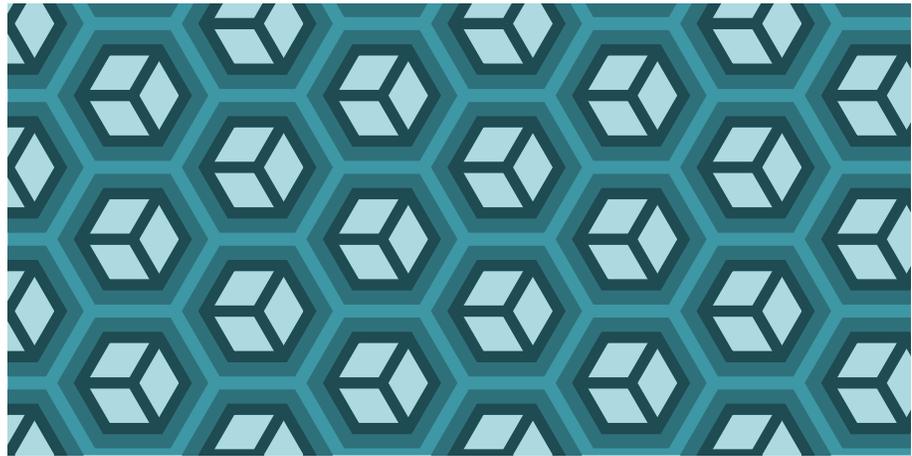


Department of

# Mathematics



Program Guide

**2018**



**MERCYHURST**  
UNIVERSITY



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# Our Faculty

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Roger Griffiths joined the faculty in the fall of 2004 from Montana State University. He has undergraduate degrees in both Mathematics and Nautical Science. Dr. Griffiths is an associate professor of Mathematics. His recent teaching duties include Differential Equations, Numerical Methods, the calculus sequence, Mathematics for the Natural Sciences, Introduction to Internet Programming, Server-side programming, and Operating Systems (GNU/Linux).

- B.S., U.S. Merchant Marine Academy
- M.A., Montana State University
- Ph.D., Montana State University

## **Dr. Donald Platte**

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Professor, Mathematics

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Donald Platte joined the faculty in the fall of 1972 after receiving a Ph.D. in Mathematics from Michigan State University. He has undergraduate degrees in both Mathematics and Physics from Aquinas College. Dr. Platte is a full professor of Mathematics and Computer Systems. His recent teaching duties include Modern Algebra, Applied Mathematics, Advanced Calculus, Computer Operations, and Networks.

- B.S., Aquinas College
- M.A., Michigan State University
- Ph.D., Michigan State University

## **Dr. Lauren Williams, Chair**

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Dr. Williams joined the department in 2013, after earning her PhD in mathematics from the University of Wisconsin Milwaukee. Her research interests lie at the intersection of algebra and combinatorics, and she has published articles in the Transactions of the AMS and The Journal of Combinatorics.

- B.A., The College of New Jersey
- M.A., University of Wisconsin Milwaukee
- Ph.D., University of Wisconsin Milwaukee

# Department Mission and Goals

The Department of Mathematics offers a baccalaureate degree program in mathematics that has been designed to develop our students' full potential. Our graduates are prepared to enter a variety of professional careers and will have the background needed to pursue further study in graduate school.

Our mathematics program is designed to provide a solid foundation for our majors, and leave them prepared to pursue a career in education or to continue their own education in graduate school. Our program will:

- Address the growing demand for individuals with mathematical training.
- Train students to become skilled in logical reasoning, and the methods of proof and problem-solving that characterize mathematics.
- Educate students to work with abstract concepts, develop analytical skills, and become effective problem-solvers.
- Continue to refine student communication skills, such as the ability to formulate a mathematical statement precisely, write mathematics correctly, and the ability to write a coherent proof.
- Develop student reading and research skills so they may independently extend their mathematical knowledge as well as solve mathematical problems which present a substantial intellectual challenge.
- Provide a supportive learning environment in which students can develop to their maximum potential, and are encouraged to become life-long learners who respect the dignity of hard work.
- Create challenging general-education and service courses that cultivate critical thinking and clear mathematical communication to ensure students acquire the quantitative methods needed in their chosen field of study.

The goal of our department is to produce graduates that:

- are fluent in the language of mathematics.
- have mastered the content knowledge needed to enter graduate school in mathematics, teach in the secondary schools, or pursue a variety of related careers.
- are able to reason scientifically and mathematically.
- can read and write mathematical proofs and to understand the role of *proofs* within mathematics.
- have a solid foundation in programming and understand the role of applied computational work within mathematics.
- explore interdisciplinary educational opportunities at Mercyhurst University and beyond.

# Why Major in Mathematics?

Most undergraduates are interested in a program that will lead to successful careers, and there is no shortage of opportunities for graduates in mathematics. While some options may require additional training or degrees, a bachelor's in mathematics can prepare you for a great number of choices.

A 2015 article in *The Economist* shows that a degree in mathematics, engineering, or computer science can be expected to have the highest return on investment, exceeding those in other sciences or humanities. NPR places mathematics and computer science in third place after engineering and pharmaceutical programs on their list of the most lucrative degrees. The US Bureau of Labor Statistics consistently ranks mathematics among the most promising career choices based on starting salaries and job growth outlooks. A number of job satisfaction rankings place mathematics in the number one position, followed by actuarial sciences and statistics.

## Careers

It is impossible to list all of the careers that you may pursue after earning your mathematics degree. Below are just a few to give you an idea of the variety of careers available. Note that some jobs may require additional training, degrees, or certification, so be sure to look into requirements before you graduate.

### Secondary Education

Many of our majors choose to pursue a career in teaching, and have been successful in doing so. Talented and dedicated mathematics teachers are needed in nearly every area of the country: an August 2017 CNN story reported that 48 states reported a shortage in math teachers.

