Oregon TECH

Applied Mathematics
2021-22 Program Assessment Report

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 during Fall convocation.)

Section 2a – 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 2b – 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 3 – Curriculum Map

		Program Student Learning Outcome							ISLO					
Semester	**Course**	1	2	3	4	5	6	7	Com	Team	Ethics	IA	QL	DivP
Fresh-Fall	MATH 251	F	F	F	F								F	
	SPE 111								F					
	WRI 121								F					
	Social Science Elective										F			
	General Elective													F
Total Credits	16													
Fresh-Winter	MATH 252	F	F	F	F									
	ENGR 266					F								
	PHY 221 & lab	F	F	F								F		
	WRI 122								F					
	Social Science Elective											F		
Total Credits	17/18													
Fresh-Spring	MATH 253	F	F	F	F									
	PHY 222 & lab	F	F	F	F									
	Humanities Elective													F
	Social Science Elective													
Total Credits	16													
		Program Student Learning Outcome							ISLO					
Semester	**Course**	1	2	3	4	5	6	7	Com	Team	Ethics	IA	QL	DivP
Soph-Fall	MATH 254	F	F	F	F									
	MATH 310	F			F		F		F					
	PHY 223 & lab	F	F	F										
	WRI 227								P					
Total Credits	15													
Soph-Winter	MATH 341	F	F	F	F	F	F							
	MATH 354	F/P	F/P	F/P	F			F						
	General Elective													
	Humanities Elective													F
Total Credits	15													
Soph-Spring	MATH 361			F									F	
	Humanities Elective													F
	General Elective													
	General Elective													
	General Elective													
Total Credits	16													
		Program Student Learning Outcome							ESLO					
Semester	**Course**	1	2	3	4	5	6	7	Com	Team	Ethics	IA	QL	DivP
Junior-Fall	MATH 321	F/P	F/P	F/P	P				P	P				
	SPE 321								P	P				
	Focused Elective		F											

	Elective (Upper Div)													
Total Credits	14													
Junior-Winter	MATH 311	P			C		C	P						
	WRI 227								P					
	Focused Elective	P	P	P	P	P								
	Elective (Upper Div)													
	Elective													
Total Credits	16													
Junior-Spring	MATH 322									P				
	MATH 451	P	P	P	P	P								
	Focused Elective	P	P	P	P	P								
	MATH/PHY Elec UD	P	P	P	P	P								
	Elective													
Total Credits	16													
		Program Student Learning Outcome							**ESLO**					
Semester	**Course**	1	2	3	4	5	6	7	Com	Team	Ethics	IA	QL	DivP
Senior-Fall	MATH 421	C	C	C	C	P	P	C						
	Focused Elective	P	P	P	P	P								
	MATH/PHY Elec UD	P	P	P	P	P								
	Elective													
Total Credits	15													
Senior-Winter	MATH CORE UD	C	C	C	C	C	C	C						
	Focused Elective	P	P	P	P	P								
	Social Science Elective													P
	Elective													
	Elective													
Total Credits	16													
Senior-Spring	MATH CORE UD	C	C	C	C	C	C	C						
	WRI 327 -0r- WRI 350								P					
	Elective													
	Elective													
Total Credits	16													
Total Program	180 - 184													

Key: F = Foundation, P = Practicing, C = Capstone

Section 4– 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	**'20-21**	**'21-22**	**'22-23**
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**		

Applied Mathematics B.S. Cycle for PSLOs and ESLO's			
Outcome	2020/2021	2021/2022	2022/2023
PSLO 1	Act	Plan	Assess
PSLO 2	Plan	Assess	Act
PSLO 3	Assess	Act	Plan
PSLO 4	Plan	Assess	Act
PSLO 5	Act	Plan	Assess
PSLO 6	Assess	Act	Plan
PSLO 7	Assess	Act	Plan
ISLO: Communication	Plan	Assess	Act
ISLO: Teamwork	Plan	Assess	Act
ISLO: Ethical Reasoning	Plan	Assess	Act
ISLO: Inquiry & Analysis	Assess	Act	Plan
ISLO: Quantitative Lit	Assess	Act	Plan
ISLO: Diverse Perspectives	Act	Plan	Assess

ISLO	PSLO	2021-2022	2022-2023	2023-2024
Quantitative Literacy	**PSLO1**		Math 354 Math 322	
	PSLO2	Math 321		
	PSLO3			TBD
	PSLO5		M452	
Communication	**PSLO3**			
	PSLO4	Math 311		
	PSLO6			TBD
Inquiry and Analysis	**PSLO7**			TBD
Diversity				
Teamwork				
Ethics				

Section 5– Assessment Data Collection Process 2021-22

Assessment of two student learning outcomes was conducted during this academic year (Outcomes 2,4). A combined rate of proficiency and high proficiency of at least 70% is considered a minimum acceptable performance. We used three direct measures for each outcome and one indirect measure. We had planned to also include an additional indirect measure for each outcome by using the student exit survey, however, since the response rate was only one student, we decided to omit this data as it was deemed statistically insignificant.

