UNIVERSITY OF WASHINGTON

CREATING AND CHANGING UNDERGRADUATE ACADEMIC PROGRAMS

FEB 09 2015

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College/Campus UW Tacoma	**Department/Unit** Interdisciplinary Arts & Sciences	**Date** December 19, 2014

New Programs

☐ Leading to a Bachelor of _____ in _____ degree.

X Leading to a Bachelor of Science degree with a major in Mathematics.

☐ Leading to a _____ Option within the existing major in _____.

☐ Leading to a minor in _____

Changes to Existing Programs

☐ New Admission Requirements for the Major in _____ within the Bachelor of _____.

☐ Revised Admission Requirements for the Major in _____ within the Bachelor of _____.

☐ Revised Program Requirements for the Major in _____ within the Bachelor of _____.

☐ Revised Requirements for the Option in _____within the major in _____.

☐ Revised Requirements for the Minor in _____.

Other Changes

☐ Change name of program from _____ to _____.

☐ New or Revised Continuation Policy for _____.

☐ Eliminate program in _____.

Proposed Effective Date: **Quarter:** X Autumn ☐ Winter ☐ Spring ☐ Summer **Year:** 20 15

Contact Person: **Bonnie Becker/Ruth Vanderpool**	Phone: **253-692-4546**	Email: **bjbecker@uw.edu**	Box: **358436**

EXPLANATION OF AND RATIONALE FOR PROPOSED CHANGE

For new program, please include any relevant supporting documentation such as student learning outcomes, projected enrollments, letters of support and departmental handouts. (*Use additional pages if necessary*).

Proposal Attached

OTHER DEPARTMENTS AFFECTED

List all departments/units/ or co-accredited programs affected by your new program or changes to your existing program and acquire the signature of the chair/director of each department/unit listed. Attach additional page(s) if necessary. *See online instructions.

Department/Unit:	Chair/Program Director:	Date:
UWT Institute of Technology		12-19-2014
Department/Unit: UWT Education	Chair/Program Director Karen M. Vandenberger	Date: 12/19/2014

CATALOG COPY

Catalog Copy as currently written. Include only sections/paragraphs that would be changed if your request is approved. Please cross out or otherwise highlight any deletions.

NA (new major)

PROPOSED CATALOG COPY

Reflecting requested changes (Include exact wording as you wish it to be shown in the printed catalog. Please underline or otherwise highlight any additions. If needed, attach a separate, expanded version of the changes that might appear in department publications). **Please note:** all copy will be edited to reflect uniform style in the General Catalog.

Bachelor of Science in Mathematics

The Mathematics major encourages students to both study mathematics in its own right and to apply it to another discipline. Students develop the mental skills necessary for the creation, analysis, and critique of mathematical and quantitative topics.

The curriculum provides a nucleus of essential courses where students learn and work with many of the significant results in the three branches of mathematics: algebra, analysis, and geometry. A two-quarter sequence of study in one of these branches is required fostering a depth and maturity of mathematical thought in a modern context. The electives can be customized to prepare students for careers in education, government agencies, or the private sector. Specifically students in math can pursue careers in engineering, physics, actuarial science, quantitative finance, database and computer systems administration, network and data communication analysis, statistical analysis, secondary mathematics teaching, and other fields. Students with a major in mathematics often pursue graduate studies in mathematics, physics, and engineering.

Student Learning Objectives

Students graduating with a B.S. in Mathematics will be able to understand, communicate, and apply mathematics. In particular a student will be able to:

- Comprehend, discover, and communicate common principles from algebra, geometry, and analysis,
- Use probability or statistics correctly and effectively,
- Recognize, understand and also make his/her own mathematically rigorous arguments,
- Interpret and present results to a technical audience, both in writing and verbally,
- Describe how mathematical or quantitative based arguments effect society,
- Modify problems to make them tractable,
- Use technology to aid in solving problems,
- Apply quantitative theory, modeling, or mathematical principals to other disciplines to solve problems.

Graduation Requirements

A total of 75 credits are required.

Requirements for BS in Mathematics (43 quarter credits)

TMATH 124 Calculus with Analytic Geometry I

TMATH 125 Calculus with Analytic Geometry II

TMATH 126 Calculus with Analytic Geometry III
TMATH 300 Foundations of Mathematical Reasoning
TMATH 307 Introduction to Differential Equations
TMATH 308 Matrix Algebra with Applications
TMATH 324 Multivariable Calculus
TMATH 327 Introduction to Real Analysis I
TMATH 350 Mathematics Research Seminar
TMATH 402 Introduction to Abstract Algebra I

Extended Core (5 quarter credits)

The extended core requires three classes listed below. Notice that students must complete at least one two-quarter sequence but only one sequence is offered every year. Algebra is offered winter and spring of even years and Analysis is offered winter and spring of odd years.

TMATH 328 Introduction to Real Analysis II or TMATH 403 Introduction to Abstract Algebra II

Electives guaranteeing breadth of knowledge (25 quarter credits)

A total of 25 credits must be taken and each area requires a minimum of one class. No more than 5 credits can be satisfied by a course numbered below 300. Note that a class may satisfy two elective areas which will afford students the promised flexibility to tailor their studies toward their desired career goals.

