Section 1 – Program Mission

The mission of the Applied Mathematics degree program is to prepare students for immediate participation in the workforce, or for graduate study. Employment opportunities include pharmaceutical companies, government agencies (like the National Security Agency), insurance companies (as actuaries), publishing companies (as editors of technical publications) and public K-12 and higher education.

Graduates will have knowledge and appreciation of the breadth and depth of mathematics, including the connections between different areas of mathematics, and between mathematics and other disciplines.

(The mission, objectives, and student learning outcomes for the Applied Mathematics program are reviewed annually by the department at the fall retreat during convocation.)

Section 2 – Program Educational Objectives

Graduates of the Applied Mathematics Program will be prepared to do the following in the first few years after graduation.

1) Apply critical thinking and communication skills to solve applied problems.
2) Use knowledge and skills necessary for immediate employment or acceptance into a graduate program.
3) Maintain a core of mathematical and technical knowledge that is adaptable to changing technologies and provides a solid foundation for future learning.

Section 3 – Program Description and History:

The Applied Mathematics Degree was approved by the Oregon University System in the spring of 2006, and the program was implemented beginning in the fall of that year. The program graduated its first student in the spring of 2008. We have had problems identifying the number our students because some of them are dual majors and are not required to declare themselves as an Applied Math major or have a math advisor until two terms before graduating. However, we currently estimate there are approximately 35 Applied Mathematics majors, 20 of which are earning dual degrees.

Coursework for Applied Mathematics intends to provide a solid foundation of mathematical theory and a broad selection of applied work both in and outside mathematics and across many fields. Graduates with a B.S. in Applied Mathematics work for such organizations as pharmaceutical companies (doing statistical analysis, or modelling the behavior of developing drugs using differential equations), insurance companies (as actuaries), publishing companies (as editors of technical publications), government agencies (like the National Security Agency), and public schools and colleges.

Program Location: Klamath Falls Campus Only

Program Graduates:

2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
1	**5**	3	7	4	4	5	7	8	8

Employment Rates and Salaries:

The following data were combined with information collected for the classes of 2015, 2016, 2017 and 2018. More information regarding the data used is available from Oregon Tech's Career Services.

Years	Employed	Continuing Education	Median Salary	Success Rate
2015/2016/2017	70%	30%	$47,000	100%
2016/2017/2018	33%	44%	$47,000	78%

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Section 4 – Program Student Learning Outcomes

Upon graduation, students will be able to

1. apply mathematical concepts and principles to perform computations
2. apply mathematics to solve problems
3. create, use and analyze graphical representations of mathematical relationships
4. communicate mathematical knowledge and understanding
5. apply technology tools to solve problems
6. perform abstract mathematical reasoning
7. learn independently

Section 5 – Curriculum Map

Freshman Year

Fall
MATH 251 - Differential Calculus (4)
SPE 111 - Public Speaking (3)
WRI 121 - English Composition (3)
Social Science Elective (3)
Elective Credit Hours: (3)
Total: 16 Credit Hours

Winter
ENGR 266 - Engineering Computation (3)
MATH 252 - Integral Calculus (4)
PHY 221 - General Physics with (4)
WRI 122 - Argumentative Writing (3)
Social Science Elective (3)
Total: 17/18 Credit Hours

Spring
MATH 253N - Sequences and Series (4)
PHY 222 - General Physics with Calculus (4)
Humanities Elective (3)
Social Science Elective (3)
Total: 14 Credit Hours

Sophomore Year

Fall
MATH 254N - Vector Calculus I (4)
MATH 310 – Mathematical Structures (4)
PHY 223 - General Physics with Calculus (4)
Elective (3)
Total: 15 Credit Hours

Winter
MATH 341 - Linear Algebra I (4)
MATH 354 - Vector Calculus II (4)
Elective (4)
Humanities Elective (3)
Total: 15 Credit Hours

Spring
MATH 361 - Statistical Methods I (4)
Elective (3)
Elective (3)
Elective (3)
Humanities Elective (3)
Total: 16 Credit Hours

Junior Year

Fall
MATH 321 - Applied Differential Equations I (4)
SPE 321 - Small Group and Team Communication (3)
Focused Elective (3)
Elective (4) (upper division)
Total: 14 Credit Hours

Winter
MATH 311 - Introduction to Real Analysis (4)
WRI 227 - Technical Report Writing (3)
Focused Elective (3)
Elective (3) (upper division)
Elective (3)
Total: 16 Credit Hours

