

MATHEMATICS, B.S. (ALTOONA)

Begin Campus: Any Penn State Campus

End Campus: Altoona

Program Description

Not all options are available at every campus. Contact the campus you are interested in attending to determine which options are offered.

Two degrees are offered in mathematics: the Bachelor of Arts and the Bachelor of Science. Both programs have a common core of mathematics courses; both programs prepare students for graduate work in mathematics. In addition, the Bachelor of Arts degree is oriented toward applications of mathematics in the arts and the humanities. The Bachelor of Science degree has a number of options. These options are oriented toward actuarial science, applied and industrial, computational mathematics, graduate study and systems analysis.

Many of the options are designed for students who want to use mathematics in industry, commerce, or government. In short, the degree requirements have the flexibility to fit many individual interests. The student, with the assistance of a faculty adviser, should select an option by the end of the sophomore year.

What is Mathematics?

The study of mathematics emphasizes careful problem analysis, precision of thought and expression, and the development of mathematical skills needed for work in many other areas. Theoretical mathematicians increase basic knowledge in "pure" fields like abstract algebra, analysis, or topology. Applied mathematicians use tools growing out of calculus, analysis, computing, statistics, and operations research to solve problems in science, industry, government, and other areas.

You Might Like This Program If...

- You like mathematics, like to think, like a challenge, and like to know why things are true.
- You want to develop strong problem-solving skills, comprehension of abstract concepts, and creative thinking ability.
- You want to have access to a wide variety of careers in the fields of science and technology, finance and risk analysis, research and industry, and teaching.

Entrance to Major

In order to be eligible for entrance to the Mathematics major, a student must have:

1. attained at least a 2.00 cumulative grade point average; and
2. completed MATH 140 and MATH 141 and earned a grade of C or better in each of these courses.

Degree Requirements

For the Bachelor of Science degree in Mathematics, a minimum of 120 credits is required:

| Requirement | Credits |
|----------------------------|---------|
| General Education | 45 |
| Electives | 0-1 |
| Requirements for the Major | 80-83 |

6 of the 45 credits for General Education are included in the Requirements for the Major. This includes 6 General Education GQ courses.

General Education

Connecting career and curiosity, the General Education curriculum provides the opportunity for students to acquire transferable skills necessary to be successful in the future and to thrive while living in interconnected contexts. General Education aids students in developing intellectual curiosity, a strengthened ability to think, and a deeper sense of aesthetic appreciation. These are requirements for all baccalaureate students and are often partially incorporated into the requirements of a program. For additional information, see the General Education Requirements (<http://bulletins.psu.edu/undergraduate/general-education/baccalaureate-degree-general-education-program/>) section of the Bulletin and consult your academic adviser.

The keystone symbol appears next to the title of any course that is designated as a General Education course. Program requirements may also satisfy General Education requirements and vary for each program.

Foundations (grade of C or better is required.)

- **Quantification (GQ):** 6 credits
- **Writing and Speaking (GWS):** 9 credits

Knowledge Domains

- **Arts (GA):** 6 credits
- **Health and Wellness (GHW):** 3 credits
- **Humanities (GH):** 6 credits
- **Social and Behavioral Sciences (GS):** 6 credits
- **Natural Sciences (GN):** 9 credits

Integrative Studies (may also complete a Knowledge Domain requirement)

- **Inter-Domain or Approved Linked Courses:** 6 credits

University Degree Requirements

First Year Engagement

All students enrolled in a college or the Division of Undergraduate Studies at University Park, and the World Campus are required to take 1 to 3 credits of the First-Year Seminar, as specified by their college First-Year Engagement Plan.

Other Penn State colleges and campuses may require the First-Year Seminar; colleges and campuses that do not require a First-Year Seminar provide students with a first-year engagement experience.

First-year baccalaureate students entering Penn State should consult their academic adviser for these requirements.

Cultures Requirement

6 credits are required and may satisfy other requirements

- United States Cultures: 3 credits
- International Cultures: 3 credits

Writing Across the Curriculum

3 credits required from the college of graduation and likely prescribed as part of major requirements.