- **Area: Computing (3+ quarter credits)**

TMATH 310 Statistics for Environmental Applications
TMATH 390 Probability and Statistics in Engineering and Science
TMATH 412 Cryptography
TESC 430 Environmental Modeling
TESC 453 Environmental Remote Sensing
TBGEN 210 Computer-Based Business Problem Solving
TCSS 142 Introduction to Programming
TCSS 143 Fundamentals of Object-Oriented Programming Theory and Application
TINST 310 Computational Problem Solving
TINST 311 Database Management and Data Analysis

- **Area: Math in Culture (3+ quarter credits)**

TMATH 420 Math History
TCSS 325 Computers, Ethics, and Society
TEDUC 473 Mathematics, Power, and Society
TEDUC 475 Science, Technology, Engineering, Arts & Mathematics Education for Democracy
TEST 211 Women in Science
TSOCWF 351 Applied Statistics for Social and Human Services
TURB 225 Statistics for Urban Analysis

- **Area: Modeling (3+ quarter credits)**

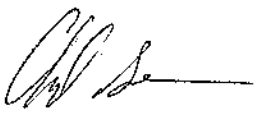
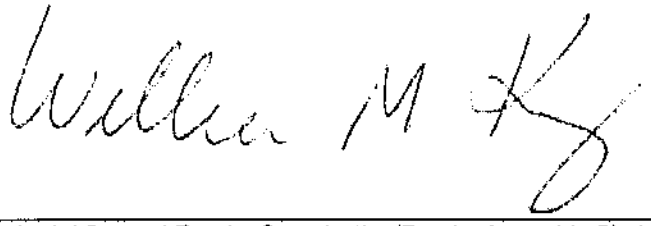
TBECON 420 Intermediate Microeconomic Theory
TBUS 301 Quantitative Analysis for Business
TESC 430 Environmental Modeling
TESC 453 Environmental Remote Sensing
TESC 122 Physics - Electromagnetism and Oscillatory Motion

• **Area: Probability / Statistics (3+ quarter credits)**
TMATH 310 Statistics for Environmental Applications
TMATH 390 Probability and Statistics in Engineering and Science
TBUS 301 Quantitative Analysis for Business
TSOCWF 351 Applied Statistics for Social and Human Services
TURB 225 Statistics for Urban Analysis

• **Area: Topology/Geometry (3+ quarter credits)**
TMATH 321 Geometry
TMATH 420 Math History
TMATH 427 Complex Analysis
TMATH 441 Topology

• **Additional Courses that count as general electives:**
TMATH 496 Mathematical Internship
TCSS 321 Discrete Structures I
Any additional courses beyond the required 15 credits taken from the extended core class list.

Capstone Experience (2+ quarter credits)
The Mathematics Capstone class TMATH 450 must be completed and is designed to hone students' technical communication skills. Students must complete a research experience such as an independent reading, undergraduate research experience, special topics course, internship, or senior thesis before enrolling so that they can draw upon the experience and results when creating their paper and presentation.

APPROVALS	
Chair/Program Director: 	Date: 1/7/15
College/School/Campus Curriculum Committee: 	Date: 1/27/15
UWT Associate Vice Chancellor: 	Date: 1/27/15
Faculty Council on Academic Standards/ General Faculty Organization/Faculty Assembly Chair:	Date:
POST TRI-CAMPUS APPROVAL (when needed)	
Faculty Council on Academic Standards/ General Faculty Organization/Faculty Assembly Chair:	Date:

Bachelor of Science in Mathematics, new degree proposal
Interdisciplinary Arts and Sciences
University of Washington Tacoma
November 19, 2014

Catalog Copy

The Mathematics major encourages students to both study mathematics in its own right and to apply it to another discipline. Students develop the mental skills necessary for the creation, analysis, and critique of mathematical and quantitative topics.

The curriculum provides a nucleus of essential courses where students learn and work with many of the significant results in the three branches of mathematics: algebra, analysis, and geometry. A two-quarter sequence of study in one of these branches is required fostering a depth and maturity of mathematical thought in a modern context. The electives can be customized to prepare students for careers in education, government agencies, or the private sector. Specifically students in math can pursue careers in engineering, physics, actuarial science, quantitative finance, database and computer systems administration, network and data communication analysis, statistical analysis, secondary mathematics teaching, and other fields. Students with a major in mathematics often pursue graduate studies in mathematics, physics, and engineering.

Contents

1 Introduction

The University of Washington Tacoma (UWT) proposes to offer a Bachelor in Science in Mathematics. The degree is to be housed in the School of Interdisciplinary Arts and Sciences (IAS) and is designed to accept courses from across campus so that students have flexibility in entering the major through a variety of pathways and fulfilling career directed outcomes.

Mathematics is an established field of study and growing area of opportunity. Students with mathematical degrees can pursue careers in engineering, physics, actuarial science, quantitative finance, statistical analysis, secondary mathematics education, and other fields.

1.1 Brief Program Description

The purpose of this degree is to provide a four year course of study that leads to a Bachelor of Science with a strong theoretical foundation and practical applications to help graduates secure STEM related jobs in the South Sound region.

The program takes into account the forthcoming curriculum guideline from the Mathematical Association of America[1]. The program is structured so that every graduate will see the three branches of mathematics: algebra, analysis, and geometry and study one of these topics in depth. Its flexibility allows students multiple pathways into the major and upper division courses while supporting personal career goals.

1.2 Projected Enrollment

We expect a majority of our students to be pursuing a career in a Science, Technology, Engineering, or Mathematics (STEM) related industry. However, advising can help students carefully select courses that can prepare them for math education or graduate school.

Given the data described in Section 2 where we consider UW Tacoma comparable institutions, we expect 1% of the graduating undergraduate student population to complete a math major. We assume that the proportion of students graduating with a math major is the same as the proportion of the undergraduate population working towards a math major. UWT currently plans reach an enrollment of 7000 students by 2020. Assuming that the proportions of graduate to undergraduate students remains approximately equal to the current 85%, this would imply 60 students will be in the mathematics program regularly.