### Federal Agencies

There are a wide variety of careers available for math majors through the US government. The National Security Agency (NSA) employs more mathematicians than any other company or institution in the United States. Math majors are also in demand at the Bureau of Labor Statistics, the Census Bureau, the Internal Revenue Service, and more. Many of these positions require a bachelor's degree only, and will provide support for further education.

### Operations Research

Operations research analysts help companies make better decisions and solve problems using mathematics and statistics. Many entry level positions require a bachelor's degree in mathematics or related field, and offer competitive salaries.

### Data Science

This is a rapidly growing and well compensated field, and requires a very strong foundation in mathematics. Many positions would require additional degrees or training, but a mathematics major and the undergraduate level is a perfect starting point.

### Actuarial Sciences

An actuary uses statistical analysis to determine the probability of events in order to reduce the risks associated with them. Most work for the insurance industry, but actuaries can also be employed in the financial services and health industries. Becoming an actuary requires passing a series of difficult exams with a heavy focus on statistics, probability, and calculus, among other topics.

### Cost Estimator

Cost estimators use calculus and statistics to determine the total cost of manufacturing and construction projects, including materials, labor, and equipment.

### Financial Advisor

A mathematics degree is often enough to get started in several financial career fields. Advisors help clients reach their long term financial goals, and need a strong understanding of mathematics to perform their job.

### Meteorology

Mathematical models are used to predict and explain the weather, and are constantly being improved. A math degree can prepare you for some positions related to meteorology, particularly when paired with a major in another science such as physics or geosciences.

### Law

While a bachelor's in mathematics alone is not enough to become a lawyer, it will train you to make a rigorous, logical, and well supported argument. Undergraduate degrees in mathematics have been shown to be a significant indicator of success in law school.

## Graduate Programs

A bachelor's degree in mathematics will give you an overview of just some of the topics in the field. To learn more, or to develop your own specialty in the field, you may want to consider graduate programs in mathematics.

Most graduate students in mathematics are supported by teaching or research assistantships. Some students assist a faculty member with their research or grading, and others will teach a section or two of an undergraduate course each semester. In exchange, no tuition is charged to the graduate student, and they will receive a stipend to cover living expenses. Insurance and other benefits are also frequently available.

A master's degree in mathematics usually takes two to three years to complete, and may involve writing a thesis or taking examinations in addition to coursework. A master's degree makes you a more competitive applicant for many of the career options mentioned above.

If you're truly dedicated and have the talent to go with it, you might want to pursue a PhD in mathematics. Many mathematicians with a PhD become professors, where they focus on both teaching and research. Other PhDs may apply for industry positions, frequently with government agencies such as the NSA. This is a degree for a student that truly enjoys research, as you will need to produce your own original contribution to the field in the form of your dissertation.

## Why Study Mathematics at Mercyhurst?

Most mathematics programs at the undergraduate level are quite similar. All will require a calculus sequence, courses in linear algebra and differential equations, a course on logic and writing proofs, and advanced subjects such as modern algebra, geometry, and analysis. With so little variation in course requirements, choosing a program can be daunting.

Some key points that make our program stand out:

- We are a small department, and our faculty are dedicated to teaching. You will get to know your professors and classmates very well. The classes you take in your first year, such as Calculus I, will be the largest in your entire program and are capped at 30 students. More advanced courses that are taken by majors only are much smaller, allowing personal attention from your professors. All major courses are taught by full time faculty.
- Our program is designed on the current recommendations from the Mathematical Association of America. Our courses ensure you will be exposed to all of the expected topics in undergraduate mathematics.
- Our program includes a programming requirement, which significantly increases the opportunities for you on graduation. Many jobs that require programming will provide further training, but employers are always interested to see that you have already had some experience. You will need to take one programming course for the degree, and you will also have exposure to programming in some of the mathematics courses.
- You may have an opportunity to work as a paid department tutor. This University sponsored program is an excellent choice for students considering a career in education, though all math majors that have successfully completed certain coursework may be interested. Tutors are responsible for assisting students enrolled in courses up through Calculus II on a drop-in basis. You may also arrange to be a private tutor through the University's tutoring program, working one on one with a single student over a semester.

## Dual Majors and Minors

Outside of teaching, most careers will not specifically require a bachelor's degree in mathematics. Those that are dependent on strong mathematics skills will often prefer a master's degree. If you are not convinced that graduate school is right for you, or you would like to have even more options on graduation, you should strongly consider adding a second major or minor to your undergraduate plan.

The number of required courses for the mathematics major is small enough that you can often "fit" a second major in a related field - or branch out into something completely different. Some of our recent mathematics majors have also earned a degree in economics, intelligence studies, finance, physics, dance, information technology, english, and chemistry. We have also had students earn minors in philosophy, religious studies, theater, music, graphic design, and geology. Having a second area of expertise is always attractive to employers, and will help you stand out when applying for the perfect job.

## More Information

For updated information on career options and trends for mathematics majors:

- WeUseMath.org  
(<http://weusemath.org/>)  
From the Site: *The most common question students ask math teachers at every level is “When will I use math?” WeUseMath.org is a non-profit website that helps to answer this question. This website describes the importance of mathematics and many rewarding career opportunities available to students who study mathematics.*
- American Mathematical Society: What do Mathematicians Do?  
(<http://www.ams.org/profession/career-info/math-work/>)  
This page includes articles on some of the unexpected career options available to mathematicians, along with links to occupational outlook statistics and studies.
- Society of Industrial and Applied Mathematics Career Page  
(<https://www.siam.org/careers/>)  
From the Site: *Whether you are a student considering a career in mathematics, or an established mathematician, you will find the job-search and career information resources in this section invaluable.*
- Mathematical Association of America Careers in Math  
(<https://mathcareers.maa.org/>)  
Information on career options for mathematics students, plus a wealth of resources on the application process, strategies for getting hired, and what to expect after graduation. There is also information on preparing for graduate programs in mathematics and related fields.
- Stony Brook Career Guide in Quantitative Finance  
(<http://www.ams.sunysb.edu/~frey/QuantitativeFinance/Resources/CareerGuide/>)  
This site has an excellent overview of the positions available under the heading of quantitative finance, and the requirements for these positions.