Total Minimum Credits

A minimum of 120 degree credits must be earned for a baccalaureate degree. The requirements for some programs may exceed 120 credits. Students should consult with their college or department adviser for information on specific credit requirements.

Quality of Work

Candidates must complete the degree requirements for their major and earn at least a 2.00 grade-point average for all courses completed within their degree program.

Limitations on Source and Time for Credit Acquisition

The college dean or campus chancellor and program faculty may require up to 24 credits of course work in the major to be taken at the location or in the college or program where the degree is earned. Credit used toward degree programs may need to be earned from a particular source or within time constraints (see Senate Policy 83-80 (<http://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#83-80>)). For more information, check the Suggested Academic Plan for your intended program.

Requirements for the Major

To graduate, a student enrolled in the major must earn a grade of C or better in each course designated by the major as a C-required course, as specified by Senate Policy 82-44 (<http://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#82-44>).

Common Requirements for the Major (All Options)

| Code | Title | Credits |
|---|---|---------|
| Prescribed Courses | | |
| STAT 200 | Elementary Statistics | 4 |
| <i>Prescribed Courses: Require a grade of C or better</i> | | |
| MATH 140 | Calculus With Analytic Geometry I | 4 |
| MATH 141 | Calculus with Analytic Geometry II | 4 |
| MATH 220 | Matrices | 2 |
| MATH 230 | Calculus and Vector Analysis | 4 |
| MATH 311W | Concepts of Discrete Mathematics | 3-4 |
| MATH 312 | Concepts of Real Analysis | 3 |
| Additional Courses | | |
| Select one of the following: | | 3 |
| CMPSC 101 | Introduction to Programming | |
| CMPSC 121 | Introduction to Programming Techniques | |
| CMPSC 201 | Programming for Engineers with C++ | |
| <i>Additional Courses: Require a grade of C or better</i> | | |
| MATH 250 | Ordinary Differential Equations | 3-4 |
| or MATH 251 | Ordinary and Partial Differential Equations | |
| Requirements for the Option | | |
| Select an option | | 50-51 |

Requirements for the Option

Actuarial Mathematics Option (50-51 credits)

Available at the following campuses: University Park

| Code | Title | Credits |
|---|--|---------|
| Prescribed Courses | | |
| <i>Prescribed Courses: Require a grade of C or better</i> | | |
| IE 425 | Stochastic Models in Operations Research | 3 |
| MATH 414 | Introduction to Probability Theory | 3 |
| MATH 415 | Introduction to Mathematical Statistics | 3 |
| MATH 416 | Stochastic Modeling | 3 |
| MATH 484 | Linear Programs and Related Problems | 3 |
| RM 302 | Risk and Insurance | 3 |
| RM 410 | Financial Mathematics for Actuaries | 3 |
| RM 411 | Actuarial Mathematics I | 3 |
| RM 412 | Actuarial Mathematics II | 3 |
| STAT 462 | Applied Regression Analysis | 3 |
| Additional Courses | | |
| <i>Additional Courses: Require a grade of C or better</i> | | |
| MATH 451 | Numerical Computations | 3 |
| or MATH 486 | Mathematical Theory of Games | |
| STAT 463 | Applied Time Series Analysis (or 400-level MATH course) ¹ | 3 |
| Supporting Courses and Related Areas | | |
| Select 14-15 credits from department list | | 14-15 |

- ¹ Select 3 credits from STAT 463 or 400-level MATH courses except:
- MATH 401
 - MATH 405
 - MATH 406
 - MATH 441
 - MATH 470
 - MATH 471

Applied and Industrial Mathematics Option (50-51 credits)