Section 6 – Assessment Data

Outcome 2: *Apply mathematics to solve problem*s was assessed in Math 322, in the Spring of 2022. The instructor was Dr. Cristina Negoita. There were three criteria assessed.

a) Write a "well-posed" problem based on content studied in the course.

b) Correctly solve problem posed in (a), showing all appropriate steps/computations.

c) State conclusion.

The criteria were measured by performance on an assignment (Assignment 3, worth 5% of the student's grade). The Assignment was worded as follows:

> For this assignment, create one short video (no longer than 20min or so) focused on one problem/topic we discussed in our course.
>
> The topic should be one you are confident talking about - so you can either explain a theorem or an application, or solve a particular problem (like you might do if you were tutoring someone on this material).

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 7 math majors enrolled in Math 322 this term, though two did not attempt this assignment. This assessment looks at the performance of the remaining 5 majors.

As noted above, the Assignment was rather open-ended, yet students were instructed to completely formulate their own problem, with all the necessary information to make the problem "solvable". Three of the students proposed and formulated a problem in which they would solve a second order differential equation with appropriate initial conditions using Laplace transforms. One student proposed and presented the derivation of the 3D heat equation (where as in class we looked at solutions of the 2D heat equation in relation to the convolution operation). One student used Matlab (implemented his own code as part of the solution presented) to solve differential equations using Laplace transforms.

To assess criterion (a) the instructor looked at the formulation of the problem by each student. In particular, was the problem clearly stated, with proper directions as to what was to be accomplished; were initial conditions provided, and were the IC appropriate for the given differential equation (first order vs second order).

To assess criterion (b) the instructor used student performance in showing the solution to the proposed problem.

Nearly every student who chose to solve an IVP using Laplace transforms were able to show the implementation of the transform, using properties of the transform, and also use the inverse transform to finally reach a solution in time-domain.

To assess criterion (c) the instructor used student conclusions stated in the final solution.

Student Performance

	Student Performance		
Criterion	Some/no proficiency	Proficient	High Proficiency
Problem description (a)	0%	20%	80%
Correct Solution (b)	0%	20%	80%
Conclusion (c)	0%	20%	80%

Three of the students did quite well on all criteria. One of the students who worked on implementing Matlab code as part of the solution via Laplace transform stumbled on criterion (b) mainly due to their poor ability to implement code "on the fly". As this was to be presented in video format (no longer than 15 – 20 min) the student wasted time and was unable to finish the problem as expected (their ability to form a proper conclusion, criterion (c), also suffered). In addition, the student who opted to show a derivation for the 3D heat equation showed less proficiency in the statement of the problem (criterion (a)).

Outcome 4: *Communicate Mathematical Knowledge and Understanding*, Math 311 during Winter 2021. The instructor was Dr. Randall Paul. There were five students enrolled in the course (all mathematics majors). One student ceased participating very early in the course, so I have not included them.

Real Analysis is a good course to assess this outcome because it is a formal proof class, rather than a calculation class. Often the result is known from the outset. The challenge is communicating in formal, rigorous, mathematical language why the result is true.

Outcome 4 was assessed using the following criteria:

(a) Ability to present examples and counter-examples of various mathematical statements about sets of real numbers.

This criterion was assessed using problems 1(d) on the first exam, 2(d) on the second exam, and 2(d) on the final exam. Each of these were True/False questions, where the correct answer was False. The instructions on the problem then obliged the student to give a short counterexample, and explain why their counterexample demonstrated that the statement was false. Each problem was worth 1 point. One student got 3 of 3, two students got 2 of 3, and one student got 0 of 3. If we call 2 of 3 correct a ``success", then there was a **75% success rate**.

(b) Ability to present a classic "delta-epsilon" proof of the value of the point-wise limit of a function.

This criterion was assessed using problem 1 on the final exam. The problem was worth 5 points, and the scores were: 5, 4.5, 2.0, and 1.0. If we call 4 points out of 5 a ``success", then there was a **50% success rate on this criterion.**

(c) Course grade.

The course grade was determined by homework problems (usually proofs) presented in class by the students. There were also three in-class exams. Students received one A, two Cs, and one D. If we call a passing grade (C or above) a ``success" then there was a **75% success rate on this criterion**.

The results of this assessment were reasonable, but not compelling. While our success rate was not terrible, several of the ``successes" above were fairly marginal. (e.g. There was only one A and no Bs awarded, and only one student got all three counterexamples). The mathematics department introduced a more proof-oriented Discrete Mathematics course (Math 310) specifically to improve our students' math communication skills, and particularly to improve their performance in Real Analysis. While one shouldn't draw too many conclusions on the results of four students, it does not appear to have helped all that much. It may be that we should address outcome 4 in a less challenging class, particularly given that our degree is ``applied", and our students are mostly trained to calculate. Rather than a formal Real Analysis course, our students might be better served by seeing mathematical communication and proof in the context of an elementary number theory course, or a more straight forward follow-on to our proof-based discrete mathematics course.