# Program Requirements

Earning any BA or BS degree at Mercyhurst requires a minimum of 121 credits and completion of the REACH Curriculum.

The BA in Mathematics requires successful completion 13 courses, for a total of 43 credits. Students must maintain a minimum 2.0 grade point average in their major courses.

## Mathematics Course Requirements

Number	Course	Credits	Offered
Math 170	Calculus I	4	All
Math 171	Calculus II	4	Spring
Math 233	Calculus III	4	Fall
Math 150	Linear Algebra	4	Spring
Math 240	Differential Equations	3	Fall Odd
Math 265	Transition to Advanced Mathematics	3	Fall Even
Math 245	Geometry	3	Spring Even
Math 280	Modern Algebra I	3	Fall Odd
Math 281	Modern Algebra II	3	Spring Even
Math 291	Statistical Analysis	3	
Math 370	Advanced Calculus	3	Spring Odd
Math 400	Topics in Mathematics	3	Spring Odd
Varies	Programming Elective	3	All

The Programming Elective requirement can be satisfied by several courses at the discretion of your major advisor. Possible suggestions include:

- Math 201: Technical Writing with  $\text{\LaTeX}$
- CIS 100: Introduction to Computer Science
- CIS 210: Algorithm Design and Analysis

## REACH Curriculum Requirements

The REACH Curriculum, adopted in 2016, includes special experiences in the freshman and senior years, as well as coursework from a wide variety of the liberal arts and sciences during your four years here. All the courses in the REACH Curriculum are designed to:

- Challenge mindsets and assumptions
- Develop critical thinking and problem-solving skills
- Encourage curiosity and creative inquiry
- Cultivate an appreciation of arts and culture
- Ignite community awareness and engagement
- Help you learn to become resilient in the face of challenges

### The Freshman Experience

An introduction to academic writing and thought, as well as to college life. COMP120 (Writing and Research), plus two one-credit courses to help ease the transition from high school to college (iMU101: Introduction to Mercyhurst and iMU102: Involvement at Mercyhurst).

### The Liberal Arts Experience

The Liberal Arts Experience includes 10 courses in 10 different disciplines. To make sure you explore a variety of fields of study, no two of these course numbers can have the same prefix. You'll take two courses (at the 100- or 200- level) from each of these five broad areas:

R	Reason and Faith	Catholic Studies, Philosophy, Religious Studies
E	Expression and Creativity	One in English, plus one in Art, Dance, Music, or Theatre
A	Analytical Thought	One in Mathematics, plus one science with a lab in Biology, Chemistry, Geology, Physics, or Science
C	Contexts and Systems	Economics, History, Political Science
H	Humans in Connection	Anthropology, Psychology, Sociology, World Languages

### The Senior Experience

Ethics 400, a capstone course for the REACH Curriculum, along with the capstone course in your academic major.

### outREACH

Sometime after your freshman year, you'll do at least one, one-credit experience in service learning or civic engagement. Many of these experiences will involve travel abroad or around the country, combined with a significant service component.

## Suggested 4-Year Plans

Earning your degree in mathematics requires careful planning, as the required courses typically have several prerequisites and must be taken in order. Additionally, many of our classes are only offered every two years, so you may only have one opportunity to take each course before your expected graduation date.

Your individual course plan will be determined by the year you begin your studies and the results of your ALEKS Math Assessment, as well as any credits you may be eligible to transfer from another institution towards the degree. Most of our majors begin with either Math for the Natural Sciences or Calculus I.

Be sure to speak with your major advisor before making any adjustments, as the course offerings and requirements are subject to change during your time at Mercyhurst. You'll be required to meet with your advisor every semester before registration.

Some of the REACH Curriculum requirements must be taken during particular semesters or years. These suggestions are shown in *grey italics*.

### Freshmen Entering Fall of Odd Year

	<i>Beginning with Math 118</i>		<i>Beginning with Math 170</i>	
	Fall	Spring	Fall	Spring
FR	Math for Nat Sci <i>COMP 120</i> <i>iMU 101</i>	Calculus I Linear Algebra <i>iMU 102</i>	Calculus I <i>COMP 120</i> <i>iMU 101</i>	Calculus II Linear Algebra <i>iMU 102</i>
SO	Tran to Adv Math Programming	Calculus II <i>BTG outREACH</i>	Tran to Adv Math <i>BTG outREACH</i>	Programming Statistics
JR	Diff Equations Mod Algebra I	Geometry Mod Algebra II	Diff Equations Mod Algebra I	Geometry Mod Algebra II
SR	Calculus III Statistics <i>ETH 400</i>	Topics in Math Adv Calculus	Calculus III <i>ETH 400</i>	Topics in Math Adv Calculus

## Freshmen Entering Fall of Even Year

<i>Beginning with Math 118</i>			<i>Beginning with Math 170</i>		
	Fall	Spring	Fall	Spring	
FR	Math for Nat Sci <i>COMP 120</i> <i>iMU 101</i>	Calculus I <i>iMU 102</i>	Calculus I <i>COMP 120</i> <i>iMU 101</i>	Calculus II Linear Algebra <i>iMU 102</i>	
SO	Programming Statistics <i>BTG outREACH</i>	Calculus II Linear Algebra	Diff Equations <i>BTG outREACH</i>	Programming Statistics	
JR	Calculus III Tran to Adv Math	Topics in Math Adv Calculus	Calculus III Tran to Adv Math	Topics in Math Adv Calculus	
SR	Diff Equations Mod Algebra I	Geometry Mod Algebra II <i>ETH 400</i>	Mod Algebra I <i>ETH 400</i>	Geometry Mod Algebra II	

## Current Students

Current Mercyhurst students can add a Mathematics major, but will need to speak with a member of the Mathematics Department before the fall of their sophomore year to ensure all requirements can be met on time.

