Mathematics Program Assessment Plan

University of Alaska Southeast

Permanent Program Faculty

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Contents

1 – Introductory Comments

This assessment plan will continue to be refined and/or revised as needed to best fit the needs of the UAS Mathematics Program as well as serve as a resource for Annual Program Assessment and five-year Program Reviews as per the Board of Regent's and UAS Program Review Policy 10.06.01A.

The majority of mathematics departments/programs in US colleges and universities implement assessment practices and curriculum designs based on the research and recommendation of the Mathematics Association of America (MAA), the American Mathematical Society (AMS), American Statistical Association (ASA), and affiliated committees. The advice given in reports compiled by such committees stress designing assessment plans around the needs of the program in question. References and resources for this plan include relevant publications of, and activities organized by the MAA, the AMS, and the ASA.

Assessment of the UAS Mathematics B.S. degree program follows guidelines set forth in the *CUPM Curriculum Guide, 2015,* published by the *MAA Committee on the Undergraduate Program in Mathematics*. Revisions of the Mathematics Program Assessment Plan, when made, will follow recommendations that arise from Program Reviews, or those that are provided in relevant publications of the MAA, AMS and ASA.

The current plan contains refinements pertaining to continued data collection efforts and outcomes assessment of student learning. These refinements are in response to observations from annual assessment reports through the 2014 academic year and requests made by the Dean of Arts and Sciences.

2 – Assessment Cycle

The Mathematics Program assessment cycle consists of *Annual Assessment Reports* and Board of Regents (BoR) required *Program Reviews*.

Annual Assessment Reports are prepared each academic year based on pro-active and ongoing discussions among program faculty, focused on Program Learning Outcomes (PLOs), and may include additional material where applicable. Among other material, these reports may include:

a. Summary of Program Learning Outcomes assessment for the B.S. Mathematics Program;

b. Summary of activities and proposals concerning student assessment in lower level mathematics coursework;

c. Data on Mathematics Program Performance as indicated in Section 4.3 below;

d. Observations on current trends and areas of possible concern;

e. Recommendations and/or proposals agreed upon by the Mathematics Program faculty with justifications;

f. Implementation time-line of proposed changes, if applicable; and

g. Observations concerning the status and effectiveness of recent changes implemented as described in earlier annual reports.

Program Reviews, as per Board of Regent's Policy, are performed according to the timeline established by the UAS Provost's Office. Annual reports and UAS IR data will serve as resources for BoR required Program Reviews.

2.1 – Annual Timeline

Spring semester – Math Program Assessment Coordinator assembles Individual Record File for each graduating mathematics major.

Early May – Permanent Juneau program faculty meet to evaluate each Individual Record File.

Last week of Spring/First week of Fall Contract – Math Program Assessment Coordinator aggregates and summarizes data from the evaluations and proposes revisions to program and/or courses to improve student learning performance.

Fall Convocation – Math program faculty discuss the data and any potential program revisions at convocation meetings.

Fall Semester – Program faculty continue to deliberate potential revisions to program and/or courses. Deliberations and proposals include prioritization of changes and alignment with resource allocation (i.e., workload) requests. Decisions are finalized by end of the fall semester.

February 1 – Math Program Assessment Coordinator distributes a draft Annual Assessment Report to the math program faculty for discussion and approval.

March 1 – Assessment Report due to the Dean's Office.

April 1 – Assessment Report due to the Provost's Office. (Cycle repeats.)

September – All Program Assessments in the School of Arts & Sciences from previous "cycle" are presented and discussed at the Arts & Sciences Dean's Council.

3 – Assessment of GER and Service Courses

General Education Requirements (GER) and Service courses offered by the UAS Mathematics Program include:

a. Developmental courses such as MATH S054, S055 and S105 (Note that MATH S105 is a GER for applied associate (AAS) degrees at UAS).

b. Bachelor's degree GER courses such as MATH S151, MATH S113, and STAT S107.

c. Service courses[1] for degrees in other disciplines, including MATH S152, S251, S252, STAT S273, STAT S400, and STAT S401.

The relevance of course content, the coordination of multi-section courses, student abilities and preparedness, as well as *student assessment tools and practices (as defined in course syllabi)* are discussed by the mathematics program faculty at the end of each semester after final examinations have been graded in preparation of upcoming semesters.

The mathematics program faculty may also conduct periodic evaluations of how these courses compare to similar courses offered at other institutions and how they contribute toward the relevant outcomes in *the Common UA General Education Student Learning Outcomes (Faculty Alliance Report, May, 2015)* discussed in Section 3.2.

3.1 – Consistency of GER and Service Courses

MATH S055 through MATH S152 as well as STAT S107 and STAT S273 are offered through all three UAS campuses, and since there are typically two or more sections of these courses offered each semester, the Mathematics Program has established some *consistency practices* to ensure course uniformity over time, and across campuses and sections of these courses.

Practice 1: During the 2006, 2007 and 2008 academic years Program faculty prepared and agreed upon "Course Guidelines" for local and distance delivered sections of the above listed courses. These guidelines are available to all full-time faculty, and part-time faculty through their respective full-time faculty supervisor.

Practice 2: At the Juneau campus, for each semester each multi-section MATH S054 – MATH S151 course is assigned a course coordinator. The coordinator's duties include arranging and moderating meetings for midterm exams as well as preparing the Juneau campus final exam for the course and semester in question.