Available at the following campuses: University Park

| Code | Title | Credits |
|---|---|---------|
| Prescribed Courses | | |
| <i>Prescribed Courses: Require a grade of C or better</i> | | |
| MATH 403 | Classical Analysis I | 3 |
| MATH 412 | Fourier Series and Partial Differential Equations | 3 |
| MATH 414 | Introduction to Probability Theory | 3 |
| MATH 415 | Introduction to Mathematical Statistics | 3 |
| MATH 436 | Linear Algebra | 3 |
| MATH 450 | Mathematical Modeling | 3 |
| MATH 455 | Introduction to Numerical Analysis I | 3 |
| Additional Courses | | |
| <i>Additional Courses: Require a grade of C or better</i> | | |
| Select 12 credits of the following: | | 12 |
| MATH 411 | Ordinary Differential Equations | |
| MATH 416 | Stochastic Modeling | |
| MATH 417 | Qualitative Theory of Differential Equations | |
| MATH 419 | Theoretical Mechanics | |
| MATH 421 | Complex Analysis | |
| MATH 456 | Introduction to Numerical Analysis II | |
| MATH 461 | | |
| MATH 467 | Factorization and Primality Testing | |

| | | |
|----------|--------------------------------------|--|
| MATH 468 | Mathematical Coding Theory | |
| MATH 479 | Special and General Relativity | |
| MATH 484 | Linear Programs and Related Problems | |
| MATH 485 | Graph Theory | |
| MATH 486 | Mathematical Theory of Games | |

Supporting Courses and Related Areas
 Select 17-18 credits from department list 17-18

Computational Mathematics Option (50-51 credits)
Available at the following campuses: University Park

| Code | Title | Credits |
|---|---|---------|
| Prescribed Courses | | |
| CMPSC 122 | Intermediate Programming | 3 |
| CMPSC 465 | Data Structures and Algorithms | 3 |
| <i>Prescribed Courses: Require a grade of C or better</i> | | |
| MATH 414 | Introduction to Probability Theory | 3 |
| MATH 415 | Introduction to Mathematical Statistics | 3 |
| MATH 455 | Introduction to Numerical Analysis I | 3 |
| MATH 456 | Introduction to Numerical Analysis II | 3 |
| MATH 467 | Factorization and Primality Testing | 3 |
| MATH 484 | Linear Programs and Related Problems | 3 |

Additional Courses
Additional Courses: Require a grade of C or better
 Select 3 credits of the following: 3

| | | |
|----------|---|--|
| MATH 411 | Ordinary Differential Equations | |
| MATH 412 | Fourier Series and Partial Differential Equations | |
| MATH 417 | Qualitative Theory of Differential Equations | |

Select 6 credits of the following: 6

| | | |
|----------|----------------------------|--|
| MATH 310 | Elementary Combinatorics | |
| MATH 468 | Mathematical Coding Theory | |
| MATH 485 | Graph Theory | |

Supporting Courses and Related Areas
 Select 17-18 credits from department list 17-18

General Mathematics Option (50-51 credits)
Available at the following campuses: Altoona, University Park

| Code | Title | Credits |
|---|---|---------|
| Prescribed Courses | | |
| <i>Prescribed Courses: Require a grade of C or better</i> | | |
| MATH 403 | Classical Analysis I | 3 |
| MATH 414 | Introduction to Probability Theory | 3 |
| MATH 415 | Introduction to Mathematical Statistics | 3 |
| Additional Courses | | |
| <i>Additional Courses: Require a grade of C or better</i> | | |
| MATH 435 | Basic Abstract Algebra | 3 |
| or MATH 436 | Linear Algebra | |
| Select 3 credits of the following: 3 | | |
| MATH 411 | Ordinary Differential Equations | |
| MATH 412 | Fourier Series and Partial Differential Equations | |
| MATH 417 | Qualitative Theory of Differential Equations | |
| MATH 419 | Theoretical Mechanics | |
| MATH 421 | Complex Analysis | |

Select 6 credits of 400-level MATH courses ¹ 6

Supporting Courses and Related Areas
 Select an approved sequence of 12 credits in MATH or a related area 12
 or an area of application
 Select 17-18 credits from department list 17-18