	Aut 2015	Aut 2016	Aut 2017	Aut 2018	Aut 2019
Seniors	0	2	3	8	13
Juniors	2	3	8	13	15
Sophomores	0	5	10	13	15
Freshmen	5	10	13	15	15
Total	7	20	34	49	58

Table 1: Projected Enrollments

[1] Carol Schumacher. "Overview of Majors in the Mathematical Sciences". Accessed April 10, 2014. url: http://www2.kenyon.edu/Depts/Math/schumacherc/public_html/Professional/CUPM/Birds_feather.html.

Notice in Table 1 that there are students beginning the program each year with Junior standing. This population is likely to transfer to UW Tacoma from the local community college system. Interest has been documented at Tacoma Community College for the past two years as each year approximately ten students have self-identified as pursuing a career in secondary mathematics education and thus interested in a Mathematics major. The proposed Mathematics major would create a clear pathway for students to move from the Community college to the post graduate work in education. Currently these students transfer to Pacific Lutheran University, Central Washington University Pierce County, or UW Seattle but several have indicated that UW Tacoma would be a more ideal location and fit for their interests.

This proposal recommends that UW Tacoma continues the policy of limiting the size of its mathematics courses to 30 students. Smaller class sizes are essential for quantitative courses as instructors must provide substantial individual feedback and support for our diverse student body. This class size is assumed in Section 6.2 and should be taken into account when considering resources for the major.

2 Documented Need for Program

Mathematics is a STEM discipline and is recognized as a field where immediate production in graduates is needed both nationally and regionally. However the "United States is losing ground to global competitors" as our 15 year old students continue to score poorly on the world wide stage.[2]

2.1 National Demand

Graduates of a mathematics degree are in high demand and so have additional opportunities to secure high paying positions nationwide. Currently "STEM fields produced graduates with the least likelihood of underemployment" with Mathematics majors occupying the tenth least underemployed major.[3] The current and growing need for STEM workers has helped to increase the wages for these positions. According to a recent survey conducted by Payscale, the top ten majors ordered by salary potential were all in STEM fields. Mathematics generally contributes to all STEM fields, but mathematics itself was listed with the 2nd, 16th, and 22nd highest potential pay as Actuarial Mathematics, Applied Mathematics, and Mathematics respectively out of a list of 129 majors.[4] Furthermore, this current need is likely to be exacerbated as projections from the Bureau of Labor and Statistics suggest that computer and mathematical occupations will increase by 18% and STEM occupations in general are projected to add over 1 million more positions and total over 9 million by 2022. This rate of growth is faster than the 11% growth projected for all occupations over the next decade.

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[2] Lyndsey Layton. "U.S. students lag around average on international science, math and reading test". In: *The Washington Post* (2013)

[3] Christopher Ingraham. "The college majors most and least likely to lead to underemployment". In: *The Washington Post* (2014).

[4] Majors That Pay You Back". In: *2013-2014 Pay Scale College Salary Report* (2014).

2.2 Regional Demand

Washington state mirrors the national demand for STEM and Mathematics degrees. "There are currently 25,000 unfilled jobs in Washington due to a lack of qualified candidates. Eighty percent of those jobs are in high-demand health care and STEM fields, such as computer science and engineering."[5] The unmet demands for these workers is likely to increase as projected growth for traditional STEM positions in Washington state "will continue to grow. ... [as well as] occupations competing for STEM workers. In fact, the occupations that poach top STEM talent are also among the fastest-growing and highest-paid in the economy."[6] Employers have already reported moving positions out of state "because of the job skills gap"[7] and have imported more than 17,000 international workers "because local talent was not available in 2010."[8]

In order to reduce the need for Washington's employers to rely on workers from other states or nations and to ensure access to good paying jobs and stable employment, the Washington Legislature of 2012 "reallocated over $9 million in targeted funding to the state's public universities and colleges. These funds were dedicated to expanding enrollments in engineering at the research universities and to expanding enrollments in science, technology, engineering, and mathematics fields."[9]

2.3 Student Demand

Interest in the proposed degree already exists on campus. As of autumn of 2013 there were 76 declared Mathematics Minors at UW Tacoma. The majors of these students range over the entire UW Tacoma campus from within the different divisions in IAS to the Milgard School of Business, Urban Studies, and the Institute of Technology reflecting the wide interests of mathematically appreciative students that could be well served by the proposed degree. Some of these students may choose to pursue the proposed degree as it is known that several students from UW Tacoma have changed their planned major or transferred institutions because of the lack of a Mathematics program. Another indicator that there is strong interest already on campus for a Mathematics degree, is the two dozen active members in the UW Tacoma math club student organization with 60 students requesting email notifications of events. Furthermore, during the autumn of 2013 faculty in all mathematics courses at UW Tacoma explicitly asked students in their classes to self-identify if they would have "considered a Math Major". Seventy students responded positively to the survey.

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[5] *Great Jobs Within Our Reach: Solving the problem of Washington state's growing job skills gap.* 2013.

[6] State Board for Community Washington Student Achievement Council, Workforce Training Technical Colleges, and Education Coordinating Board. *A Skilled and Educated Workforce 2013 Update.* 2014.

[7] *Great Jobs Within Our Reach: Solving the problem of Washington state's growing job skills gap.*

[8] Washington Student Achievement Counsel. "Critical Crossroads: A call for action". In: *The 2012 Strategic Action Plan for Educational Attainment* (2012). http://www.wsac.wa.gov/sites/default/files/Critical_Crossroads-Revised4-13.pdf.