Practice 3: At the Juneau campus, MATH S151 sections also have a course coordinator. However, the final exam is prepared by a Juneau faculty member who is not teaching a MATH S151 section during the semester in question to ensure unbiased examinations.

Practice 4: The Juneau campus typically shares final exams for MATH S151 with Ketchikan and Sitka faculty who are teaching MATH S151 during the semester in question. An effort is also made to share midterm and final exams for the remaining

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[1] Of these courses, MATH S251, MATH S252 and STAT S273 are Mathematics B.S. degree core requirements, and STAT S400 and STAT S401 are Mathematics B.S. degree electives.

mathematics courses, but this is mainly at the request of Ketchikan and Sitka faculty.

Practice 5: Coleen Ianuzzi of Ketchikan and Joseph Liddle of Sitka serve as mentors/supervisors for part-time instructors who teach out of Ketchikan or Sitka, respectively. Juneau course coordinators and the Program Coordinator serve as mentors/supervisors for Juneau part-time instructors.

All program course guidelines are posted in an "electronic" file cabinet on UASOnline. All full-time and regular part-time mathematics faculty members have access to this "file cabinet" and may refer to the contents as needed.

Consistency among other service courses is currently maintained through fairly regular consultations among faculty.

3.2 – Learning Outcomes

The Northwest Commission on Colleges and Universities (NWCCU) accreditation standard 2.C.2 requires that

> The institution identifies and publishes expected course, program, and degree learning outcomes. Expected student learning outcomes for courses, wherever offered and however delivered, are provided in written form to enrolled students.

Consequently, we have published student learning outcomes (SLOs) for each mathematics and statistics course offered. The SLOs for each course are found in Appendices 5.3 and 5.4. Program Learning Outcomes (PLOs) for the B.S. mathematics program are itemized and discussed in Section 4.1.

PLOs for the General Educational component of UAS' undergraduate degree program as required by NWCCU accreditation standard 2.C.10 do not exist at UAS. However, in a report from UA Faculty Alliance dated May, 2015, there is acknowledgment that the Faculty Senates of UAA, UAF, and UAS have endorsed "guiding principles" for GER learning outcomes.

All baccalaureate graduates in the University of Alaska system shall achieve the following student learning objectives (*italics added*):

1. **Build Knowledge of Human Institutions, Socio-Cultural Processes, and the Physical and Natural World** through study of the natural and social sciences, *mathematics*, humanities, and the arts.
2. **Develop Intellectual and Practical Skills** across the curriculum, including inquiry and analysis, *quantitative literacy*, critical and creative thinking, *problem solving*, written and oral communication, information literacy, and collaborative learning.
3. **Acquire Tools for Effective Civic Engagement** in local through global contexts, including ethical reasoning and intercultural competence with particular emphasis on Alaska and the circumpolar north.
4. **Integrate and *Apply Learning*,** including to *synthesize knowledge and skills* across general and specialized studies, *adapting them to new settings*, questions, and responsibilities, and forming a foundation for lifelong learning.

The BoR Regulation 10.04.040 specifies that at least three credits in mathematics (or statistics) is sufficient to provide the requisite quantitative skills. The mathematics faculty emphasizes depth of knowledge over breath focusing on quantitative problem solving and application in our GER courses.

3.3 – Assessment of Student Learning

3.3.1 – College Algebra – MATH S151

College Algebra is the GER math course taken by the majority of UAS students. It is also an important prerequisite to many subsequent mathematics and statistics courses. As mentioned in Section 3.1, this course is closely coordinated and monitored for consistency in content and rigor.

On the Juneau campus, there are routinely multiple sections of MATH S151 offered each semester. The instructors collaborate on course policies, course pacing, mid-term exams, and the final exam. Grading policies are identical and each mid-term exam is equivalent in length, content and difficulty among the sections.

All (Juneau) students take the same final exam (prepared by a Juneau faculty member not currently teaching the course) at the same time. Typically, the final exam has 12 questions; these questions are formulated with the course learning outcomes in mind and with an emphasis on problem solving over rote, mechanical manipulation. This final exam is group graded by all Juneau mathematics faculty members after agreement on the grading rubric and discussion of partial credit scenarios. Each faculty member grades two or three questions chosen by random draw. This further ensures consistency in grading among the papers. The assessment coordinator keeps longitudinal data on number of students taking the exam, the mean score, the median score, and the standard deviation. Careful attention to these data over time assists in maintaining consistent course expectations and allows for analysis of trends in student performance.

3.3.2 – Contemporary Concepts and Applications of Mathematics – MATH S113

This GER course was designed for students pursuing BA degrees in fields that do not require subsequent mathematics or statistics courses. For many liberal arts and social science students, this is the math GER that is most applicable to their primary fields of study. It will not, however, satisfy any prerequisite for subsequent mathematics or statistics courses. The student learning outcomes for this course (when offered) are assessed at the individual section level.

3.3.3 – Survey of Statistics – STAT S107

Survey of Statistics is another GER option for students not pursuing further study in mathematics or statistics. This course emphasizes statistical literacy, assuming the student will be a "consumer" of statistical information instead of a "creator" of statistical reports. It does not satisfy any prerequisite for subsequent mathematics or statistics courses. The student learning outcomes for this course (when offered) are assessed at the individual section level.

