

Assessment Findings and Curricular Improvements
Department of Mathematics
Undergraduate Program

Assessment Measures

The Department of Mathematics uses the following measures to assess departmental learning outcomes: grades and grade trends in interrelated courses and pass-rates on the Comprehensive Exam (for majors in mathematics). The findings below will consider several different portions of the curriculum: calculus (two different course sequences), precalculus, statistics (two levels), upper-level courses for majors, the Comprehensive Exam.

Assessment Findings

Calculus:

The Department offers two separate calculus course sequences:

1. Calculus for the Social and Life Sciences I and II (Math 111 and 112) taken primarily by students majoring in Business/Economics and students majoring in Biology. Some majors in Chemistry also take these two courses. Each is a 3-credit course.
2. Analytic Geometry and Calculus I, II, III and IV (Math 121, 122, 221 and 222). The first three of these courses are taken by students in the School of Engineering, majors in mathematics, and physics. Some majors in Chemistry take 121 and 122. Calculus I-IV are 4-credit courses.

Students who need these courses but who are not mathematically prepared for them must take a preparatory course. Prior to the Fall, 2008 semester, there were two preparatory courses: Math 101 (leading to Math 111) and Math 120 (leading to Math 121). As of the fall 2008 semester, these courses were replaced by Math 108 (Elementary Functions) leading to either Math 111 or Math 121.

Therefore, the task of assessment for these courses consists of tracing students progressing through one of several possible sequences and measuring the success rate in courses which had an earlier mathematics course as prerequisite.

A student must receive a C- or higher in a course in order to use that course as a prerequisite for a later course. Therefore, the summaries below show the numbers in parentheses and the percentage of students who received grades of C- or above.

Here are the figures from fall 2001 through spring 2008:

academic year	Math 121	Math 122
2001-02	77 (47) 57%	83 (55) 66%
2002-03	82 (56) 68%	73 (49) 67%
2003-04	74 (57) 77%	66 (33) 50%
2004-05	78 (56) 72%	81 (48) 59%
2005-06	62 (54) 87%	69 (55) 80%
2006-07	106 (91) 86%	87 (70) 80%
2007-08	85 (74) 87%	94 (67) 71%
totals	564 (435) 77%	553 (377) 68%

Comments: In each of these years, the “standard cycle” was 121 in the fall and 122 in the spring. Since some students need to take these courses out of the usual cycle (due to advanced placement, the need for precalculus or some other postponement) there is always one section of 122 in the fall and of 121 in the spring.

One notable feature for the Calculus I and II results is that the percentages are somewhat lower for Calculus II (Math 122) than for Calculus I. There are two likely general reasons for this: (1) Calculus II is a more difficult course. It has a larger number of topics and includes new ideas which students are unlikely to have seen previously. (2) Many students have earlier exposure (in high school) to some topics covered in Calculus I, even though they don’t qualify for advanced placement. The earlier experience helps those students do better in Calculus I to some extent. However, that earlier exposure is unlikely to have included any detailed material covered in Calculus II.

Here are the figures for Calculus III (Math 221):

academic year		
2001-02	54 (41)	76%
2002-03	96 (74)	77%
2003-04	77 (62)	81%
2004-05	72 (62)	86%
2005-06	69 (58)	84%
2006-07	89 (76)	85%
2007-08	101 (89)	88%
totals	558 (462)	83%

The higher success rates in Calculus III probably follow from: (1) The students are stronger mathematically. All of them either passed Calculus I and II or took Calculus III on an advanced placement basis. (2) Most of the students are older than Calculus I, II students and are somewhat more mature as students.

Here are the figures for Calculus IV (Math 222):

semester		
s02	15 (15)	100%
s03	31 (28)	90%

s04	33 (31)	94%
s05	23 (21)	91%
s06	27 (24)	89%
s07	30 (29)	97%
s08	28 (28)	100%
	187 (148)	94%

Here are the figures for Math 111 and Math 112 during the same period:

academic year	Math 111	Math 112
2001-02	147 (115) 78%	55 (39) 71%
2002-03	150 (112) 75%	56 (40) 71%
2003-04	107 (79) 74%	56 (44) 79%
2004-05	90 (66) 73%	43 (40) 93%
2005-06	141 (99) 70%	41 (34) 83%
2006-07	150 (126) 84%	70 (66) 94%
2007-08	179 (131) 73%	51 (44) 86%
totals	964 (728) 76%	372 (307) 83%

Comments: The standard cycle is 111 in the fall and 112 in the spring. Some students took 112 in the fall due to advanced placement, or due to the need for precalculus or for some other reason. Some students took 111 in the spring following precalculus in a previous semester.