[9] Washington Student Achievement Council, Technical Colleges, and Board, *A Skilled and Educated Workforce 2013 Update.*

Judging by the current level of student interest in the mathematics at UW Bothell and UW Seattle, it is expected that a Mathematics degree at UW Tacoma will attract many place - bound students by offering a local academic program that fits their career choices. UW Bothell proposed a Mathematics program in 2012 and had 27 majors by the start of the second year of the program. In the Seattle-Tacoma area Mathematics is the second fastest growing major.[10] Furthermore it supports applied economics which is the second fastest growing major in the Pacific Northwest and education which is the most popular in the Seattle-Tacoma area.

Nationally STEM and Mathematics degrees have increasingly been identified as practical, lucrative, and critical for the future. The mean percentage of students majoring during the 2013 to 2014 academic year with a Mathematics degree is 1.0% among UW Tacoma identified peer institutions across the nation. UW Tacoma is likely to draw a similar range of students to the program thus these numbers were used for the projected enrollments given in Section 1.2.

3 Relation with Mission, Policies, and Priorities

3.1 Fit within the Campus

The new degree program will help attract new students to UW Tacoma and help retain those interested in further mathematical studies. The flexibility of the proposed degree program should prove attractive to students coming to mathematics from nonstandard tracks and those wishing to tailor and apply their studies to fit with their career interests.

3.1.1 UW Tacoma's Mission

The University of Washington Tacoma's mission is to educate diverse learners and transform communities by expanding the boundaries of knowledge and discovery.[11] The proposed Mathematics program will help advance this mission by enhancing access to higher education, broadening the mathematical research conducted on campus, and increasing the connection between UW Tacoma and the communities it serves.

The proposed Mathematics program provides new opportunities for students including those arriving to mathematics through nonstandard pathways. The flexibility of the curriculum is highlighted in Section 6.2 and the major is still accessible even when the calculus sequence is not completed in the first year. In fact, the design is such that motivated but underprepared students can gain necessary skills and complete the major in four years.

In the third year of the program students will be strongly encouraged to reach outside of UW Tacoma and become involved in authentic undergraduate research, local volunteer activities, and public or private internships. These direct interactions with the community can then serve as the basis for the culminating research project in their degree. The students will ultimately complete this program with highly developed analytic, communication, and research skills that are in high demand.

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[10] *Popular and High-Growth Degree Fields*. Tech. rep. Hanover Research, 2014.

[11] *Mission, values and vision*. Accessed September 12, 2014. url: http://www.tacoma.uw.edu/chancellor/mission-values-and-vision.

3.1.2 Other Campus Units and Students

Graduates of the proposed Mathematics major will have highly developed critical thinking, technical writing, and verbal communication skills making them well prepared for industry or post graduate studies. Students who choose to follow the math education pathway provided in Section 6.2 may apply for the School of Education at the University of Washington Tacoma. We are working closely with the Education faculty to develop courses that will both broaden math students' experiences while preparing future math educators for success in their graduate studies.

The proposed degree program in Mathematics draws on existing curricula at UW Tacoma. As students in the proposed Mathematics program tailor their electives to align with their career interests they may elect to take courses from the Institute of Technology, Social Work, Milgard School of Business, or the School of Education that satisfy a required elective area. IAS is working with other units to ensure access and capacity. This increase in demand is likely to be small for each unit as the elective areas identify courses across five separate units on campus. Some of these math courses could also serve as electives for other majors on campus.

The proposed Mathematics program will also increase opportunities for faculty and students in other units. Additional math faculty can provide increased access to mathematical consultations which are frequently requested but not always possible because of demands on our current faculty. The major will dedicate new resources to courses popular across campus, increasing the number of sections offered and providing greater flexibility for students' schedules. It will also enable faculty to apply for state and federal STEM funding that rigidly requires collaborators from a Mathematics degree granting program.

3.2 Fit with University

Both the Bothell and Seattle campuses offer a Bachelor of Science in Mathematics but increasing demands for STEM education, UW Tacoma's location, and the distinct structure of the proposed degree make this a valuable addition to the university system.

The current need and projected growth in STEM careers discussed in Section 2 highlights the need to increase capacity and throughput of STEM majors in higher education. The Boston Consulting Group recommended that Washington state prioritize existing resources, invest additional resources to grow [STEM] programs, and innovate in service delivery.

> *[By] taking these steps [Washington state] has the potential to increase the supply of qualified employees in highly skilled STEM positions by 1,200 to 3,600 per year. The low end of this range is based on the estimated number of qualified applicants denied positions in these programs at the state's three universities with the largest programs in [STEM] disciplines, while the top end of the range is based on the estimated number of qualified applicants denied access to these programs at all public four-year universities in Washington and an estimate of increased student interest.*[12]

In addition to expanding overall capacity, the proposed Mathematics degree will also increase accessibility for STEM programs in the south Puget Sound. The Seattle and Bothell

[12] *Great Jobs Within Our Reach: Solving the problem of Washington state's growing job skills gap.*

campuses are not easily accessible for south Puget Sound residents. UW Tacoma's mission and commitment to serve the local community, including Joint Base Lewis-McChord, has helped shape the structure of the proposed degree so as to better assist a student body with many diverse learners and first-generation students.

A Mathematics program on every campus has the potential to increase the diversity of mathematics courses available and pathways to an undergraduate degree. The math faculty from UW Tacoma are working with both the Bothell and Seattle campuses to agree on transfer policies for common math courses. These polices would assist students at UW Tacoma with interests in graduate school to take advantage of the well-developed modern mathematics courses regularly offered on the Seattle campus.

3.3 Adherence to University and Campus Policies

The proposed Mathematics program will adhere to all university and campus policies.