<i>Beginning Fall Odd Year</i>			<i>Beginning Fall Even Year</i>		
	Fall	Spring	Fall	Spring	
SO	Calculus I Programming	Calculus II Linear Algebra	Calculus I Tran to Adv Math	Calculus II Linear Algebra	
JR	Calculus III Programming	Adv Calculus Topics in Math Statistics	Diff Equations Mod Algebra I	Geometry Mod Algebra II	
SR	Diff Equations Mod Algebra I	Geometry Mod Algebra II	Calculus III Programming	Adv Calculus Topics in Math Statistics	

## Mathematics Minor

A mathematics minor can be a valuable addition to any degree. You will need to have a minor advisor in the Mathematics Department along with your major advisor's approval. Our minor has been designed to give you an overview of topics that are of importance to any applied field, as well as an introduction to abstract mathematics. The list of elective courses allows flexibility to build a minor that best complements your current program.

Number	Course	Credits	Offered
Math 170	Calculus I	4	All
Math 171	Calculus II	4	Spring
Math 233	Calculus III	4	Fall
Math 150	Linear Algebra	4	Spring
Math 265	Transition to Advanced Mathematics	3	Fall Even

*Two electives from the list below:*

Math 201	Technical Writing with L <sup>A</sup> T <sub>E</sub> X	3	Spring Odd
Math 240	Differential Equations	3	Fall Odd
Math 245	Geometry	3	Spring Even
Math 280	Modern Algebra I	3	Fall Odd
Math 281	Modern Algebra II	3	Spring Even
Math 291	Statistical Analysis	3	
Math 370	Advanced Calculus	3	Spring Odd
Math 400	Topics in Mathematics	3	Spring Odd
CIS 100	Introduction to Computer Science	3	All
CIS 210	Algorithm Design and Analysis	3	Fall
PHYS 201	General Physics with Lab	4	All

## 4+1 Program

Students interested in a career in secondary education may be interested in our 4+1 Program. After completing this program, you'll earn a BA in Mathematics and an MA in Education, all within 5 years. Your requirements for the mathematics degree are as outlined above. During your senior year, you'll begin taking graduate courses in education, which you'll continue for one additional year. This program includes placement in a supervised classroom, so you'll be ready to start teaching right away.

# Other Information

## Major Advisor

Every mathematics is assigned to a major advisor. This advisor is a faculty member in the Mathematics Department that will help you with scheduling, degree progress, and more. You will also need to speak with your advisor if you would like to drop a class after the add/drop deadline, change or add a major or minor, register for courses, and ensure that all graduate requirements are met. You should plan to meet with your advisor during Advising Day every semester at a minimum.

## AP Calculus

If you have earned a score of 4 or better on the AP Calculus AB Exam, you will receive credit for Calculus I and you may begin your degree program in Calculus II. If you have earned a score of 4 or better on the AP Calculus BC Exam, the requirements for both Calculus I and Calculus II will be waived, and you may begin with Calculus III.

## Transferring Credits

If you have earned a grade of C or better in an equivalent course at another college or university, you may be able to transfer your credits towards a degree at Mercyhurst. Approval should be sought from the Mathematics Department chair before you register for a course at another school. Generally, credits will be transferred if the course description is similar and the course is for the same number of credits for the course you would like to replace. *Transfer credit will not be approved for any online courses by department policy.*

## Textbooks and Supplies

Most courses will require the purchase of a textbook, though you'll often be able to use the same book for multiple classes in a sequence. Required books are available for purchase from the Mercyhurst Bookstore shortly before each semester begins.

While computers are available for student use on campus, you may find it convenient to purchase your own computer. In particular, a laptop allows you to bring your machine to class. You will be able to use your own computer for any courses that have a programming component. Software used in mathematics courses will typically run on any operating system (Windows, Linux, Mac OS). Chromebooks, tablets, and similar devices are not recommended as your primary computer.

You will not need to purchase a calculator, nor will you be permitted to use one while taking quizzes or exams in any of our courses.

# Resources for Math Students

## Research Opportunities

While it can be difficult for undergraduate mathematics majors to make an independent contribution to the field, there are still plenty of opportunities to learn how mathematics research is done and to investigate topics you find interesting.

## Independent Studies

Though not required for the degree, students that have developed an interest in a certain area of mathematics may request to work with a faculty member for one semester. The faculty member must submit a course plan, outlining an individual study plan and goal. Generally, mathematics students should wait until they have completed Transition to Advanced Math before pursuing an independent study.

The following university policies must also be considered:

- Students must have completed 70 credits and have a cumulative GPA of 2.5 or better in their major.
- The independent study must be on a topic not offered in a traditional course (a Tutorial may be an option).
- Students must meet with the sponsoring faculty member at least one hour per week.
- Students must have permission of the sponsoring faculty member, their major advisor, and the department chair.
- Independent studies that are not required for the major can only be taken on a pass/fail basis.

## MAA Allegheny Mountain Section Meeting

Each year, our department attends the Allegheny Mountain Section Meeting of the Mathematical Association of America. The meeting is held at a different location within the section, including institutions from western Pennsylvania and northern West Virginia. Our students are encouraged to present brief talks at the meetings, usually in their senior year.