In these two courses, the rate for “C- or better” is slightly higher in Math 112 than in Math 111. The most likely explanation is that students in Math 111-112 are less likely to have seen any calculus earlier (unlike the 121-122 students who, as science, engineering and mathematics majors are self-selected for an interest in mathematical work). Some of those whose aptitude in mathematics is marginal do not continue with Math 112. That is, the Math 112 group is somewhat stronger in mathematics.

Precalculus:

Math 110: *Finite Mathematics for Business and Economics*

In Fall, 2007 the Department introduced this course for business and economics majors aimed at those who were not yet ready to take calculus. It exposes students to some of the applications of mathematics occurring in business and economics and also serves to sharpen the students’ general mathematical skills to prepare them for calculus.

Forty students took both Math 110 (Fall, 2007) and Math 111 (Spring, 2008). Of these 40, 33 got C- or above in Math 111.

Math 108: *Elementary Functions*

The majority of students in this course are from the School of Architecture. That School requires students to either demonstrate a knowledge of mathematics at the precalculus level (or higher) or to pass Math 108. The success rates (C- or above) are:

Year		
2001-02	32 (23)	72%
2002-03	48 (38)	79%
2003-04	70 (57)	81%
2004-05	55 (45)	82%
2005-06	49 (43)	88%
2006-07	70 (66)	94%
total	363 (307)	85%

Note: Prior to fall, 2007, this course was numbered 120.

Statistics:

The Department offers two statistics courses for non-majors: **Probability and Statistics (Math 114)** and **Probability and Statistics for Engineers (Math 309)**. Math 114 is open to any student without any prerequisite while Math 309 (introduced in Fall, 2005) is open to Engineering majors and has Math 221 (Analytic Geometry and Calculus III) as prerequisite.

The Math 114 results:

year		
2001-02	119 (91)	76%
2002-03	119 (96)	81%
2003-04	148 (138)	93%
2004-05	191 (140)	73%
2005-06	205 (162)	79%
2006-07	204 (189)	93%
2007-08	238 (214)	90%
total	1224 (1030)	84%

The Math 309 results:

semester		
f05	47 (36)	77%
f06	42 (33)	79%
f07	42 (36)	86%
total	131 (105)	80%

Courses for mathematics majors

In Math 305, 501, 505, 506 and 521 (with specific numbers shown below), the high percentage of C- or above grades is as expected for students self-selected for an interest in and aptitude for mathematics beyond calculus.

Math 305: *Fundamentals of Advanced Mathematics*

This course prepares students, mostly mathematics majors and minors, for upper-level mathematics courses by covering topics and ideas which are common in those upper-level courses. It is usually taken by mathematics majors in their fourth semester at CUA, but could be taken earlier by students who arrive with advanced placement. It has Math 122 (Analytic Geometry and Calculus II) as a prerequisite. It serves as a gateway course for upper-level courses.

Results for Math 305:

semester		
s02	8 (7)	87.5%
s03	12 (11)	92%
s04	7 (7)	100%
s05	6 (6)	100%
s06	9 (9)	100%
s07	2 (2)	100%
s08	13 (12)	92%
total	57 (54)	95%

Math 501: *Linear Algebra*

Math 505: *Abstract Algebra I*

Math 506: *Abstract Algebra II*

Math 521: *Introductory Analysis I*

These are the four upper-level courses required of all majors in the B.A. program and B.S. program.

Math 501:

semester		
f01	9 (8)	89%
f02	8 (8)	100%
f03	2 (2)	100%
f04	12 (11)	92%
f05	11 (11)	100%
f06	6 (6)	100%
f07	5 (5)	100%
total	53 (51)	96%

Math 505, 506 and 521

Since these classes are small, here are only the aggregate results:

Math 505: Fall, 2001 to Fall 2007; 28 students (27 at C- or above) 96%

Math 506: Spring 2002 to Spring 2008 (not Spring 2003); 19 students (18 at C- or above) 95%

Math 521: Fall 2001 to Fall 2007; 24 students (23 at C- or above) 96%

Note: Math 521 is a 4-credit course. The other 500-level course are all 3-credits.

Next we consider other 500-level courses used as elective options. Since these course are small and not (in some cases) offered every academic year, we present only aggregate figures from the period fall 2001 through spring 2008 and only if the course was taught more than once.

Math 503 (Euclidean and non-Euclidean Geometry): 22 (22) 100%

Note: This course is required in the Mathematics/Secondary Education B.S. degree program.