4 – Assessment of Mathematics Major

4.1 – Program Learning Outcomes

The following program learning outcomes have been identified by the Mathematics Program faculty as being relevant to measuring the potential success of UAS mathematics Bachelor of Science graduates in the workforce or in academics.

Outcome 1: Competency in Core Subject Content

1A. Graduates will demonstrate skills in basic quantitative and analytic problem solving and competency in basic undergraduate mathematics coursework.

1B. Graduates will demonstrate knowledge of foundational theoretical concepts essential to the study of mathematics.

1C. Graduates will demonstrate an ability to extend and generalize foundational concepts and critically analyze and solve abstract problems in mathematics.

Outcome 2: Skills in Analysis, Application, and Technology Utilization

2A. Graduates will demonstrate the ability to use technology as an aid to understanding and solving mathematical problems.

2B. Graduates will demonstrate the ability to apply mathematical knowledge in new settings and situations.

2C. Graduates will demonstrate the ability to critically analyze and solve a wide variety of problems using theoretical or technological tools.

Outcome 3: Communication Skills

3A. Graduates will demonstrate the ability to read and comprehend mathematical ideas.

3B. Graduates will demonstrate the ability to communicate mathematical ideas in writing.

3C. Graduates will demonstrate the ability to communicate mathematical ideas verbally.

Outcome 4: Professionalism and Independence

4A. Graduates will produce a resume highlighting marketable mathematical skills and knowledge.

4B. Graduates will demonstrate confidence in communicating mathematical ideas verbally and in writing.

4C. Graduates will demonstrate the ability to independently pursue investigations in the mathematical sciences.

4.2 – Assessment Process

Qualitative and quantitative data are obtained from a variety of sources and organized by the Mathematics Program Assessment Coordinator into an Individual Record File for each math major. The permanent Juneau faculty members meet each spring (in early May) to review and evaluate each file according to the rubric in Section 4.2.7. Use of this rubric will enable the Assessment Coordinator to aggregate and summarize student data with respect to PLOs for presentation and discussion at the following fall commencement program meeting. The Assessment Coordinator (or any permanent program faculty member) may make suggestions for program revisions based on these data. The program faculty will consider and deliberate suggested revisions during the fall semester and make decisions about implementing them prior

to the spring term.. By February 1, the Assessment Coordinator will share with program faculty a draft of the annual Assessment Report for discussion and approval. The Annual Assessment Report is due to the Dean by March 1 and to the Provost's Office by April 1.

4.2.1– Assessment Timeline

Spring semester – Math Program Assessment Coordinator assembles Individual Record File for each graduating mathematics major.

Early May – Permanent Juneau program faculty meet to evaluate each Individual Record File.

Last week of Spring/First week of Fall Contract – Math Program Assessment Coordinator aggregates and summarizes data from the evaluations and proposes revisions to program and/or courses to improve student learning performance.

Fall Convocation – Math program faculty discuss the data and any potential program revisions at convocation meetings.

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September – All Program Assessments in the School of Arts & Sciences from previous "cycle" are presented and discussed at the Arts & Sciences Dean's Council.

4.2.2 – Entry into Mathematics Major

Upon entry into the mathematics major, each student meets with the Math Program Coordinator. At this meeting, the Program Coordinator explains the design of the degree program, its goals, and its requirements. As a result of previous program recommendations, particular emphasis is placed on the capstone requirements of a research paper and seminar presentation. The program coordinator assigns a faculty advisor to the student after this consultation.

Qualitative data obtained from entry interviews of incoming majors include:

- Date of entry in the program, advisor assigned, and entry classification (high school, mathematics degree track/option, change of major/double major, or transfer).

- Intent (plans to complete B.S. degree at UAS, or plans to transfer to another school).

- Gender, ethnicity and place of origin.

  The program coordinator keeps a tracking spreadsheet with this data as well as the date of degree completion or date of discontinued progress toward the B.S. Mathematics degree.

4.2.3 – Mid-Point Survey

The following survey will be administered to mathematics majors midway through the curriculum near the end of the Introduction to Mathematical Proofs course (MATH S265). This survey focuses on student perception and satisfaction. Program faculty have opportunity to respond to identified weaknesses during the students' upper division coursework.

I.   Please indicate your current level of satisfaction with the Mathematics Program at UAS.

Area of satisfaction	Extremely unsatisfied	Somewhat unsatisfied	Neutral	Somewhat satisfied	Extremely satisfied
	1	2	3	4	5
1. Overall satisfaction with the education you are receiving in the math program					
2. Overall satisfaction with your interaction with mathematics faculty					
3. Overall satisfaction with your interaction with other math students					
4. Overall satisfaction with your interaction with your academic advisor					

II.   Please discuss your current level of satisfaction with your curriculum in the Mathematics Program.
1. What attracted you to the UAS mathematics program?
2. What do you perceive as strengths in the mathematics program?
3. What do you perceive as weaknesses in the mathematics program?
4. Are there any changes or additions to the mathematics program that would enhance your educational experience? Is there any mathematical content that you wish you had seen that you haven't yet seen?
5. Would you recommend the UAS math program to a friend? Why or why not?