## Research Experiences for Undergraduates (REUs)

Advanced students interested in a more intense research experience could apply for a summer REU program, often hosted by larger research universities. These programs are funded and offer a stipend to participants, and are highly encouraged for students that are considering graduate school in mathematics. The programs change on an annual basis, but a good place to begin a search is through the National Science Foundation's program list, which can be found at <https://www.nsf.gov/crssprgm/reu/>.

Students applying for an REU will be expected to have completed Transition to Advanced Math, and each REU may require additional coursework. Recent graduates are not eligible, so you would usually plan for an REU in the summer before your senior year. However, the application process may begin a year earlier.

## Park City Mathematics Institute Summer Session

The Park City Mathematics Institute in Park City, Utah, hosts a three week summer program on a different topic each year. The programs are open to faculty and graduate students, with many lectures and workshops reserved for undergraduates.

## Internships

Many large companies offer internships that could be relevant to mathematics majors. These positions will differ from year to year, but you might begin your search with the American Mathematical Society's internship and co-op list: <http://www.ams.org/programs/students/emp-internships>.

Locally, there are often internship opportunities for our students at Erie Insurance. These can be arranged through the University or by applying directly. Erie Insurance will also host internship and career fairs at least once a year where you can learn more about their expectations and available positions.

## Professional Organizations

There are several professional organizations for mathematics, statistics, and applied fields that undergraduates may be interested in joining. Most organizations offer career information, scholarships, summer research and internship opportunities, and a chance to meet your colleagues in the field. Some also offer their members a discount on books, conference fees, and more. Even if you choose not to join, most of these organizations have valuable information freely available on their websites. Non-members are also welcome to attend or present at conferences for all organizations.

### Mathematical Association of America (MAA)

<https://www.maa.org>

Student Membership: \$35 per year

From the Site: *Student Members now receive online subscriptions to ALL MAA Journals, in addition to member discounts and much more. MAA Membership is your portal to the community of mathematicians and mathematical educators all focused on advancing mathematics at the collegiate level, and on providing you with opportunities to build your network of professionals and peers.*





## American Mathematical Society (AMS)

<https://www.ams.org>

Student Membership: \$49 per year

From the Site: *The American Mathematical Society (AMS) connects mathematician and student members to the national and international community through its publications, meetings, advocacy and other programs. Our members work to further the interests and reach of mathematical research, scholarship and education. Join the AMS today and receive access to exclusive content, publication and meeting registration discounts, and access to the vast community of mathematician members!*

## Society for Industrial and Applied Mathematics (SIAM)

<https://www.siam.org>

Student Membership: \$25 per year

From the Site: *Applied mathematics, in partnership with computational science, is essential in solving many real-world problems. Our mission is to build cooperation between mathematics and the worlds of science and technology through our publications, research, and community. SIAM welcomes students with opportunities to participate in SIAM, as well as online resources on education and careers.*



## American Statistical Association (ASA)

<https://www.amstat.org>

Student Membership: \$25 per year

From the Site: *As the world's largest community of statisticians, the ASA is the Big Tent for Statistics, working to promote the practice and profession of statistics. ASA membership connects you to a community of statisticians serving in industry, government, and academia throughout the world. Our members work to advance research, promote sound statistical practice, inform public policy, and improve human welfare.*

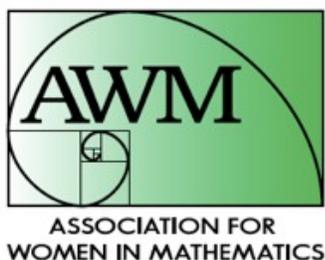


## Association for Women in Mathematics (AWM)

<https://sites.google.com/site/awmmath/home>

Student Membership: \$20 per year

From the Site: *The purpose of the Association for Women in Mathematics is to encourage women and girls to study and to have active careers in the mathematical sciences, and to promote equal opportunity and the equal treatment of women and girls in the mathematical sciences. AWM currently has more than 3000 members (women and men) representing a broad spectrum of the mathematical community - from the United States and around the world!*



## National Council of Teachers of Mathematics (NCTM)

<https://www.nctm.org>

Student Membership: \$48 per year

From the Site: *Founded in 1920, the National Council of Teachers of Mathematics (NCTM) is the world's largest mathematics education organization, with 60,000 members and more than 230 Affiliates throughout the United States and Canada. In addition to exclusive resources and the latest research, membership in NCTM connects you to a network of over 60,000 fellow math educators who share your commitment to student success. Enhance your teaching expertise when you exchange solutions and first-hand insights with this extensive network.*



## Software

- L<sup>A</sup>T<sub>E</sub>X (<https://www.tug.org/>)  
Typesetting for math and science. Anyone planning to teach or study math should know LaTeX (because  $\frac{x^2}{x+2}$  looks so much better than  $x^2/(x+2)$ ). LaTeX can be used for non-scientific papers as well - this handbook was written in LaTeX, for example. The TeX User's Group (TUG) site has all the information you'll ever need, including links to download all required software.
- SageMath (<http://www.sagemath.org/>)  
Open source replacement for Mathematica, Maple, and Matlab. Based on Python. Can be installed on Mac or Linux machines, or run in the cloud (now called CoCalc) on any machine connected to the internet.
- Maxima (<http://maxima.sourceforge.net/>)  
Open source computer algebra system that can be installed on any machine.
- Scilab (<http://www.scilab.org/>)  
Open source replacement for Matlab that can be installed on any machine.
- R (<https://www.r-project.org/>)  
Free software environment for statistical computing and graphics. Used extensively for data analysis.
- Wolfram Alpha (<http://www.wolframalpha.com/>)  
A free (with paid option) AI tool from Wolfram, the makers of Mathematica. Ask it nearly any question and you'll get an answer, from the integral of  $x^2$  to a map of which planes are currently passing over your location. Fun to play with, and useful when checking your homework.

