Assessment Report: Mathematics – Mathematics Option

2017-2018

M-383 Fall 2017 Assessment Results

According to the below description of Mathematics Program Learning Outcomes and Assessment, 14 Mathematics Option students were assessed for Outcomes 1, 2 and 6 in M 383. The Class had a total of 24 students.

Outcome 1: Effectively communicate mathematical ideas by precisely formulating them in proper mathematical language.

Outcome 2: Produce rigorous proofs of results that arise in the context of real analysis.

Outcome 6: Write solutions to problems and proofs of results that meet rigorous standards based on content, organization, coherence, logical arguments, and style.

Description of Assignment Assessed

All three outcomes were assessed on one of the take-home midterms.

Assessment Items

Outcomes 1 and 6 were assessed on the overall writeup and formatting of a take home midterm exam. The students were required to turn in a LaTeX document with their solutions/proofs. An overall score on the writeup was given on a scale of 1-4, 4 being excellent, 3 meets expectations, 2 needs minor revision and 1 needs major revision. A score of 1 was deemed Unacceptable, 2 Acceptable and 3 - 4 Proficient.

Outcomes 1 & 6	Unacceptable Level	Acceptable Level	Proficient Level
Number of students achieving this level	0	2	12

Outcome 2 was assessed on the following two questions from the take home midterm.

3. (2 credit ___) Let k be a real number and let (x_n) be a sequence of real numbers that converges to the real number x. Suppose that for all $n \in \mathbb{N}$, $x_n \geq k$. Prove that $x \geq k$.

5. Let T be a non-empty subset of $\mathbb{R}$ with least upper bound y.

   (a) (2 credit ___) Prove that if $y \notin T$, there exists a sequence of distinct points in T converging to y. (Thus showing that y is a limit point of T.)

These were assessed on a 4 point scale:

4 --- excellent work; no real complaints on content or on writing
3 --- argument basically correct but missing some details/less clearly argued than we would like
2 --- argument mostly correct, but there is a misstep in the mathematics.
1 --- serious gaps in the mathematics, some ideas in the right direction, but didn't really get anywhere.

A 4 or 3 was deemed Proficient, 2 Acceptable, and 1 Unacceptable.

Outcome 2	Unacceptable Level	Acceptable Level	Proficient Level
Number of students achieving this level	2	4	8

Results

For outcomes 1 and 6, this course required the students to LaTeX at least one problem in each problem sets that was turned in throughout the semester in addition to the take home midterms and final. It is felt that this requirement is very beneficial to obtain good results on these outcomes.

For outcome 2, the prerequisite for this course was M-242, method of proof or equivalent. One of the two students that was deemed unacceptable did not take this class here. A prerequisite diagnostic assessment might be beneficial in this course.

Spring 2018 Assessment Results

According to the below description of Mathematics Program Learning Outcomes and Assessment, 12 Mathematics Option students were assessed for outcomes 2 and 5 in M 384.

Outcome 2: Produce rigorous proofs of results that arise in the context of real analysis.

Outcome 5: Construct direct, indirect, and proofs by induction and determine the appropriateness of each type in a particular setting. Analyze and critique proofs with respect to logic and correctness.

Description of Assignment Assessed

Both outcomes were assessed on the take home final.

Assessment Items

Outcomes 2 and 5 were assessed on two problems on the take home final.

Outcome 5 was assessed on the following question from the take home final.

5. Let K be a compact metric space.

[a] (1 cr.) Suppose that (f_n) is a sequence in $C(K)$ that converges pointwise to the constant function $f(x) \equiv 0$. Also suppose that for all $x \in K$ and $n \in \mathbb{N}$, $|f_{n+1}(x)| \leq |f_n(x)|$. Prove that (f_n) converges uniformly.

This proof is most easily done by contradiction. The outcome 5 was assessed on a 3 point scale:

3 --- The student recognized that the proof is best done by contradiction and the proof more or less correct. We deemed this proficient on this objective.
2 --- The student recognize that an indirect proof is the best approach but the given proof was not correct or the negation of the statement was incorrect. We deemed this Acceptable on this objective.
1--- Was given to the students who not recognize that a indirect means is the best approach. We deemed this Unacceptable.

Outcome 2 was assessed on the following problem:

1. Let a and $b \in \mathbb{R}$. Suppose that $f : (a, b) \to \mathbb{R}$ is differentiable at $x \in (a, b)$.

[a] (1 cr.) Prove that

$$\lim_{h \to 0} \frac{f(x+h) - f(x-h)}{2h} \tag{1}$$

exists and is equal to $f'(x)$.

[b] (1 cr.) Give an example of a function f and an interval (a, b) such that the limit (1) above exists everywhere in (a, b), but f is not differential on all of (a, b).

This problem was assessed on a 4 point scale:

4 --- excellent work; no real complaints on content or on writing
3 --- argument basically correct but missing some details/less clearly argued than we would like
2 --- argument mostly correct, but there is a misstep in the mathematics.
1 --- serious gaps in the mathematics, some ideas in the right direction, but didn't really get anywhere.

A 4-3 was deemed proficient, 2 acceptable and 1 unacceptable.

Results

Outcome 5	Unacceptable Level	Acceptable Level	Proficient Level
Number of students achieving this level	3	2	7

Outcome 2	Unacceptable Level	Acceptable Level	Proficient Level
Number of students achieving this level	1	3	8

Recommendations

The question chosen to assess this outcome may have been too difficult to obtain a valid conclusion. Four different methods of proof were used throughout the course by all of the students successfully. This problem was chosen because everyone had to typeset the solution in LaTeX and that may it very easy to assess the content of the student's work. However this was the only problem on the final were a clear choice of proof technique made a difference. A better choice of problem should be made in the future or we should assess this learning outcome only in M- 242.

A comment on learning outcome 5. By checking the prerequisite for M-383, M-242 method of proof, it is apparent that learning outcome 5 listed below is being more then adequately covered in M-242. It could be the case that there is no need to assess learning outcome 5 in M-383 and M-384.

Action: Review and Revise assessment schedule and include M 242 where appropriate.

Action: Implement last year’s recommendation of making M 242 a prerequisite to M 333.

Program Learning Outcomes

Students should demonstrate the ability to:

1) Effectively communicate mathematical ideas by precisely formulating them in proper mathematical language (M 333, M 383, M 384, M 431).
2) Produce rigorous proofs of results that arise in the context of real analysis (M 383, M 384).
3) Produce rigorous proofs of results that arise in the context of abstract algebra (M 431).
4) Produce rigorous proofs of results that arise in the context of linear algebra (M 333).
5) Construct direct, indirect, and proofs by induction and determine the appropriateness of each type in a particular setting. Analyze and critique proofs with respect to logic and correctness. (M 333, M 383, M 384)
6) Write solutions to problems and proofs of results that meet rigorous standards based on content, organization, coherence, logical arguments, and style. (M333, M 383, M 384, M 431)