4 Academic Quality

The structure of the major is such that graduates will know and will have worked with many of the significant results of the three branches of mathematics: algebra, analysis, and geometry. Students will have completed a two-quarter sequence in one of these branches and thus have some depth in knowledge as recommended in the forthcoming curriculum guidelines from the Mathematical Association of America (MAA).[13] Additionally the electives in the major have been structured to ensure a breadth of knowledge and skills as recommended in the MAA's guidelines such as applying statistics or probability, building computing skills, and connecting mathematics to another subject through modeling or data analysis.

In addition to content, our major's structure has been "guided by a general set of cognitive" goals as suggested by the forthcoming guidelines from the MAA and explicitly written into the major's Student Learning Objectives. Students are introduced to the conventions of mathematical research, writing, and presentation during the second year of study in the four 300 level required courses. Students can refine these skills in the electives and then use them extensively during the capstone class where they present a project both verbally and in writing.

4.1 Student Learning Objectives

Students graduating with a B.S. in Mathematics will be able to understand, communicate, and apply mathematics. In particular a student will be able to:

- Comprehend, discover, and communicate common principles from algebra, geometry, and analysis,
- Use probability or statistics correctly and effectively,
- Recognize, understand and also make his/her own mathematically rigorous arguments,
- Interpret and present results to a technical audience, both in writing and verbally,
- Describe how mathematical or quantitative based arguments effect society,

[13] Carol Schumacher. "Overview of Majors in the Mathematical Sciences". Accessed April 10, 2014. url: http://www2.kenyon.edu/Depts/Math/schumacherc/public_html/Professional/CUPM/Birds_feather.html.

- Modify problems to make them tractable,
- Use technology to aid in solving problems,
- Apply quantitative theory, modeling, or mathematical principals to other disciplines to solve problems.

4.2 Degree Overview

The proposed curriculum for the Bachelor of Science in Mathematics requires 75 credit hours and is presented in Section 6.1. This is in between the number credits required for a standard Mathematics degree at UW Seattle (66) and UW Bothell (86). The UWT Mathematics major is general and is intended to serve students interested in careers in education, government agencies, or the private sector.

The program is loosely comprised of four types of courses: required core courses, courses from an extended core, upper division electives, and a capstone experience. The required courses provide the fundamentals used in the upper division and elective courses. After completing the core courses, students are required to study a modern mathematical subject in depth by completing a two-quarter sequence from the extended core. The elective courses give the students flexibility to investigate a wide range of sophisticated topics but are structured to guarantee breadth. Students are then required to complete a capstone experience where they apply mathematical knowledge generated though courses into a comprehensive individual or group undergraduate project. Details of the degree are given below. Explicit class listings are provided in Section 6.1, and new courses are starred with descriptions in Section 6.5.

Required Courses (43 quarter credits):

(* designates new courses)
TMATH 124 Calculus with Analytic Geometry I (5)
TMATH 125 Calculus with Analytic Geometry II (5)
TMATH 126 Calculus with Analytic Geometry III (5)
TMATH 300* Foundations of Mathematical Reasoning (5)
TMATH 307: Differential Equations (3)
TMATH 308: Matrix Algebra (3)
TMATH 324*: Advanced Multivariable Calculus (5)
TMATH 327*: Introduction to Real Analysis I (5)
TMATH 350*: Mathematics Research Seminar (2)
TMATH 402: Introduction to Abstract Algebra I (5)

Extended Core (5 quarter credits):

Students are introduced to multiple areas in modern mathematics. To guarantee depth, students must also complete at least one two-quarter sequence in either algebra or analysis.

Electives (25 quarter credits):

Students develop an appropriate breadth of knowledge by taking 25 credits of electives. To guarantee breadth, students must take at least one class in each of five identified categories,

listed below. Note that some classes can satisfy multiple categories. (A list of specific courses for each area is included in Section 6.1.) The five required areas and their descriptions are:

1. Computing (3+ quarter credits): Courses cover material that is similar in complexity to a 300 level math course. Courses must also make heavy use of either professional-level technological tools (such as computer algebra systems, visualization software, statistical packages) or writing and using their own computer programs.
2. Math in Culture (3+ quarter credits): Courses should be similar in complexity to a 300 level math course and investigate how mathematical or quantitative based arguments and thinking have influenced society.
3. Modeling (3+ quarter credits): The material should be similar in complexity to a 300 level math course and must involve using mathematical structures to describe social, science, or artistic systems.
4. Probability or Statistics (3+ quarter credits): Courses cover material that is similar in complexity to a 300 level math course and must make use of statistics or probability. These should not be comparable to an introductory statistics course.
5. Topology or Geometry (3+ quarter credits): Currently only two courses (TMATH 321* and TMATH420*) are available, but future courses at a 300 level or higher covering geometry or topology will satisfy this area.

Capstone Experience (2+ quarter credits):

The capstone experience guarantees that students gain practical knowledge applying their skills to researching new topics or math beyond their coursework. Students then enroll in the TMATH 450 Mathematics Capstone class to hone their technical communication skills producing a paper and presentation shared with their peers. The goal of this requirement is to give students the opportunity to apply mathematical knowledge generated through courses to a comprehensive individual or group undergraduate research project communicated both verbally and in writing.

Students have many options for their research experience such as an taking an independent reading, participating in a Research Experience for Undergraduates (REU), enrolling in a special topics course, or working in a highly quantitative internship. To date, our students have become active in the community, contributing to the Pearl Street Center and the Freedom Education Project Puget Sound at the Washington Correctional Center for Women. By requiring all students to register for the capstone course we can guarantee students present their work, are meeting the degrees standards, and bring diversity to the capstone course.