- ¹ Select 6 credits of 400-level MATH courses except:
- MATH 401
 - MATH 405
 - MATH 406
 - MATH 441
 - MATH 470
 - MATH 471

Graduate Study Option (50-51 credits)
Available at the following campuses: University Park

| Code | Title | Credits |
|---|---|---------|
| Prescribed Courses | | |
| <i>Prescribed Courses: Require a grade of C or better</i> | | |
| MATH 403 | Classical Analysis I | 3 |
| MATH 404 | Classical Analysis II | 3 |
| MATH 414 | Introduction to Probability Theory | 3 |
| MATH 415 | Introduction to Mathematical Statistics | 3 |
| MATH 421 | Complex Analysis | 3 |
| MATH 429 | Introduction to Topology | 3 |
| MATH 435 | Basic Abstract Algebra | 3 |
| MATH 436 | Linear Algebra | 3 |

Additional Courses
Additional Courses: Require a grade of C or better
 Select 9 credits of 400-level MATH courses ¹ 9

Supporting Courses and Related Areas
 Select 17-18 credits from department list 17-18

- ¹ Select 9 credits of 400-level MATH courses except:
- MATH 401
 - MATH 405
 - MATH 406
 - MATH 441
 - MATH 470
 - MATH 471

Systems Analysis Option (50-51 credits)
Available at the following campuses: Altoona, University Park

| Code | Title | Credits |
|---|---|---------|
| Prescribed Courses | | |
| <i>Prescribed Courses: Require a grade of C or better</i> | | |
| MATH 414 | Introduction to Probability Theory | 3 |
| MATH 415 | Introduction to Mathematical Statistics | 3 |
| MATH 436 | Linear Algebra | 3 |
| MATH 484 | Linear Programs and Related Problems | 3 |
| Additional Courses | | |
| <i>Additional Courses: Require a grade of C or better</i> | | |
| Select 6 credits of the following: 6 | | |
| MATH 310 | Elementary Combinatorics | |

| | | |
|--|------------------------------|-------|
| MATH 451 | Numerical Computations | |
| MATH 485 | Graph Theory | |
| MATH 486 | Mathematical Theory of Games | |
| Select 3 credits from 400-level MATH courses ¹ | | 3 |
| Supporting Courses and Related Areas | | |
| Select an approved sequence of 12 credits in an area of application; possible areas include business, economics, industrial engineering, social sciences | | 12 |
| Select 17-18 credits from department list | | 17-18 |

¹ Select 3 credits of 400-level MATH courses except:

- MATH 401
- MATH 405
- MATH 406
- MATH 441
- MATH 470
- MATH 471

Program Learning Objectives

- Students should be able to demonstrate a strong understanding of the core concepts of differential and integral calculus, elementary linear algebra, and differential equations, and to use these concepts to describe physical problems mathematically.
- Students should develop an understanding of mathematical proof techniques, and demonstrate skill in the effective communication of mathematical concepts and proofs, especially in written form.
- Students should demonstrate an understanding of advanced mathematical concepts and their use to solve problems both from within mathematics and from applied areas.
- Graduating students should be prepared to cope with the mathematical challenges they meet in continuing their mathematical education or at the workplace.

Academic Advising

The objectives of the university's academic advising program are to help advisees identify and achieve their academic goals, to promote their intellectual discovery, and to encourage students to take advantage of both in-and out-of class educational opportunities in order that they become self-directed learners and decision makers.

Both advisers and advisees share responsibility for making the advising relationship succeed. By encouraging their advisees to become engaged in their education, to meet their educational goals, and to develop the habit of learning, advisers assume a significant educational role. The advisee's unit of enrollment will provide each advisee with a primary academic adviser, the information needed to plan the chosen program of study, and referrals to other specialized resources.

READ SENATE POLICY 32-00: ADVISING POLICY (<https://senate.psu.edu/policies-and-rules-for-undergraduate-students/32-00-advising-policy/>)

Altoona

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University Park

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Suggested Academic Plan

The suggested academic plan(s) listed on this page are the plan(s) that are in effect during the 2021-22 academic year. To access previous years' suggested academic plans, please visit the archive (<https://bulletins.psu.edu/undergraduate/archive/>) to view the appropriate Undergraduate Bulletin edition (*Note: the archive only contain suggested academic plans beginning with the 2018-19 edition of the Undergraduate Bulletin*).