Spring
MATH 322 - Applied Differential Equations II (4)
MATH 451 - Numerical Methods I (4)
Focused Elective (3)
Math/Physics Elective (3) (upper division)
Elective (2)
Total: 16 Credit Hours

Senior Year

Fall
MATH 421 - Applied Partial Differential Equations I (4)
Focused Elective (4)
Math/Physics Elective (4)(upper division)
Elective (3)
Total: 15 Credit Hours

Winter
Mathematics Core (4) (upper division)
Focused Elective (3)
Social Science Elective (3)
Elective (3)
Elective Credit Hours: 3
Total: 16 Credit Hours

Spring
Mathematics Core (4) (upper division)
WRI 327 - Advanced Technical Writing Credit Hours: 3 **or** WRI 350 - Documentation Development (3)
Elective (3)
Elective (3)
Total: 13 Credit Hours

BS Applied Mathematics
Total Credit Hours: 183-184

Section 6 – Assessment Cycle

The department assesses the 7 Program student learning outcomes using a 3-year cycle. The following table shows the schedule.

Table 1. Assessment Cycle

	Academic Year Assessed		
Learning Outcomes	**’18-19**	**’19-20**	**’20-21**
1. Apply mathematical concepts and principles to perform symbolic computations.		**X**	
2. Apply mathematics to solve problems.	**X**		
3. Create, use and analyze graphical representations of mathematical relationships.			**X**
4. Communicate mathematical knowledge and understanding.			**X**
5. Apply technology tools to solve problems.		**X**	
6. Perform abstract mathematical reasoning.	**X**		
7. Learn independently.			**X**

Comment: The assessment cycle was changed in 18-19 due to lack of math majors enrolled in Math 451 where SLO 5 was to be assessed. We swapped SLO 5 and 6 in years 18-19 and 19-20.

Section 7 – Assessment Activities 2018-19

Assessment of two learning outcomes was conducted during this academic year. A combined rate of proficiency and high proficiency of at least 60% is considered a minimum acceptable performance. We used three direct measures for each outcome. We had planned to also include an indirect measure for each by using the student exit survey. Since the response rate was only 3 students, we decided to omit this data as it was deemed statistically insignificant.

Outcome 2: *Apply mathematics to solve problems* was assessed in Math 354, in the Winter of 2019. The instructor was Dr. Randall Paul. There were three criteria assessed.

a) Write a mathematical description of a physical problem.
b) Correctly solve the higher dimensional integral.
c) Interpret results.

These criteria were measured by performance on a final exam question, and the results *for only the math majors* are given in Table 2. Percentages indicate the fraction of students performing at the given level for each criterion.

There were 12 math majors enrolled in Math 354 this term, though two did not attempt the final, and one other was omitted from this analysis. The omitted student was a nontraditional student taking his first math class at OIT. This was unfortunate because the level of vector calculus taught at the local community college did not prepare him for the class, and he did not do well. This assessment looks at the performance of the remaining nine majors.

On their final exam, the students were each given a standard problem which had three parts. In the first part they were asked to calculate the volume integral of a function over the region enclosed by a paraboloid and a plane. In the second part they were given a vector-valued function, and asked to calculate the flux through a disk (which happened to be the base of the volume from the part). For the third part, they were asked to calculate the flux through a parabolic surface (which happened to be the other boundary from the first part). For this last part they were warned not to try to calculate the result directly, but rather use the earlier parts of the problem and Gauss's Theorem.

To assess criterion(a) the instructor used student performance on the **second** part. Students had to first parametrize the disk, then set up, and solve a flux integral. If set up correctly, the calculation was very straight-forward, hence this part makes a good test of the student's ability to describe the problem mathematically, that is, to describe the disk with a parametrization and use that parametrization to construct a flux integral.

To assess criterion(b) the instructor used student performance on the **first** part. The students were presented with a volume integral, a region in space, and a function on that region. They were told to change to polar coordinates and evaluate the integral. This part simply tests whether the students knows how to accomplish these basically mechanical tasks and get a correct answer. It does not really test any deeper understanding.

To assess criterion(c) the instructor used student performance on the **third** part. It was, for all intents and purposes, impossible to do this problem directly. The students were given gentle suggestions, but no clear way to proceed. They had to use Gauss' Theorem, which relates a volume integral (calculated in the first part) with the flux through the boundary (a portion of which was calculated in the second part, and the remainder of which is the quantity requested). They can find the correct answer by simply adding the first and second parts, but the real point was to understand and explain why that is what you must do.