4.3 Assessment Plans

The Mathematics degree will make use of ongoing assessment methods that are standard practice at UW Tacoma as well as make a few key additions. Currently course- specific student evaluations, annual faculty peer reviews on class visits, and faculty-student advising occurs throughout the year and will provide qualitative feedback for each math faculty about the program. Additional data described below will be collected, cataloged, and presented by the Science and Mathematics divisional staff (working closely with the faculty math coordinator and appropriate instructors) to the math faculty every autumn.

- Entrance and exit surveys will be administered in TMATH 300 and TMATH 450 respectively. Faculty and staff will design these surveys making use of readily available and modern survey designs such as Panorama's open source survey tools.[14] The entrance survey will provide a baseline for tracking retention and the exit survey will focus on pedagogical effectiveness, classroom environment, expectations and rigor, and student engagement.
- Alumni surveys will be designed and distributed annually. These surveys will help faculty evaluate the effectiveness of the program and update Student Learning Objectives.
- Capstone projects completed in TMATH 450 will be used to assess the skills that the students have acquired, and to determine how well these students have met the student learning objectives for the degree.

Every autumn, a time will be set aside for faculty to discuss any concerns and make changes or refinements to the curriculum so that the student learning objectives are achieved. In these meetings, quantitative data from the staff will be presented, reflections from the TMATH 450 instructor will be shared, and assessment of the program and students will be discussed in detail as outlined in the table below.

Item	Assessment Topic	Method	Data Collection
Enrollment	• Retention • Diversity	a. Tracking entrance & exit surveys b. UWT provided admissions data	Annual
Curriculum	• Program Coherence • Suitable with SLO	a. Course evaluations b. Student & Alumni surveys	Quarterly evals Annual surveys
Faculty	• Teaching Improvement (if applicable) • Research (if applicable) • Service to Program	a. Faculty self-evaluations	Annual
Academic Support	• TLC • Access to Technology • Advising Resources	a. Student & Alumni surveys b. Faculty self-evaluations	Annual
Student Assessment	• Course Specific SLO • General Program SLO	a. Course Evaluations b. TMATH410 Project Assessment c. Student & Alumni surveys	Quarterly evals Annual project & surveys

Table 2: Data Collection & Relevance for Program & Student Assessment

5 Feasibility and Operational Viability

5.1 Curriculum

In the first year the proposed Mathematics degree requires three courses be developed and taught. Four additional upper division courses will be created and added to the schedule over the next two years with several being offered biennially. By the third year we expect 11 new math sections to be offered each year, six of which are already popular and routinely at

[14] Hunter Gehlbach. *User-Guide Panorama Student Survey*. https://panorama-www.s3.amazonaws.com/files/User-Guide.pdf Panorama Education. 2014.

capacity. A detailed schedule of this growth is provided in Section 5.2.

This degree program requires no prerequisites of incoming students, and any UW Tacoma student admitted to IAS will be eligible for declaring this as his or her major. There is also the possibility of admitting freshman students directly to this major, which could be explored further after the major is approved.

Potential degree path models (pathways) are presented in Section 6.2.

5.2 Faculty: Proposed hires

The projected 60 students in the Mathematics program are most likely to be a separate and new population from the students we currently serve. Although the Mathematics majors will be able to take advantage of our already developed lower division classes, they will add to our overall numbers. Thus this proposal recommends adding 3 new math faculty by 2018 according to the following schedule:

Academic Year	Total enrollment	Tenured/tenure track faculty	Lecturers
2014-2015	0	Request 1 TT Faculty	Request FT Lecturer
2015-2016	7	Search for Geometer or Math Historian	1 FT lecturer to cover 10 FTE plus increased growth in service math
2016-2017	20	Geometer or Math Historian begins work; request 1 TT	
2017-2018	34	Search for Complex or System Analyst	
2018-2019	49	Complex or System Analyst begins work	
2019-2020	58	Add additional hires consistent with growth	Add additional hires consistent with growth

Table 3: Proposed Hiring Schedule

By year 2019, the major will have brought in 58 students, which requires three hires. Initially we propose hiring a full time lecturer and then two tenure track positions, one per year to directly support the major. A more detailed schedule of what each hire would be responsible for is included in Section 5.2.

The initial hire that starts in autumn of 2015 will be will be a full time lecturer. One-half of this position will directly support the major; the remaining half will address the current needs and growth of the service courses that support UW Tacoma as a whole. This hire will free up current faculty with the expertise to develop and implement the first three critical courses intended to be taken by math majors in the second year.

Year	Proposed Hire	Additional Courses beyond Current Offering & Lower Division
2015 Autumn	'15 full time lecturer	free resources for TMATH300†& TMATH324†
2016 Winter		
2016 Spring		provides space for TMATH420†
2016 Autumn	'15 full time lecturer	free resources for TMATH300 & TMATH324 &TMATH350†
	'16 tenure hire	additional TMATH 124 & TMATH321†
2017 Winter	'16 tenure hire	additional TMATH 125 & TMATH450†
2017 Spring	'15 part time lecturer	provides space for TMATH328†
	'16 tenure hire	additional TMATH 126 & TEDUC 475
2017 Autumn	'15 full time lecturer	additional TMATH 124
	'16 tenure hire	TMATH 390 & TMATH350
	'17 tenure hire	TMATH300 & TMATH324
2018 Winter	'16 hire	additional TMATH 125 & TMATH450
	'17 tenure hire	TMATH308
2018 Spring	'16 hire additional	TMATH 126 & TMATH307
	'17 tenure hire	TMATH403†& TMATH420

Table 4: Courses Proposed Hires would teach

In each of the next two years a tenure track faculty should be brought in to strengthen the major, increase undergraduate research opportunities, and support math across campus and within the South Sound community.

