UNIVERSITY OF SAN FRANCISCO | College of Arts and Sciences

Department of Mathematics & Statistics
Mathematics major and minor

ASSESSMENT REPORT
ACADEMIC YEAR 2017 – 2018

I. LOGISTICS & PROGRAM LEARNING OUTCOMES

1. **Please indicate the name and email of the program contact person to whom feedback should be sent (usually Chair, Program Director, or Faculty Assessment Coordinator).**

Cornelia Van Cott (cvancott@usfca.edu)
Chair of the Department of Mathematics & Statistics

2. **Were any changes made to the program mission statement since the last assessment cycle in October 2017? Kindly state "Yes" or "No." Please provide the current mission statement below. If you are submitting an aggregate report, please provide the current mission statements of both the major and the minor program.**

Yes, there were changes. We did not have a mission statement last year. Below is our new mission statement.

The USF Department of Mathematics & Statistics seeks to deliver a quality mathematics education to our majors and minors, inspiring them to appreciate, understand, and engage with clear and rigorous thinking, both in abstract and concrete settings.

3. **Were any changes made to the program learning outcomes (PLOs) since the last assessment cycle in October 2017? Kindly state "Yes" or "No." Please provide the current PLOs below. If you are submitting an aggregate report, please provide the current PLOs for both the major and the minor programs.**

Yes, there were changes. In response to the feedback on the 2017 assessment report, we edited the wording in PLO #1, but the statement's meaning remains unchanged. The PLOs for the major are the same as those for the math minor, and are listed below.

1. Differentiate and integrate functions of one and several variables;
2. Use differentiation and integration to solve problems in mathematics and other disciplines;
3. Solve and understand linear systems;
4. Give direct proofs, proofs by contradiction, and proofs by induction; formulate definitions and construct counterexamples;
5. Read mathematics without supervision; write mathematics with correct style, including typesetting;
6. Apply mathematics to problems in other disciplines; and
7. Use technology to solve mathematical problems.

4. Which particular Program Learning Outcome(s) did you assess for the academic year 2017-2018?

We assessed Program Learning Outcomes 1, 2, 3, 4, 5, and 6.

II. METHODOLOGY

5. Describe the methodology that you used to assess the PLO(s).

To assess the aforementioned Program Learning Outcomes, our graduating math majors took the **ETS Major Field Test for Mathematics** in May 2018. This exam is written by the Educational Testing Service, the same organization that writes the GRE and TOEFL. In the past year (September 2017 through June 2018), this exam was taken by graduating math majors at a total of 108 institutions all across the United States. The total number of examinees in this time period is 1,184.

The exam has 50 multiple choice questions and covers topics most commonly offered as part of an undergraduate mathematics curriculum.

The content breakdown of the exam is as follows:

- **Calculus** (about 30%)
  Both single-variable and multivariable calculus.
- **Linear & Abstract Algebra** (about 30%)
  Matrices, linear transformations, eigenvalues, eigenvectors, vector spaces, systems of linear equations, elementary group/ring/field theory, elementary topics from number theory.
- **Additional Topics** (about 40%)
  Complex analysis, differential equations, discrete mathematics (including graph theory and combinatorics), foundations (including logic, proofs, sets, functions and relations), geometry, point-set topology, probability and statistics, and real analysis.

The exam questions are at three cognitive levels:

- **Routine** (about 55%)
  These questions cover definitions, questions with no more than a two-step reasoning process, or questions that require a standard technique that is practiced extensively in math courses at most institutions.
- **Non-routine** (about 25%)
  Includes questions that require an idea that is considered insightful, questions that require several steps of reasoning, and questions that require either the use of several definitions or a new definition that the student would not be expected to know. Some questions may require bringing techniques from two or more areas to bear on one problem.
- **Applied** (about 20%)
  This includes, for example, questions that are cast in real-world settings.

The relationship between this exam and our Program Learning Outcomes is as follows:

- 30% percent of the exam problems cover calculus knowledge, which corresponds to Program Learning Outcomes 1 and 2.
- 30% of the exam problems cover algebra knowledge, which corresponds to Program Learning Outcomes 3 and 4.
- 25% of the exam problems are classified as non-routine, requiring several steps of reasoning or a new definition that the student would not be expected to know, which corresponds to Program Learning Outcomes 4 and 5.
- 20% of the exam problems are classified as applied, requiring the student to apply math to real-world settings. This corresponds to Program Learning Outcome 6.

III. RESULTS & MAJOR FINDINGS

6. What are the major takeaways from your assessment exercise?

This year we had some surprising scores, both good and bad. One math major earned a perfect score (200), while two other math majors scored 127 and 129, respectively (the minimum score is 120). Knowing these math majors personally, none of these scores surprised faculty members. Individual scores for all 13 students are in Table 1, listed in ascending order.

Our overall mean score remained average, as compared to the nationwide data (Table 2). Comparing across years, our majors' average score has decreased slightly though insignificantly. If we break down our students' performance by question type (Table 3), our students again performed close to the national means. With only three years of data thus far, it is not possible to make strong generalizations.

Table 1. USF Math major scores on the 2018 ETS Major Field Test for Mathematics. (Scores are listed in ascending order. The scale range for the total score is 120 – 200.)