	Student Performance		
Criterion	Some/no proficiency	Proficient	High Proficiency
Mathematical description	22%	33%	44%
Correct Integration	11%	22%	67%
Interpretation	22%	22%	56%

Table 2. Assessment results for Outcome 2.

The students did quite well on criterion(b). This was not surprising as math students at this level are generally quite good at calculation. The students also did well on the other criteria, however, though not quite as well as the pure calculation criterion. It is particularly reassuring that the students did a good job of understanding how the quantities they'd calculated fit into another, larger problem, as evidenced by the good performance in criterion(c). This sort of knowledge synthesis can often be a problem for students who concentrate on performing rote calculation well.

Outcome 6: *Perform abstract mathematical reasoning* was assessed in Math 311, in the Winter of 2019. The instructor was Dr. Jim Fischer. We looked at two indirect measures: student final exam scores and student course grades. Additionally, we assessed performance on two criteria directly from student work.

Final Exam Score	100	100	100	98	93	83	82	78	72	67	67	0	0
Course Grade	A	A	A	A	B	C	B	B	C	C	C	F	F

Table 3. Final Exam Scores and Course Grades

There are two performance criteria for this PSLO assessed directly from student work.

a) Present a formal proof of the limit of a function at a point.
b) Present a formal proof that a sequence is a Cauchy sequence.

These criteria were measured by final exam problems. Since two students did not take the final exam, they are not included in the results for these direct measures. The results are given in Table 3.

The first criterion was tested by presenting the students with a rational function and its limit at a point. The students were then asked to present a formal delta-epsilon proof. A response showed high proficiency if the student chose an appropriate delta and showed algebraically that this bounded the function to within epsilon of its limit. A response showed proficiency if the student bounded the difference between the function and its limit, but did not clearly tie together epsilon and delta.

The second criterion was tested by presenting the students with a sequence and asking them to use the definition of Cauchy sequence to prove that the sequence is Cauchy. The definition was provided. The proof requires constructing a choice of integer N and to follow thru by showing that the difference of any two terms "after N" is bounded by epsilon. A response showed high proficiency if the student constructed an appropriate choice of N and followed thru with appropriate proof that any two terms differ by at most epsilon. A response showed proficiency if one of these steps was either poorly done or omitted entirely,

Table 4. Assessment results of direct measures for Outcome 6.

		Student Performance	
Criterion	Some/no proficiency	Proficient	High Proficiency
Proof of Convergence	2	4	5
Proof of Limit	2	3	6

Table 4 indicates student performance related to abstract reasoning is acceptable (9/11 or 81%). While there was some evidence of a lack of proficiency in these direct measures, when considering Table 4, student performance over all was acceptable.

8. Evidence of Improvement – Closing the Loop PSLO 6

In the last assessment cycles when we assessed PSLO 6 *Perform Abstract Mathematical Reasoning,* we found that students' performance was not meeting expectations. The problem occurred in the course Math 311 *Introduction to Real Analysis.* The instructors for this course felt that the students were not adequately prepared. We decided students needed more instruction on how to write mathematics including appropriate logical structure of proofs. In 2017 the applied mathematics program committee decided that an introductory course in abstract reasoning should be developed and required by all majors. During the 2017-18 the course Math 310 *Mathematical Structures* was created to serve as a prerequisite to Math 311. Math 310 was offered for the first time Fall term 2018.

Overall, the program committee feels that adding the Math 310 course was a good idea. Several students informally mentioned that the Math 310 prerequisite was appropriate. The instructor for Math 311 (J Fischer) was particularly happy with the fact that students were ready to focus on the Math 311 content at the start of the winter term. There were 13 students enrolled in Math 311, winter 2019. Two of the 13 chose not to participate with the assignments and they did not pass the course. Of the remaining 11, 2 students were borderline C/D. The remaining 9 students performance was quite good. 11 out of 13 earned a C or better in the course.

9. Data-driven Action Plans: Changes Resulting from Assessment

The faculty assessed two program student learning outcomes during the 2018-19 academic year. The faculty reviewed the results during the fall term 2019 during a faculty meeting and had the following conclusions.

Outcome 2:

Students met all performance criteria and no further action is required at this time.

Outcome 6:

Students met all performance criteria and no further action is required at this time.

Changes Resulting From Assessment

Based on our assessment results for the learning outcomes PSLO 2 and 6, no changes were deemed necessary.