5.3 Infrastructure, Support, and Administrative Needs

Teaching space is currently scarce on campus due to the recent growth in the UW Tacoma student body. The new Mathematics program will add three classes to the schedule in its first year, which can be accommodated by the existing teaching space. However, the continued growth of the University as a whole coupled with the additional eight courses offered in 2016-2017 suggest that additional general purpose teaching spaces must be found or created. The proposed degree's elective area in computing may lead some instructors to prefer a classroom with computers, but the current resources are likely to easily support the additional one or two classes a year. The two tenure track faculty and full time lecturer recruited for the program will also require standard support including office space, computer equipment, research support, and startup funds.

6 Appendices

6.1 Complete Curricular Requirements

A total of 75 credits are required. New courses are indicated with an asterisk.

Requirements for BS in Mathematics (43 quarter credits)

TMATH 124 Calculus with Analytic Geometry I
TMATH 125 Calculus with Analytic Geometry II
TMATH 126 Calculus with Analytic Geometry III
TMATH 300* Foundations of Mathematical Reasoning
TMATH 307 Introduction to Differential Equations
TMATH 308 Matrix Algebra with Applications
TMATH 324* Multivariable Calculus
TMATH 327 Introduction to Real Analysis I
TMATH 350* Mathematics Research Seminar
TMATH 402 Introduction to Abstract Algebra I

Extended Core (5 quarter credits)

The extended core requires one of two classes listed below. Notice that students must complete at least one two-quarter sequence but only one sequence is offered every year. Algebra is offered winter and spring of even years and Analysis is offered winter and spring of odd years.

1. TMATH 328* Introduction to Real Analysis II or TMATH 403* Introduction to Abstract Algebra II

Electives guaranteeing breadth of knowledge (25 quarter credits)

A total of 25 credits must be taken and each area requires a minimum of one class. No more than 5 credits can be satisfied by a course numbered below 300. Note that a class may satisfy two elective areas which will afford students the promised flexibility to tailor their studies toward their desired career goals.

- **Area: Computing (3+ quarter credits)**

TMATH 310 Statistics for Environmental Applications
TMATH 390 Probability and Statistics in Engineering and Science
TMATH 412 Cryptography
TESC 430 Environmental Modeling
TESC 453 Environmental Remote Sensing
TCSS 142 Introduction to Programming
TCSS 143 Fundamentals of Object-Oriented Programming Theory and Application
TINST 310 Computational Problem Solving
TINST 311 Database Management and Data Analysis

• **Area: Math in Culture (3+ quarter credits)**
TMATH 420* Math History
TCSS 325 Computers, Ethics, and Society
TEDUC 473* Mathematics, Power, and Society
TEDUC 475* Science, Technology, Engineering, Arts & Mathematics Education for Democracy
TEST 211 Women in Science
TSOCWF 351 Applied Statistics for Social and Human Services
TURB 225 Statistics for Urban Analysis
• **Area: Modeling (3+ quarter credits)**
TBUS 301 Quantitative Analysis for Business
TESC 430 Environmental Modeling
TESC 453 Environmental Remote Sensing
TESC 122 Physics - Electromagnetism and Oscillatory Motion
• **Area: Probability / Statistics (3+ quarter credits)**
TMATH 310 Statistics for Environmental Applications
TMATH 390 Probability and Statistics in Engineering and Science
TBUS 301 Quantitative Analysis for Business
TSOCWF 351 Applied Statistics for Social and Human Services
TURB 225 Statistics for Urban Analysis
• **Area: Topology/Geometry (3+ quarter credits)**
TMATH 321* Geometry
TMATH 420* Math History
TMATH 427* Complex Analysis
TMATH 441* Topology
• **Additional Courses that count as general electives:**
TMATH 496 Mathematical Internship
TCSS 321 Discrete Structures I
Any additional courses beyond the required 15 credits taken from the extended core class list.

Capstone Experience (2+ quarter credits)
The Mathematics Capstone class TMATH 450* must be completed and is designed to hone students' technical communication skills. Students must complete a research experience such as an independent reading, undergraduate research experience, special topics course, internship, or senior thesis before enrolling so that they can draw upon the experience and results when creating their paper and presentation.

6.2 Pathways

	Autumn	Winter	Spring	Summer
1st year	TMATH124 Calc 1 1st year Core	TMATH 125 Calc 2 1st year Core 1st year Core	TMATH 126 Calc 3 1st year Core	
2nd year	TMATH300 Reasoning TMATH324 Multivariable	TMATH307 Dif Eq stat. elect. (TMATH390)	TMATH308 Matrix model elect. (TESC430)	
3rd year	TMATH350 Jr. Seminar TPSYCH 101	TMATH327 Real 1 geom. elect. (TMATH321) TPSYCH 321	TMATH328 Real 2 comp elect (TMATH412)	
4th year	elective (TCSS321) TIAS498 Reading	TMATH402 Alg 1 TMATH 450 Capstone	cult. elect. (TMATH420)	

Table 5: Math Education Pathway starting in Autumn of an even year

	Autumn	Winter	Spring	Summer
1st year	TMATH124 Calc 1 1st year Core	TMATH 125 Calc 2 1st year Core 1st year Core	TMATH 126 Calc 3 1st year Core	
2nd year	TMATH300 Reasoning	TMATH307 Dif Eq stat. elect. (TBUS301)	TMATH308 Matrix model elect. (TBECON420)	
3rd year	TMATH350 Jr. Seminar TMATH324 Multivariable	TMATH402 Alg 1	TMATH403 Alg 2 comp elect (TMATH430)	
4th year	elective (TCSS321) TMATH496 Internship	TMATH327 Real 1 geom. elect. (TMATH321) TMATH 450 Capstone	cult. elect. (TEST211)	