Performance Criteria	Assessment Methods	Performance Target	Results	Met?
PSLO2- Apply Mathematics…	Assignments in Classes assessed	At least 70% of students proficient	100% Math 322	Yes
PSLO4- Communicate Mathematics…	Assignments in Classes assessed	At least 70% of students proficient	67%-Math 311	Yes/No
Graduation Rate	University Dashboard	6-year rate >50%	71.4%	Yes
Retention	University Dashboard	1-year rate >75%	50%	No**
Certification	Accreditor's report	1-year >75%	NA	
DFWI	University Dashboard	All program <30%	26.3%	Yes*

* Regarding the DFWI. The DWFI rate for mathematics can be significantly higher than 12% and still be acceptable due to national averages. For example the national DWFI rate for college algebra is around 50% . There is further discussion about the DWFI rate below in Section 7.

** Regarding Retention: See the discussion under action items in Section 7.

Program Headcounts*:

Fall 2016	Fall 2017	Fall 2018	Fall 2019	Fall 2020	Fall 2021		
32	28	35	31	36	21		

* The headcount is often difficult to measure since many students are dual majors and sometimes not counted.

Program Graduates:

2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	
5	7	8	4	7	11	

Adendum:

ISLO Quantitative Literacy: The applied mathematics program requires Math 361 Statistical Methods. Last year Professor Joseph Reid performed a campus-wide assessment of QL by way of assessing student work in the Math 361. The institution report suggests that in general OIT students are performing at a satisfactory level

ISLO: Inquiry & Analysis: The department was not given any information or guidance as to how to assess this ISLO and therefore no data was collected.

Section 7 – Data-driven Action Plans:

The faculty assessed two program student learning outcomes (2,4) during the 2021-22 academic year. The faculty reviewed the results during the fall term 2022 during a faculty meeting and had the following conclusions.

Outcome 2 (Apply Mathematics to Solve Problems): Students met all performance criteria and no further action is required at this time. The student performance was quite good, 80% highly proficient and 100% were at least proficient.

Outcome 4 (Communicate Mathematical Knowledge): The low number of students assessed (4) makes this outcome data difficult to judge. The overall success rate was about 67% which is close but not quite at the departmental established level of 70%.

Changes Resulting From Assessment of PSLOs

Based on our assessment results for the learning outcomes PSLO 2 and 4 no formal changes are deemed necessary of PSLO 2. However, there is some concern that the PSLO 4 on communication of mathematics does not have sufficient data to make a judgement. The department will discuss PSLO 4 further as we work on the changes for our program. For example, we are considering removing Math 311 Intro to Real Analysis with a different, more applied course. The instructor (Dr. Paul) has made a suggestion that we might want to assess our students ability to communicate mathematics in a more applied setting, such as Math 42X or Math 45X.

Changes Resulting From Assessment of ISLOs

While there was no indication of a need for change regarding quantitative literacy, the department recognizes that the Applied Math Program is not fully aligned with the current institutional learning outcomes. Specifically we recognize a deficiency in the areas of Teamwork, Ethics and Diverse perspectives. Throughout this year, the department will be working on a significant overhaul of the applied math program where we will address these deficiencies. For example , we will discuss the need for requiring some additional coursework in the areas of Ethics and Diversity.

Changes Resulting From Assessment Enrollment and Retention

The applied math program enrollment has been rather consistent for the past 10 years at around 30 to 45 majors. While this number may seem low, it is consistent with the national average of about 1 to 2% of total university enrollment. However, this past year we saw a considerable drop in the number of majors; the drop was from 36 to 21 students (see table above). This is the reason for the 50% retention number in the table from Section 6. The department has met to discuss what we can do to improve these enrollment numbers. Throughout this academic year the department will be working on a significant overhaul of the math program. For example, we are considering moving away from the current "Focused Elective" model and possibly replacing this with an Applied Mathematics Major with a number of more specific options or tracks. Initial discussions indicate that we feel such a change would help with recruitment and retention of new majors.

Changes Resulting From Assessment of DWFI

It is difficult to assess DWFI rate for all math majors as many of our courses only have 1 or 2 math students enrolled. When computing the overall DWFI for our Math Majors, we chose to look at the Junior and Senior level courses for which only Math majors enroll. For this last year we chose to consider Math 310, 311, 322, 421, 452, 453. The overall DWFI rate is 26.3% . However, when Math 311 is removed, the DWFI rate drops to 19.2%, an acceptable DWFI rate for Mathematics. This year we will be looking at significant changes to the Math program. One of the changes could be the removal of the abstract course Math 311 Intro to Real Analysis and replacing it with a more applied course such as Introduction to Complex Analysis.

Summary of possible changes resulting from Assessment

- Retention: Work on new structure for the program, one that includes options or tracks.
- DWFI: Replace the Math 311 Intro to Real Analysis with a more applied course.
- PLSO 4 : Assess students communication skills in a more applied course.
- Deficiency in Program aligning with the OIT ISLOs:
  (1) Consider requiring a course such as "Ethics in the Professions" to help with assessing the ISLO on Ethics
  (2) Consider offering a History of Mathematics Course to help with assessing the ISLO on Diverse Perspectives.

Section 8 – Closing the Loop: Reflection on previous work

Based on our assessment activities last year, we found no actions were necessary and therefore there are no closing the loop items to discuss.