III.   How well prepared do you feel at this point in the following areas?

Program Learning Outcome	Very poorly prepared	Somewhat unprepared	Neutral	Somewhat prepared	Very well prepared
	1	2	3	4	5
1A. Demonstrate skills in basic quantitative and analytic problem solving and competency in basic undergraduate mathematics coursework					
1B. Demonstrate knowledge of foundational theoretical concepts essential to the study of mathematics					
1C. Demonstrate an ability to extend and generalize foundational concepts and critically analyze and solve abstract problems in mathematics					
2A. Demonstrate the ability to use technology as an aid to understanding and solving mathematical problems					
2B. Demonstrate the ability to apply mathematical knowledge in new settings and situations					
2C. Demonstrate the ability to critically analyze and solve a wide variety of problems using theoretical or technological tools					

4.2.4 – Exit Interview/Survey of Majors

Qualitative data obtained from exit interviews of graduating majors include responses to the following questions focused on post-graduation plans, satisfaction with the program, and perceptions of preparedness.

I. Indicate your post-graduation future plans.

Future Plans	Yes	No
1. I will be attending graduate school on a full-time basis.		
2. I will be attending graduate school part-time after graduation.		
3. I have a full-time military obligation after graduation.		
4. I have joined the Peace Corps, Teach for American or similar organization.		
5. I have accepted full-time employment after graduation.		
6. I have an offer of employment that I plan to accept.		
7. I expect to receive an offer of full-time employment shortly.		
8. I am/will be searching for full-time employment.		
9. I will be working part-time after graduation.		
10. I expect to receive an offer of part-time employment shortly.		
11. I have other plans not listed here.		

II. Details of post-graduation plans
1. Information about full-time employment
   a. Employer:
   b. Location of Employer:
   c. Job title:
   d. Base salary:
2. Information about graduate school
   a. College/University:
   b. Location of graduate school:
   c. Intended graduate degree:
   d. Intended graduate major:
3. Information about other plans
   a. If you have a military obligation, which branch are you joining?
   b. If you have joined a service organization, which organization?
   c. If you have "other" plans not listed, please elaborate on your plans.
   d. If you have additional comments on your future plans, list them here.

III. Please indicate your current level of satisfaction with the Math Program at UAS.

Area of satisfaction	Extremely unsatisfied	Somewhat unsatisfied	Neutral	Somewhat satisfied	Extremely satisfied
	1	2	3	4	5
1. Overall satisfaction with the education you are receiving in the math program					
2. Overall satisfaction with your interaction with mathematics faculty					
3. Overall satisfaction with your interaction with other math students					
4. Overall satisfaction with your interaction with your academic advisor					

IV. Please discuss your current level of satisfaction with your curriculum in the Mathematics Program.
1. What attracted you to the UAS mathematics program?
2. What do you perceive as strengths in the mathematics program?
3. What do you perceive as weaknesses in the mathematics program?
4. Are there any changes or additions to the mathematics program that you feel would enhance students' educational experience?
5. Would you recommend the UAS math program to a friend? Why or why not?

V. How well prepared do you feel in the following areas?

Program Learning Outcome	Very poorly prepared	Somewhat unprepared	Neutral	Somewhat prepared	Very well prepared
	1	2	3	4	5
1A. Demonstrate skills in basic quantitative and analytic problem solving and competency in basic undergraduate mathematics coursework					
1B. Demonstrate knowledge of foundational theoretical concepts essential to the study of mathematics					
1C. Demonstrate an ability to extend and generalize foundational concepts and critically analyze and solve abstract problems in mathematics					
2A. Demonstrate the ability to use technology as an aid to understanding and solving mathematical problems					
2B. Demonstrate the ability to apply mathematical knowledge in new settings and situations					
2C. Demonstrate the ability to critically analyze and solve a wide variety of problems using theoretical or technological tools					
3A. Demonstrate the ability to read and comprehend mathematical ideas					
3B. Demonstrate the ability to communicate mathematical ideas in writing					
3C. Demonstrate the ability to communicate mathematical ideas verbally					
4A. Produce a resume highlighting marketable mathematical skills and knowledge					
4B. Demonstrate confidence in communicating mathematical ideas verbally and in writing					
4C. Demonstrate the ability to independently pursue investigations in the mathematical sciences					

VI. Permanent Contact Information
a. Name:
b. Address:
c. Phone number:
d. Email:

4.2.5 – Post-Graduate Survey of Majors

Qualitative data obtained from post-graduation interviews of recent graduates include responses to the following questions:

1. Was the UAS mathematics program effective in preparing you for your current position?

2. What do you perceive as being the main strengths and weaknesses of the UAS mathematics program?

3. Are there any changes you might recommend to the UAS mathematics program which could have helped prepare you better for your current position?

4. Would you still recommend the UAS mathematics program to a friend?

4.2.6 –Student Individual Record File

The Mathematics Program Assessment Coordinator will compile a Student Individual Record (SIR) file on each student in the mathematics program. The SIR components are listed below and will be used to assess level of student proficiency on the PLOs. The rubric for evaluation of the SIR file is given in Section 4.2.7 below.