## Books

- American Institute of Mathematics Open Textbook Initiative (<https://aimath.org/textbooks/approved-textbooks/>)  
A list of free textbooks by subject that have met the evaluation criteria of the AIM review board. All are available as PDFs, with the option to order printed copies of some texts for a small fee.
- Science Books Online Mathematics (<http://www.sciencebooksonline.info/mathematics.html>)  
Not every text has been reviewed, but this could be a useful source for additional references.

# ALEKS Mathematics Assessment

Mercyhurst University requires an ALEKS mathematics placement assessment to determine readiness for various courses. The ALEKS Placement Assessment covers material from basic mathematics through pre-calculus, including some geometry and trigonometry.

At the end of the ALEKS Placement Assessment, you will have a much better sense of your strengths and weaknesses in math. You will then have a chance to work on those weaknesses through a targeted Prep and Learning Module geared to your goals to improve placement and eventual course outcomes.

## Requirements

All incoming Mercyhurst students are required to complete the online ALEKS Mathematics Assessment during the summer prior to beginning their freshmen year, unless they have

- earned Advanced Placement credit with a score of 4 or higher.
- passed the standard level International Baccalaureate exam with a score of 5 or higher.
- passed the advanced level International Baccalaureate exam with a score of 4 or higher.
- earned CLEP credits with a score of 50 or higher.
- took an approved 3-credit math or statistics course from an accredited college or university with a grade of C or higher.

You will not be able to register for any courses that requires a particular score until you earn that score unless one of the above cases applies to you. Should you enroll in a course without satisfying the prerequisite, you may be dropped from the course. If you are unsure that you have met the requirements for a course, please check with your advisor before registering.

## About the Assessment

The test takes approximately two hours to complete, and is customized for each student. Based on your responses, the test will generate questions of varying difficulty and topics. The score takes this into account, and reflects your preparation for our courses. The test and recommended scores are in use at hundreds of institutions across the country.

ALEKS is a powerful artificial-intelligence based assessment tool that zeros in on the strengths and weaknesses of a student's mathematical knowledge, reports its findings to the student, and then provides the student with a learning environment for improving this knowledge to an appropriate level for course placement.

The ALEKS Math Assessment ensures students' readiness for particular math, statistics, and chemistry courses at Mercyhurst. Since these courses require the mastery of prerequisite material, it is important for students to begin in the course most likely to lead to success. Students will not be permitted to take a course unless they have demonstrated readiness. After completing the initial assessment, students who wish to improve their skills may use the included free learning modules.

## REACH Curriculum

You can satisfy the Math/Stat requirement of REACH by earning a score of 46 or better on the placement test. You will still need to earn a total of 7 or more credits in the Analytic Thought category. No credit is given for the placement test. The ALEKS Assessment score cannot be used to replace any mathematics courses that may be required by your major.

## Current Students

If you are a current Mercyhurst Student that has not yet taken the ALEKS Mathematics Assessment, or you would like to improve your score, you can arrange to take the exam with a proctor by contacting a faculty member of the Mathematics Department.

If you are not a current freshmen, you will need to pay a \$25 fee to take the placement test. This fee includes five attempts on the placement over a 1 year period, and also comes with 6 months of online, customized remediation to help you improve your score if you have not placed into your desired class.

## Requirements by Course

Required Score	Course
30	Math 110 Math Applications
	Stat 109 Introduction to Statistics
	Stat 130 Introduction to Social Statistics
	Stat 137 Biostatistics
46	Math 111 College Algebra
	Stat 139 Statistics for the Sciences
	Math 146 Programming I
54	Math 118 Math for the Natural Sciences
61	Math 112 Trigonometry and Functions
76	Math 170 Calculus I
	Phys 101 Principles of Physics

# Required Mathematics Course Descriptions

The current course descriptions, prerequisites, and objectives for all required courses can be found below.

The Department of Mathematics also offers several additional courses that may be of interest to majors. Descriptions of these courses may be found in the current Mercyhurst Undergraduate Course Catalog.

## 1. **Math 170 Calculus I**

*Prerequisite(s): ALEKS Placement Score of 76 or better; Math 118; Math 111 and Math 112*

Course Description: This is the initial course in a sequence of courses on the fundamental ideas of the calculus of one variable. It is here that truly significant applications of mathematics begin. Topics included are functions, continuity, limits, derivatives, maxima and minima and antiderivatives.

Course Objectives:

- recognize, define, and apply properties of functions, such as their domain, range, intercepts, and inverse;
- have an intuitive understanding of a limit and be able to evaluate a variety of limits;
- identify the discontinuities of a function that is presented either algebraically or graphically;
- compute the derivative of a function using the limit definition;
- compute the derivative of sums, products, quotients, and compositions of polynomial, trigonometric, exponential, and logarithmic functions;
- understand conceptual relationships between derivatives, rates of change, and tangent lines;
- graph polynomial and rational functions using properties of the functions and their derivatives;
- apply differentiation procedures to solve related rates and optimization problems;
- identify and evaluate limits involving indeterminate forms;
- compute definite and indefinite integrals using antiderivatives and substitution;
- understand the relationship between integration and differentiation.

## 2. **Math 171 Calculus II**

*Prerequisite(s): Math 170*

Course Description: Any student who has completed Calculus I should take Calculus II to obtain a complete study of the calculus of one variable. Topics included are the integral anti-derivatives, the Fundamental Theorem, volume, length of an arc, surface area, average value, moments, integration techniques, series, sequences.

Course Objectives:

- use integration to find areas between curves, volumes of solids formed by revolution, lengths of plane curves;
- find derivatives and integrals involving exponential and logarithmic functions;
- find derivatives and integrals involving the inverse trigonometric functions;
- evaluate integrals using a variety of integration techniques;
- solve first-order separable differential equations;
- evaluate improper integrals;
- find the limit of a sequence;
- determine whether a given series converges or diverges;
- find the power series expansion of a function and its radius of convergence;
- further the understanding and ability to write mathematics;
- read a theorem in a calculus text, check the hypotheses in a particular situation, and draw appropriate conclusions.