Math 507 (Graph Theory): 14 (14) 100% [3 sections]

Math 508 (Elementary Number Theory): 9 (8) 89% [2 sections]

Math 515 (Combinatorics): 14 (13) 93% [4 sections]

Math 520 (Topology): 11 (11) 100% [2 sections]

Math 524 (Complex Variables): 8 (8) 100% [3 sections]

Math 531 (Probability and Statistics with Applications I): 35 (34) 97% [7 sections]

Math 551 (Introduction to Mathematical Logic): 8 (8) 100% [2 sections]

Courses for the Honors program

Math 230 (The Mathematics of Politics): 112 (110) 98% [7 sections]

Math 330 (Topics in Mathematical Social Sciences): 63 (62) 98% [7 sections]

The Comprehensive Exam

The results of the Comprehensive Exam during 2003-2007 were: 13 pass and 1 failure.

Curricular Improvements

Summary:

Math 110: Introduced in Fall 2007 after consultation with the Department of Business/Economics.

Math 108: Created as part of a restructuring of the precalculus curriculum.

Math 309: Introduced in Fall 2005 after consultation with the School of Engineering.
Comprehensive exam revision

Math 110: Finite Mathematics for Business and Economics

During the summer of 2007 the Department of Mathematics and the Department of Business and Economics agreed to develop an alternative course for freshmen declared Business/Economics majors who were not yet prepared for Math 111 (Calculus for the Social and Life Sciences I). The course is intended to help prepare students for Math 111 while, at the same time, introduce those students to mathematics particularly relevant to the Business and Economics programs, namely linear functions and models, linear systems and their solution by geometric and algebraic methods, matrix methods and linear programming problems in two variables. The course would also introduce students to the fundamentals of financial mathematics including simple and compound interest, annuities, amortization. Finally, students would get familiar with sets and basic combinatorial methods for counting: permutations and combinations.

Math 108: Elementary Functions

The Mathematics Department restructured its precalculus options starting in the fall of 2007. It takes the place of two earlier precalculus courses, Math 101 and Math 120, and is retains the title and content of the old Math 120. Math 101 was determined to be obsolete. Its content was essentially below the university level and, primarily for that reason, carried no credit either for graduation or towards a student's official course-load. In essence, it was "off the books". Students resisted, some even protested, being required to take the course.

Math 108 plays several roles in the curriculum. For some of its students (other than majors in Business and Economics), it provides or reviews the mathematical background needed for calculus. For students in the School of Architecture, it provides the mathematical skills regarded as necessary for that area of study. The School of Architecture uses the Mathematics Placement Test system run by the Mathematics Department to either place an Architecture student in Math 108, or certify that the student has the required mathematics skills.

Math 309: Probability and Statistics for Engineers

In ABET-accredited programs in Engineering, students are required to have a calculus-based background in statistics and the use of statistical techniques in Engineering. Prior to 2005, Engineering students took a statistics offered within the School of Engineering

itself. During 2004-2005, the School of Engineering and the Mathematics Department collaborated on developing a course in statistics to be offered by the Mathematics Department and intended for Engineering majors.

Comprehensive Exam revision:

This exam is required of all mathematics majors in all programs. Up through the 2005-2006 academic year, the format of the exam was a sequence of sixteen take-home problem sets presented during a student's last four semesters. These were graded individually and a student's three highest scores each semester were retained. To pass, the sum of a student's 12 retained scores had to exceed a minimum score. A score above a specified level determined passing "with honors".

The Mathematics Department revised the exam during 2005-2006 and began using it in 2006-2007. The new Comprehensive Exam is divided into a sequence of four take-home problem sets in the fall of a student's senior year and a single written exam in the spring. For the spring exam, students also have an oral exam option. Both versions of the spring exam cover the same material at the same level with mandatory content in algebra and analysis. Each student selects a third upper-level topic.

The main reasons for the revision were: (1) To make the exam, as a whole, more rigorous; (2) To enlarge the coverage, particularly of upper-level mathematics: analysis and algebra, in particular.

Under the earlier system, the problems had to be accessible to students in the fall of their third year, and therefore had to omit substantive coverage of course material usually taken during a student's fourth year. The new system is an improvement in this regard. It retains the problem-solving aspect of the old system which at its best required students to bring to bear knowledge from several different courses. At the same time, it includes material from senior-level courses. The upper-level course cycle structure is such that students will have had Linear Algebra (Math 501), Abstract Algebra I (Math 505) and Introductory Analysis I (Math 521) before the spring of the fourth year. Topics from each of those courses is on the exam.