Society.

These are direct measures of the success of the Department in achieving Objective V.