1. Resume
2. Degree audit
3. Final transcript
4. Final capstone seminar paper
5. Summary scorecard for the final capstone presentation
6. First seminar paper and presentation scorecard
7. Exit Survey
8. Proficiency matrix for PLO competency
9. Permanent contact information
10. Post-graduate surveys, if applicable

4.2.7 – Evaluation of the Student Individual Record

The permanent Juneau faculty members meet each spring (in early May) to review and evaluate the SIR file for each graduating mathematics major according to the rubric given below. Use of this rubric will enable the Assessment Coordinator to aggregate and summarize student data with respect to PLOs for presentation and discussion at the following fall commencement program meeting.

Outcome	Does Not Meet Expectations		Meets Expectations		Exceeds Expectations	
	1	2	3	4	5	6
PLO 1: Competency in Core Subject Content						
1A. Graduates will demonstrate skills in basic quantitative and analytic problem solving and competency in basic undergraduate mathematics coursework.						
1B. Graduates will demonstrate knowledge of foundational theoretical concepts essential to the study of mathematics.						
1C. Graduates will demonstrate an ability to extend and generalize foundational concepts and critically analyze and solve abstract problems in mathematics.						
PLO 2: Skills in Analysis, Application, and Technology Utilization						
2A. Graduates will demonstrate the ability to use technology as an aid to understanding and solving mathematical problems.						
2B. Graduates will demonstrate the ability to apply mathematical knowledge in new settings and situations.						
2C. Graduates will demonstrate the ability to critically analyze and solve a wide variety of problems using theoretical or technological tools.						
PLO 3: Communication Skills						
3A. Graduates will demonstrate the ability to read and comprehend mathematical ideas.						
3B. Graduates will demonstrate the ability to communicate mathematical ideas in writing.						
3C. Graduates will demonstrate the ability to communicate mathematical ideas verbally.						
PLO 4: Professionalism and Independence						
4A. Graduates will produce a resume highlighting marketable mathematical skills and knowledge.						
4B. Graduates will demonstrate confidence in communicating mathematical ideas verbally and in writing.						
4C. Graduates will demonstrate the ability to independently pursue investigations in the mathematical sciences.						

4.3 – Program Performance

Annual program performance measures are collected and analyzed as indicators of program viability and program validity, as well as to assess the appropriateness and feasibility of course offerings and resource allocation.

The effective recruitment of new majors and minors and timely graduation of enrolled mathematics majors and minors suggests an attractive and healthy program. The teaching effectiveness of the faculty is a function of the workload under which they operate. The UAS Mathematics Program is exclusively staffed by bipartite faculty members; duties include teaching and service. Institutional data is used to determine enrollment trends as well as faculty teaching loads.

4.3.1 Course Enrollment Data

Enrollment summaries for all courses offered by the UAS Mathematics Program are compiled by semester (Summer, Fall and Spring), academic year, campus (Juneau, Sitka and Ketchikan), and program overall totals. The following data will be collected and presented.

a. Enrollment Headcount (course, campus, delivery mode, and faculty type)
b. Student Credit Hours generated (by course, campus, and delivery mode)
c. Average class size (by campus, division, delivery mode)
d. Student/faculty ratio (by campus, division, delivery mode)
e. Grade distribution (by course, campus, and delivery mode)

4.3.2 Faculty Productivity in Student Credit Hours

The teaching effectiveness of the faculty is a function of the workload under which they operate. The UAS Mathematics Program is exclusively staffed by bipartite faculty members; duties include teaching and service. Institutional data is used to determine enrollment trends as well as to inform faculty teaching loads.

Student Credit Hours generated (by faculty, by division, by semester)

4.3.3. Numbers of Active Majors, Graduates, and Grade-point-averages

The effective recruitment of new majors and minors and timely graduation of enrolled mathematics majors and minors suggests an attractive and healthy program. The following data will be collected and summarized by academic year.

a. Number of graduates
b. Average graduate grade-point-average
c. Average time to completion from program entry
d. Number of active majors

5 – Appendices

5.1 – Program Learning Outcomes for B.S. Degree in Mathematics

PLO 1: **Competency in Core Subject Content**	**1A.** Graduates will demonstrate skills in basic quantitative and analytic problem solving and competency in basic undergraduate mathematics coursework. **1B.** Graduates will demonstrate knowledge of foundational theoretical concepts essential to the study of mathematics. **1C.** Graduates will demonstrate an ability to extend and generalize foundational concepts and critically analyze and solve abstract problems in mathematics.
PLO 2: **Skills in Analysis, Application, and Technology Utilization**	**2A.** Graduates will demonstrate the ability to use technology as an aid to understanding and solving mathematical problems. **2B.** Graduates will demonstrate the ability to apply mathematical knowledge in new settings and situations. **2C.** Graduates will demonstrate the ability to critically analyze and solve a wide variety of problems using theoretical or technological tools.
PLO 3: **Communication Skills**	**3A.** Graduates will demonstrate the ability to read and comprehend mathematical ideas. **3B.** Graduates will demonstrate the ability to communicate mathematical ideas in writing. **3C.** Graduates will demonstrate the ability to communicate mathematical ideas verbally.
PLO 4: **Professionalism and Independence**	**4A.** Graduates will produce a resume highlighting marketable mathematical skills and knowledge. **4B.** Graduates will demonstrate confidence in communicating mathematical ideas verbally and in writing. **4C.** Graduates will demonstrate the ability to independently pursue investigations in the mathematical sciences.