## 3. **Math 233 Calculus III**

*Prerequisite(s): Math 171*

Course Description: This is an introduction to the calculus of several variables. Topics selected from polar coordinates, functions of several variables, partial derivatives, multiple integrals, line integrals, surface integrals, Green's theorem and Stokes' Theorem.

Course Objectives:

- graph polar equations and find area using polar coordinates;
- graph and differentiate parametric equations and find arc length;
- compute dot products and cross products in 3-space and interpret the results;
- graph quadric surfaces;
- convert equations between rectangular, spherical and cylindrical coordinates;
- compute and apply: limits, partial derivatives, directional derivatives, the gradient and equation of tangent planes for functions of two variables;
- apply the chain rule to functions of  $n$ -variables;
- find maxima and minima of functions of two variables;
- set up and evaluate double, triple, surface and line integrals;
- apply Green's and Stokes theorems.

#### 4. **Math 150 Linear Algebra**

*Prerequisite(s): Math 170 and Math 171*

Course Description: This course is an introduction to the algebra and geometry of Euclidean 3-space and its extensions to Euclidean N-Space. Topics included are systems of linear equations, determinants, vectors, bases, linear transformations and matrices.

Course Objectives:

- describe the solution(s) of a system of linear equations, or be able to decide that one does not exist.
- be able to perform arithmetic operations on vectors and matrices, where defined;
- calculate the determinant of a matrix, and understand its significance;
- define a vector space and determine whether a set is a vector space;
- find the basis and dimension of a vector space;
- define and identify linear maps;
- define and compute eigenvalues and eigenvectors;
- explain the geometric effect of a linear transformation on 2-dimensional spaces;
- produce and utilize simple computer programs to perform computations related to all of the above topics.

#### 5. **Math 240 Differential Equations**

*Prerequisite(s): Math 150 and Math 171*

Course Description: An introduction to the basic mathematical content of ordinary differential equations and their applications. This will include analytical, qualitative, and numerical methods for ordinary differential equations. Topics include first-order and second-order equations and applications, systems of differential equations, and matrix methods for linear systems.

Course Objectives:

- learn introductory mathematical content of ordinary differential equations and their applications. This will include analytical, qualitative and numerical methods for ordinary differential equations;
- use both the rules of algebra and the rules of calculus (e.g., differentiation shortcuts, integration techniques, etc.) to develop techniques for solving differential equations;
- continue to improve our ability to write mathematics.

#### 6. **Math 245 Geometry**

*Prerequisite(s): Math 150 and Math 171*

Course Description: Emphasis is given to geometry, uses of geometry in various mathematical subjects, historical aspects of geometry and mathematics, and mathematical curricular developments. The following topics are integrated into the course: Euclidean and non-Euclidean geometry, historical and cultural significance of mathematics, and mathematical software products.

Course Objectives:

- introduce the student to the rich variety of geometric topics, beyond those studied at the high school level;
- study Euclidean geometry in much more detail than in a typical high school geometry course;
- investigate Non-Euclidean and finite geometries;
- develop the skills of logical reasoning, specifically in the use of the axiomatic method and careful presentation of proof.

## 7. **Math 265 Transition to Advanced Mathematics**

*Prerequisite(s): Math 150 and Math 171*

Course Description: This course is designed to facilitate the mathematics student's transition to courses requiring a higher level of mathematical maturity. Emphasis will be on the reading and writing of proofs, and on communicating mathematically both orally and in writing. Topics will include logic, set theory, functions, relations, and number theory.

Course Objectives:

- provide the definitions of algebraic objects, and know some examples of each;
- develop abstract and critical reasoning by studying and writing mathematical proofs;
- understand the connection between modern algebra and other branches of mathematics;
- relate the material learned in this course to prerequisite courses;
- recognize algebraic structures and objects in everyday situations;
- learn about the historical development of modern algebra.

## 8. **Math 280 Modern Algebra I**

*Prerequisite(s): Math 150, Math 233, and Math 265*

Course Description: This second semester course will build on material from Math 280, with a focus on integral domains, polynomial rings, and fields. Additional topics will include the Sylow theorems, finite simple groups, symmetry and patterns, and an introduction to Galois theory.

Course Objectives:

- provide the definitions of algebraic objects, and know some examples of each;
- develop abstract and critical reasoning by studying and writing mathematical proofs;
- understand the connection between modern algebra and other branches of mathematics;
- relate the material learned in this course to prerequisite courses;
- recognize algebraic structures and objects in everyday situations;
- learn about the historical development of modern algebra.

## 9. **Math 281 Modern Algebra II**

*Prerequisite(s): Math 280*

Course Description: This course is designed to facilitate the mathematics student's transition to courses requiring a higher level of mathematical maturity. Emphasis will be on the reading and writing of proofs, and on communicating mathematically both orally and in writing. Topics will include logic, set theory, functions, relations, and number theory.

Course Objectives:

- provide the definitions of algebraic objects, and know some examples of each;
- develop abstract and critical reasoning by studying and writing mathematical proofs;
- understand the connection between modern algebra and other branches of mathematics;
- relate the material learned in this course to prerequisite courses;
- recognize algebraic structures and objects in everyday situations;
- learn about the historical development of modern algebra.

10. **Math 291 Statistical Analysis**

*Prerequisite(s): Math 150 and Math 233*

Course Description: An introduction to statistical concepts and techniques with emphasis on the underlying probability theoretical basis. Topics included are sums of random variables; moment generating functions; sampling distributions; F- and t-distributions; chi-square; point estimation; interval estimation; testing hypotheses, theory, and application; regression and correlation; analysis of variance.