Table 6: Mathematical Social Science Pathway starting in Autumn of an odd year

	Autumn	Winter	Spring	Summer
1st year	1st year Core	1st year Core 1st year Core	1st year Core TMATH 120	
2nd year	TMATH124 Calc 1	TMATH 125 Calc 2	TMATH 126 Calc 3 TMATH308 Matrix	
3rd year	TMATH300 Reasoning TMATH350 Jr. Seminar TMATH324 Multivariable	TMATH327 Real 1 TMATH307 Dif Eq	TMATH328 Real 2 comp & stat elect (TMATH390) model elect. (TBECON420)	
4th year	elect. (TCSS321) elect. (TINST310) TIAS498 Reading	TMATH402 Alg 1 TMATH 450 Capstone	geom. & cult. elect. (TMATH420)	

Table 7: Nonstandard Math Major Pathway starting in Autumn of an even year

	Autumn	Winter	Spring	Summer
1st year	1st year Core (Sc) TMATH124 Calc 1	1st year Core (Sc) TMATH 125 Calc 2	1st year Core (Sc) TMATH 126 Calc 3	
2nd year	TMATH300 Reasoning TMATH324 Multivariable	TMATH307 Dif Eq stat. elect. (TMATH390)	TMATH308 Matrix model elect. (TESC430)	
3rd year	TMATH350 Jr. Seminar	TMATH327 Real 1 geom. elect. (TMATH321)	TMATH328 Real 2 comp elect (TMATH412)	TMATH496 or REU
4th year	elective (TCSS321)	TMATH402 Alg 1 TMATH 450 Capstone	TMATH403 Alg 2 cult. elect. (TMATH420)	

Table 8: Math Graduate School Pathway starting in Autumn of an even year

	Autumn	Winter	Spring	Summer
1st year	1st year Core (Sc) TMATH124 Calc 1	1st year Core (Sc) elective (TCSS321)	1st year Core (Sc) TMATH308 Matrix	
2nd year	TMATH300Reasoning comp elect (TCSS142)	TMATH 125 Calc 2 comp prereq (TCSS143)	TMATH 126 Calc 3 model elect. (TESC430)	
3rd year	TMATH324 Multivariable TMATH307 Dif Eq TMATH350 Jr. Seminar	TMATH402 Alg 1 stat. elect. (TMATH390)	TMATH403 Alg 2 W course	
4th year	geom. elect. (TMATH321) TMATH496 Internship	TMATH327 Real 1 TMATH 450 Capstone	cult. elect. (TCSS325)	

Table 9: STEM Career Pathway starting in Autumn of an odd year

6.3 New Course Descriptions

TMATH 300* Foundations of Mathematical Reasoning: Develops skills in making mathematical arguments and writing of proofs. Elementary set theory, functions, logical statements and quantifiers, the principle of induction, cardinality, properties of number systems–integers, rational, real, and complex. Investigate proofs in both discrete and continuous mathematics.

TMATH 324* Multivariable Calculus: Introduction to the concepts and computation techniques of multivariable calculus, including double and triple integrals, the chain rule, vector fields, parametric curves and surfaces, line integrals, surface integrals, Green's Theorem, Stoke's Theorem, and the Divergence Theorem. Prerequisites: 2.0 in TMATH 126.

TMATH 328* Introduction to Real Analysis II: This course is designed to introduce students to a rigorous approach to the real numbers and calculus. Emphasis will be on understanding mathematical statements, precision in proof-writing, generating examples, and presenting arguments verbally. Specific content includes important foundational results including: the Contraction Mapping Theorem, the Fundamental Theorem of Calculus, and the Implicit Function Theorem. Students will develop a rigorous understanding of the derivative of a function of one variable, the Riemann integral and the Cauchy criterion for existence, sequences of functions including pointwise and uniform convergence, power series, differentiation of functions on Euclidean spaces and the total derivative.

TMATH 350* Mathematics Research Seminar: This is a 2 credit seminar that is required for juniors earning a B.S. in Mathematics at UW Tacoma. This class introduces students to diverse mathematical topics through invited speakers and selected readings. It also develops mathematical ways of thinking, investigating, reading, and writing while exploring future employment and graduate school options and opportunities.

TMATH 420* Math History: This is a survey of the historical development of mathematics from the earliest beginnings to the early 20th century. We will begin by studying the mathematics of ancient Babylon and Egypt, and the ways in which it was used both practically and culturally. From there we will move to ancient Greece and examine the heavily philosophical and geometry- focused approaches of the Greek mathematicians. Our studies will then pass through the Middle East, into India and China and ultimately to western Europe, where mathematics was an important part of the intellectual, philosophical, and artistic movements of the Renaissance. Finally, we will study the emergence of Calculus and the increasingly expansive and modern approaches of such mathematicians as Euler and Gauss. Throughout this course you will learn historically important problem-solving techniques

and use them to solve problems as they would have been solved by practitioners of the time.

TMATH 450* Mathematics Capstone: A 2 credit seminar that a required capstone course for seniors earning the B.S. in Mathematics. This course will synthesize the diverse tools and knowledge that students have attained in their other mathematics courses and focus on honing technical communication skills. Students must have already made significant progress on a research project (i.e. undergraduate research, internship, or senior thesis) before enrolling in this class to write, edit, and present their results. This will act as a forum for students to present their projects and is the culminating course for the B.S. degree.

TMATH 496* Mathematical Internship: This is a 1 to 5-credit mathematical internship allowing the student to work in the public or private sector while supervised by a faculty member in mathematics or a related discipline.