5.2 – Curricular Map for PLOs for B.S. Degree in Mathematics

Courses	General Education Requirements				Core Math Requirements									Electives								Required Capstone	
	Written Communication Skills	Communication GER	Humanities/Social Science GERs	Math/Science GERs	STAT S273: Elementary Statistics	MATH S251: Calculus I	MATH S252: Calculus II	MATH S253: Calculus III	MATH S265: Introduction to Mathematical Proofs	MATH S302: Differential Equations	MATH S314: Linear Algebra	MATH S311: Modern Algebra	MATH S324: Advanced Calculus	MATH S305: Geometry	MATH S411: History of Mathematics	MATH S460: Mathematical Modeling	STAT S400: Statistical Computing with R	STAT S401: Regression and Analysis of Variance	STAT S373: Probability and Statistics	MATH S410: Complex Variables	Accepted upper division electives in other disciplines of applied sciences	MATH S392: Junior Seminar	MATH S492: Senior Seminar
Outcome 1A				X	X	X	X	X	X	X	X	X	X	X		X		X	X	X			
Outcome 1B						X	X		X		X	X	X	X		X		X	X	X			
Outcome 1C									X			X	X	X					X			X	X
Outcome 2A				X	X	X	X	X		X	X			X		X	X	X			X		
Outcome 2B				X	X	X	X	X			X			X		X	X	X	X	X	X	X	X
Outcome 2C					X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X
Outcome 3A									X	X	X	X	X	X	X	X	X	X	X	X		X	X
Outcome 3B	X								X	X	X	X	X	X	X	X	X	X	X	X		X	X
Outcome 3C		X							X		X				X	X		X				X	X
Outcome 4A																						X	X
Outcome 4B	X	X												X		X		X				X	X
Outcome 4C														X		X		X				X	X

5.3 – Course Level Student Learning Outcomes for Mathematics Courses

5.3.1 – MATH S054 – Prealgebra
Upon successful completion of this course, students will be able to:
1. Understand and manipulate integers, decimals and fractions.
2. Understand and apply graphical and proportional data.
3. Calculate perimeters, areas and volumes of basic geometric shapes.
4. Simplify and evaluate basic algebraic expressions and equations.

5.3.2 – MATH S055 – Elementary Algebra
Upon successful completion of this course, students will be able to:
1. Evaluate, factor and simplify algebraic, rational and absolute value expressions.
2. Solve, graph and interpret linear equations and inequalities.
3. Solve and interpret quadratic and rational equations.
4. Solve applications of linear, quadratic and rational equations.

5.3.3 – MATH S105 – Intermediate Algebra
Upon successful completion of this course, students will be able to:
1. Combine, compose, evaluate and graph functions and inverse functions.
2. Demonstrate graphical competency for linear, quadratic, absolute value and square root functions.
3. Graph and interpret exponential and logarithmic functions 4. Solve applied problems using appropriate algebraic techniques.

5.3.4 – MATH S113 – Concepts and Contemporary Applications of Mathematics
Upon successful completion of this course, students will be able to:
1. Describe, use and compare a variety of voting methods, including analysis of weighted voting systems.
2. Describe and use a variety of methods for fair division and apportionment.
3. Use algorithms to solve scheduling and travelling salesman problems; applications of Euler circuits, Hamilton circuits and minimum spanning trees.
4. Identify and describe a variety of basic sampling methods and sampling concepts.
5. Calculate and interpret descriptive statistics and basic probabilities.

5.3.5 – MATH S151 – College Algebra for Calculus
Upon successful completion of this course, students will be able to:
1. Apply rules and properties of real numbers to the evaluation and/or simplification of polynomial and rational expressions and expressions involving rational exponents, radicals, and absolute values.
2. Solve equations and inequalities in one variable involving polynomial and rational expressions and expressions involving radicals, exponential functions, logarithmic functions, and absolute values.
3. Write mathematics using proper notation and terminology.
4. Solve problems by modeling with equations and functions.

5.3.6 – MATH S152 – Trigonometry

Upon successful completion of this course, students will be able to:

1. Describe the properties and graphs of trigonometric functions.
2. Simplify trigonometric expressions to solve equations and verify identities.
3. Apply trigonometry to solve problems.

5.3.7 – MATH S211 – Mathematics for Elementary School Teachers I

Upon successful completion of this course, students will be able to:

1. Solve open-ended elementary problems involving patterns, sets, rational numbers and basic number theory.
2. Justify the use of our numeration system by comparing it to historical alternatives and other bases.
3. Describe the development of our numeration system and its properties as it expands from the set of natural numbers to the set of rational numbers.
4. Demonstrate and justify standard and alternative algorithms for addition, subtraction, multiplication and division of whole numbers, integers, fractions, and decimals.

5.3.8 – MATH S212 – Mathematics for Elementary School Teachers II

Upon successful completion of this course, students will be able to:

1. Solve open-ended elementary problems involving geometry, measurement, real numbers, probability and statistics.
2. Analyze characteristics, measurements and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.
3. Explain and apply basic concepts of probability.
4. Formulate questions that can be addressed with data as well as collect, organize, and display relevant data to answer them.