Course Objectives:

- demonstrate understanding of the use of probability models and statistical methods for analysing data;
- apply abstract mathematical concept in real data;
- understand the scope of statistics and its applications;
- study fundamental statistical methods and employ these methods in real life problems;
- develop linear regression, multiple regression and polynomial regression models.

11. **Math 370 Advanced Calculus**

*Prerequisite(s): Math 233 and Math 265*

Course Description: This course introduces the fundamental concepts of a function of a real variable from a rigorous point of view. Topics included are completion of the rational numbers, theory of continuous functions, theory of differentiation, theory of the Riemann integral, sequences, series.

Course Objectives:

- prove properties about the reals and completeness of the reals;
- prove convergence and divergence of a sequence;
- prove convergence and divergence of limits using the  $\epsilon - \delta$  definition;
- identify and prove basic theorems about derivatives and their properties;
- define the Riemann Integral and use the definition to compute integral values in elementary cases.

12. **Math 400 Topics in Mathematics**

*Prerequisite(s): Math 265*

Course Description: Some possible areas for further study are Abstract Algebra, Geometry, Topology, Real Analysis and Complex Variables. At least one topics course is desirable for anyone wishing to pursue mathematics in graduate school.

# Just for Fun

## Recommended Reading

**Flatland: A Romance of Many Dimensions**, by A Square (Edwin A. Abbott)

Available for free at <http://www.geom.uiuc.edu/~banchoff/Flatland/>

A short, satirical story about a two dimensional world visited by a three dimensional sphere. Very entertaining, and it may help you to understand the concept of higher dimensions.

**A Mathematician's Apology**, by G. H. Hardy

Available for free at <http://www.math.ualberta.ca/mss/misc/A%20Mathematician's%20Apology.pdf>

Hardy's justification for devoting his life to mathematics, exploring its beauty and utility.

## On Mathematics

"Mathematics is the most beautiful and most powerful creation of the human spirit."

- Stefan Banach, 1892 - 1945

"In mathematics, the art of proposing a question must be held of higher value than solving it."

- Georg Cantor, 1845 - 1918

"Mathematics seems to endow one with something like a new sense."

- Charles Darwin, 1809 - 1882

"Mathematics is the art of giving the same name to different things."

- Henri Poincare, 1854 - 1912

"God may not play dice with the universe, but something strange is going on with the prime numbers."

- Paul Erdős, 1913 - 1996

"Everyone knows what a curve is, until he has studied enough mathematics to become confused through the countless number of possible exceptions."

- Felix Klein, 1849 - 1925

"Mathematics is a game played according to certain simple rules with meaningless marks on paper."

- David Hilbert, 1862 - 1943

"Pure mathematics is, in its way, the poetry of logical ideas."

- Albert Einstein, 1879 - 1955

## Famous Math Majors - But Not Famous for Math

You may recognize some of these names, but you may not know they all have a degree in mathematics:

Ralph Abernathy (Civil Rights Leader, Alabama State)  
Steve Ballmer (CEO Microsoft, Harvard)  
Sergey Brin (Cofounder and President of Google, University of Maryland at College Park)  
Lewis Carroll (Author, real name Charles Dodgson, Christ Church)  
Eileen Collins (NASA astronaut, Syracuse University)  
Marie Curie (Chemist, physicist, and Nobel Prize winner, Sorbonne)  
Felicia Day (Actress and producer, UT Austin)  
David Dinkins (Mayor of NY City, Howard)  
Helene Foellinger (Journalist, University of Illinois Urbana-Champaign)  
Alberto Fujimori (President of Peru, MA, University of Wisconsin Milwaukee)  
Art Garfunkel (Musician, MA, Columbia)  
Phillip Glass (Composer, University of Chicago)  
Larry Gonick (Cartoonist, MA, Harvard)  
Reed Hastings (Cofounder and CEO Netflix, Bowdoin)  
Davey Johnson (Baseball player and manager of NY Mets, Trinity)  
John Maynard Keynes (Economist, MA, Cambridge)  
Emanuel Lasker (Chess champion, PhD, Göttingen)  
Tom Lehrer (Musician and satirist, MA, Harvard)  
Danica McKellar (Actress and author, UCLA)  
Harvey Milk (Politician, SUNY Albany)  
Story Musgrave (NASA astronaut and physician, Syracuse University)  
David Robinson (NBA All-Star, Annapolis)  
Carl T. Rowan (Washington Post Journalist, Oberlin)  
Frank Ryan (Cleveland Browns, PhD, Rice)  
George Saitoti (Vice President of Kenya, PhD, Warwick)  
Bram Stoker (Author, Trinity Dublin)  
Laurence H. Tribe (Harvard Law Professor, Harvard)  
Alan Turing (Computer science pioneer, PhD, Princeton)  
Paul Vanhoeven (Director, PhD, University of Leiden)  
Virginia Wade (Wimbledon champion, Sussex)

## Something to Think About

What is the minimum number of straight cuts required to divide a pizza into 8 (unequal) pieces?

Does a shape with constant width have to be a circle?

Of all shapes with the same perimeter, which will have the largest area?

If a card shuffling machine shuffles a deck of 52 cards every second, how long will the machine need to run to guarantee that the same order has been produced more than once?

If you walk across half of a room, then half of the remainder, then half of that remainder, and so on, can you ever reach the other side?

How many sides does a sphere have?

If 23 people are in a room, what is the likelihood that two of them have the same birthday, assuming every date is equally likely?

If  $x!$  is the product of all whole numbers between 1 and  $x$  (so for example,  $4! = 1 \cdot 2 \cdot 3 \cdot 4 = 24$ ), how long is  $10!$  seconds?