STUDENT	TOTAL SCORE
1	127
2	129
3	138
4	141
5	147
6	150
7	153
8	159
9	165
10	174
11	177
12	180
13	200

Table 2. A summary of total scores on the 2018 ETS Major Field Test in Mathematics. (The scale range for the total score is 120 – 200.)

	Number in population	Mean score	Standard Deviation
Nationwide – 2018 individual mean score	1,184 examinees	157.3	17.5
Nationwide – 2018 institution mean score	108 institutions	157.0	9.1
USF 2018	**13**	**157**	**22**
USF 2017	11	159	22
USF 2016	12	161	20

Table 3. A breakdown of performance on the 2018 ETS Major Field Test in Mathematics by question type. (Numbers in table represent the mean percent correct *for each question type.)*

	Calculus Questions	Algebra Questions	Applied Questions	Routine Questions	Non-routine Questions
Nationwide – 2018 institution mean	32.0	34.5	34.6	26.9	36
USF 2018	**27**	**35**	**33**	**29**	**38**
USF 2017	30	35	38	32	30
USF 2016	30	45	33	38	29

IV. CLOSING THE LOOP

7. **Based on your results, what changes/modifications are you planning in order to achieve the desired level of mastery in the assessed learning outcome? This section could also address more long-term planning that your department/program is considering and does not require that any changes need to be implemented in the next academic year itself.**

We plan to administer the exam again to our graduating math majors in May 2019.

8. **What were the most important suggestions/feedback from the FDCD on your last assessment report (for academic year 2016-2017, submitted in October 2017)? How did you incorporate or address the suggestion(s) in this report?**

The report suggested that we develop a mission statement. We have now developed a mission statement.

The report suggested that we develop a Courses to PLO Curricular Map. We have now developed a Courses to PLO Curricular Map.

The report suggested that we develop a PLO to ILO Curricular Map. We do not have one at this time.

We were also told in an email separate from the report (sent during the spring semester of 2018) that we needed to assess the Mathematics Minor separately from the Mathematics Major. We did not separate out the math minors from our classes for an assessment exercise this past year.

The report questioned how PLO #4 ["Give direct proofs, proofs by contradiction, and proofs by induction; formulate definitions and construct counterexamples"] can be demonstrated or assessed by a multiple choice exam. Our department agrees that a multiple choice exam is not a perfect way to ascertain PLO #4, yet the questions in the exam categorized as *Non-routine* require reasoning that moves several steps forward logically, as a proof must do. Observe, in fact, that the ETS description of the non-routine questions explicitly states that to be the case:

> **Non-routine questions** *include questions that require an idea that is considered insightful, questions that require several steps of reasoning, and questions that require either the use of several definitions or a new definition that the student would not be expected to know. Some questions may require bringing techniques from two or more areas to bear on one problem.*

From this, it is reasonable that PLO #4 is demonstrated and assessed by this category of questions.

ADDITIONAL MATERIALS

Below is a list of sample questions for the mathematics exam, given by ETS.

MATHEMATICS TEST
SAMPLE QUESTIONS

The following questions illustrate the range of the test in terms of abilities measured, the disciplines covered, and the difficulty of the questions posed. They should not, however, be considered representative of the entire scope of the test in either content or difficulty. An answer key follows the questions.

1. A student is given an exam consisting of 8 essay questions divided into 4 groups of 2 questions each. The student is required to select a set of 6 questions to answer, including at least 1 question from each of the 4 groups. How many sets of questions satisfy this requirement?

   (A) 6
   (B) 24
   (C) 28
   (D) 48
   (E) 96

2. The function f is differentiable on the interval $(0, 4)$. If $f(1) = 1$ and $f(3) = 7$, then there is at least one c in $(1, 3)$ such that $f'(c) =$

   (A) -1
   (B) 0
   (C) 1
   (D) 2
   (E) 3

3. Let A and B be metric spaces, and let $f : A \to B$. Suppose that whenever X is an open set in B, the set $\{a \in A : f(a) \in X\}$ is closed in A. Which of the following must be true?

   I. f is injective.
   II. f is continuous.
   III. f is a homeomorphism.

   (A) None
   (B) II only
   (C) III only
   (D) I and III only
   (E) I, II, and III

4. In the xy-plane, the line tangent to the graph of $x^2 + xy + y^2 = 3$ at the point $(1, 1)$ has a slope of

   (A) -3
   (B) -1
   (C) 0
   (D) $\frac{1}{3}$
   (E) 1

5. Let $\mathbb{Z}$ be the ring of integers, and let R be a ring without identity. Let $S = \mathbb{Z} \times R$ be the ring with addition and multiplication defined by $(k, a) + (n, b) = (k + n, a + b)$ and $(k, a)(n, b) = (kn, kb + na + ab)$, where k and n are in $\mathbb{Z}$, and a and b are in R. Which of the following must be true about S?

   I. S is a ring with identity.
   II. S has a subring isomorphic to R.
   III. S is an integral domain (it has no zero-divisors).

   (A) I only
   (B) II only
   (C) I and II only
   (D) I and III only
   (E) I, II, and III