5.3.9 – MATH S251 – Calculus I

Upon successful completion of this course, students will be able to:

1. Understand and apply the concept of a limit.
2. Understand and apply the concepts of differentiation and integration, and their relationship as expressed by the Fundamental Theorem of Calculus.
3. Proficiently calculate derivatives, and definite and indefinite integrals by means of substitution.
4. Apply the derivative in modeling settings, such as for graphing, optimization, and related rates problems.

5.3.10 – MATH S252 – Calculus II

Upon successful completion of this course, students will be able to:

1. Compute definite and indefinite integrals using a variety of techniques.
2. Apply integration in modeling settings, drawn from mathematics and the natural and social sciences.
3. Understand and determine convergence of infinite series, including Taylor series.
4. Understand and use parameterizations of curves, including in polar coordinates.

5.3.11 – MATH S253 – Calculus III
Upon successful completion of this course, students will be able to:

1. Calculate and apply multidimensional notions of derivatives, such as partial and directional derivatives, gradients, curl, and divergence.
2. Formulate and solve optimization problems in multidimensional settings, including constrained optimization.
3. Calculate iterated integrals and apply them in modeling settings.
4. Understand and apply integration theorems of vector analysis.

5.3.12 – MATH S265 – Introduction to Mathematical Proofs
Upon successful completion of this course, students will be able to:

1. Apply the logical structure of proofs and work symbolically with connectives and quantifiers to produce logically valid, correct and clear arguments.
2. Perform set operations on finite and infinite collections of sets and appropriately use properties of set operations in problems.
3. Determine equivalence relations on sets and describe the associated equivalence classes.
4. Apply definitions to solve problems and prove conjectures about functions, direct and inverse images and inverse functions.
5. Construct direct and indirect proofs and proofs by induction and determine the appropriateness of each type in a particular setting.
6. Analyze and critique proofs with respect to logic and correctness.
7. Unravel abstract definitions, create intuition-forming examples or counterexamples, and prove conjectures.

5.3.13 – MATH S302 Differential Equations
Upon successful completion of this course, students will be able to:

1. Apply exact and asymptotic methods in solving first and higher order linear and nonlinear differential equations.
2. Analyze the qualitative behavior of solutions for autonomous differential equations using phase portraits; identify equilibrium points and limit cycles.
3. Apply numerical methods to obtain approximate solutions to differential equations.
4. Derive and solve initial value problems that relate to real-world applications.

5.3.14 – MATH S305 Geometry
Upon successful completion of this course, students will be able to:

1. Identify critical elements of a geometric object and describe the relationships between these elements.
2. Utilize spatial visualization and geometric modeling to explore and analyze geometric shapes, structures, and their properties.
3. Use computer technology to explore geometric concepts and verify results.
4. Apply sound mathematical writing and appropriate use of numerical, graphical, and symbolic representations to present solutions of mathematical exercises and applications.

5.3.15 – MATH S311 Modern Algebra
Upon successful completion of this course, students will be able to:
1. Define, recognize, and give examples of different types of algebraic structures.
2. State basic properties of various algebraic structures.
3. Explicitly identify similarities and differences among various algebraic structures and illustrate these similarities and differences with examples.
4. Demonstrate enhanced mathematical maturity by writing coherent proofs of basic properties of various algebraic structures.
5. Articulate the need for an axiomatic treatment of mathematics.

5.3.16 – MATH S314 Linear Algebra
Upon successful completion of this course, students will be able to:
1. Demonstrate proficiency at matrix algebra.
2. Solve systems of linear equations using various techniques.
3. Recognize the concepts of span, linear independence, basis, and dimension, and apply these concepts to various vector spaces and subspaces.
4. Explore linear algebra concepts and applications using technology.
5. Apply sound mathematical writing and appropriate use of numerical, graphical, and symbolic representations to present solutions of mathematical exercises and applications.

5.3.17 – MATH S324 Advanced Calculus
Upon successful completion of this course, students will be able to:
1. Recognize various properties of the real number line.
2. Calculate limits of sequences, functions and sequences of functions.
3. Calculate derivatives and integrals of functions and sequences of functions.
4. Describe the differences and relationships between various types of continuity and convergence.
5. Demonstrate enhanced mathematical maturity by writing coherent proofs of fundamental concepts in mathematical analysis.

5.3.18 – MATH S392 Junior Seminar
Upon successful completion of this course, students will be able to:
1. Apply sound mathematical writing and appropriate use of numerical, graphical, and/or symbolic representations to present solutions of mathematical exercises and applications.
2. Demonstrate an awareness and appreciation of the wide range of fields in mathematics through discussions with peers and instructors inside and outside of the classroom.

5.3.19 – MATH S410 Complex Variables
Upon successful completion of this course, students will be able to:
1. Calculate with complex numbers written in rectangular and exponential form.
2. Evaluate, take limits of, differentiate, integrate, and find Laurent series representations of elementary complex-valued functions of a complex variable.
3. Display mappings of regions in the complex plane by elementary functions.
4. Calculate residues of a function at its isolated singular points and use these residues in applications, such as the evaluation of real definite integrals.

5.3.20 – MATH S411 History of Mathematics

Upon successful completion of this course, students will be able to:

1. Explain and apply methods from antiquity to the nineteenth century.
2. Compare and contrast methods from antiquity to the nineteenth century with current methods used for the same purpose.
3. Research a focused topic/method from the history of mathematics or science and effectively communicate their findings.

5.3.21 – MATH S460 Mathematical Modeling

Upon successful completion of this course, students will be able to:

1. Design and/or develop mathematical models applicable to problems from fundamental principles using existing concepts, theory and methods.
2. Perform qualitative analyses of models using appropriate techniques, and classify solution behaviors resulting from varying assumptions and/or model parameters.
3. Solve models using appropriate exact, asymptotic, or numerical methods, interpret solutions and assess the approximate accuracy of short- and long-term solutions in relation to expected behavior and/or real data.
4. Determine and/or implement modifications to models based on findings from qualitative analyses and/or quantitative solutions.

5.3.22 – MATH S492 – Senior Seminar

Upon successful completion of this course, students will be able to:

1. Demonstrate appropriate competence in speaking and writing mathematics.
2. Research a focused topic from new or advanced material not covered in courses at UAS.
3. Write a formal paper and give a formal presentation of the paper.

5.4 – Course Level Student Learning Outcomes for Statistics Courses

5.4.1 – STAT S107 – Survey of Statistics
Upon successful completion of this course, students will be able to:

1. Distinguish between descriptive and inferential statistics, and between observational and experimental studies.
2. Distinguish between populations and samples, the various types of variables, types of data, and levels of measurement, and the various sampling techniques.
3. Organize data into appropriate frequency distributions.
4. Construct and interpret graphical displays of data, including Pie and Pareto Charts, histograms and boxplots, scatterplots.
5. Compute and interpret measures of central tendency, spread, and position.
6. Distinguish between classical and empirical probability. Use appropriate probability rules to compute and interpret results. Apply counting rules for combinations and permutations.
7. Distinguish between discrete and continuous probability distributions, and apply the central limit theorem as appropriate. Compute and interpret probabilities from binomial, normal, and Student's t-distributions.
8. Compute confidence intervals for population means and proportions. Correctly state hypotheses and apply methods appropriate for single of population means and proportions. Note: The traditional method, or the p-value method, or both may be used.
9. Conduct a simple regression (and correlation) analysis. This includes fitting data to a simple regression model and using the fitted model in predictions.

5.4.2 – STAT S273 – Elementary Statistics
Upon successful completion of this course, students will be able to:

1. Distinguish between descriptive and inferential statistics; and observational, experimental and quasi-experimental studies.
2. Distinguish between populations and samples, and the various types of variables, types of data, and levels of measurement, and between the various sampling techniques.
3. Organize data into appropriate frequency distributions. Construct and interpret graphical displays of data, including Pie and Pareto Charts, histograms and boxplots, scatterplots.
4. Compute and interpret measures of central tendency, spread, and position.
5. Distinguish between classical and empirical probability. Identify and/or perform probability experiments and use appropriate probability rules to compute and interpret results.
6. Distinguish between discrete and continuous probability distributions, and apply the central limit theorem as appropriate. Compute and interpret probabilities and quantiles from binomial, normal, t-, chi-square and F-distributions.
7. Compute confidence intervals for population means, variances and proportions.
8. Correctly state hypotheses and apply methods appropriate for single and two-sample tests of population means, variances, and proportions.
9. Perform a one-way ANOVA to compare three or more population means, and interpret results.

10. Correctly state hypotheses for contingency table chi-square tests and correctly interpret results. Note: The traditional method, or the p-value method, or both may be used.

11. Conduct a simple regression (and correlation) analysis.

5.4.3 – STAT S373 – Probability and Statistics

Upon successful completion of this course, students will be able to:

1. Compute probabilities corresponding to prescribed events in a discrete sample space, including conditional and posterior probabilities.

2. Derive, interpret, and apply properties of discrete and continuous random variables, including probability density functions, expected value, variance, cumulative density functions, moment generating functions, covariance, and correlation coefficients.

3. Compute point estimates for parameters, including unbiased estimators and maximum likelihood estimators.

4. Create tests of hypotheses and be able to calculate rejection regions, significance levels, and p-values.

5. Calculate the probability of a type II error for a parameter space of size two.

5.4.4 – STAT S400 – Statistical computing with R

Upon successful completion of this course, students will be able to:

1. Perform elementary and complex operations with numeric, character, and logical vectors. Extend these methods to matrices, data frames, lists and arrays.

2. Construct and apply simple and compound conditional statements, as well as simple and nested looping structures.

3. Apply built-in low- and high-level graphical functions to the construction of basic and enhanced graphical images.

4. Design original and well-documented code, including user-defined functions, to implement complex numerical and/or statistical methods.

5.4.5 – STAT S401 – Regression and Analysis of Variance

Upon successful completion of this course, students will be able to:

1. Identify and apply appropriate linear models for use in the analysis of designed experiments and observational studies, and state relevant model assumptions.

2. Perform appropriate exploratory data analysis and/or structural, residual, outlier, influence and multi-collinearity diagnostics for fitted models. Implement remedial measures as appropriate/needed.

3. Apply variable and model selection methods to identify the best model and apply the chosen model to estimation and prediction tasks.

4. Apply appropriate pairwise comparison methods or tests of general contrasts and interpret results.