General Mathematics Option: Mathematics, B.S. at Altoona Campus

The course series listed below provides **only one** of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an **Academic Requirements** or **What If** report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

First Year

| Fall | Credits Spring | Credits |
|--------------------------------|---|-------------|
| MATH 140 | 4 MATH 141 | 4 |
| PSU 3 | 1 ENGL 15, 30H, or ESL 15 ^{††} | 3 |
| STAT 200 | 4 General Education Course | 3 |
| General Education Course | 3 General Education Course | 3 |
| General Education Course | 3 General Education Course (GHW) | 1.5 |
| General Education Course (GHW) | 1.5 | |
| | 16.5 | 14.5 |

Second Year

| Fall | Credits Spring | Credits |
|--------------------------------------|--|--------------|
| MATH 220 [*] | 2-3 MATH 250 or 251 | 3-4 |
| MATH 230 [*] | 4 MATH 311W [*] | 3 |
| General Education Course | 3 CMPSC 101, 121, or 201 | 3 |
| General Education Course | 3 Supporting Course (Consult with an academic adviser for alternative) | 3 |
| CAS 100A, 100B, or 100C [‡] | 3 ENGL 202C [‡] | 3 |
| | 15-16 | 15-16 |

Third Year

| Fall | Credits Spring | Credits |
|------------------------------|-------------------------|---------|
| MATH 312 [*] | 3 MATH 414 or STAT 414 | 3 |
| MATH 435 or 436 [*] | 3 MATH 403 [*] | 3 |

| | | |
|--|---|-----------|
| Area of Application (Consult with an academic adviser for alternative options) | 3 Area of Application Course (Consult with an academic adviser for alternative options) | 3 |
| Supporting Course (Consult with an academic adviser for alternative options) | 3 General Education Course | 3 |
| General Education Course | 3 Supporting Course (Chose in consultation with your academic advisor) | 3 |
| 15 | | 15 |

Fourth Year

| Fall | Credits Spring | Credits |
|---|---|-----------|
| MATH 411, 412, 417, 419, or 421 [*] | 3 400-Level MATH course except MATH 401, 405, 406, 470, 471 | 3 |
| 400-level MATH course except MATH 401, 405, 406, 470 and 471 [*] | 3 Area of Application Course (Consult with an academic adviser for alternative options) | 3 |
| Area of Application Course (Consult with an academic adviser for alternative options) | 3 Supporting Course (Consult with an academic adviser for alternative options) | 3 |
| Supporting Course (Chosen in consultation with your academic advisor) | 3 Supporting Course (Consult with an academic adviser for alternative options) | 3 |
| Supporting Course (Chosen in consultation with your academic advisor) [†] | 3 400-Level MATH | 3 |
| 15 | | 15 |

Total Credits 121-123

- * Course requires a grade of C or better for the major
- ‡ Course requires a grade of C or better for General Education
- # Course is an Entrance to Major requirement
- † Course satisfies General Education and degree requirement

University Requirements and General Education Notes:

US and IL are abbreviations used to designate courses that satisfy University Requirements (United States and International Cultures).

W, M, X, and Y are the suffixes at the end of a course number used to designate courses that satisfy University Writing Across the Curriculum requirement.

GWS, GQ, GHW, GN, GA, GH, and GS are abbreviations used to identify General Education program courses. General Education includes Foundations (GWS and GQ) and Knowledge Domains (GHW, GN, GA, GH, GS, and Integrative Studies). Foundations courses (GWS and GQ) require a grade of 'C' or better.

Integrative Studies courses are required for the General Education program. N is the suffix at the end of a course number used to designate an Inter-Domain course and Z is the suffix at the end of a course number used to designate a Linked course.

Systems Analysis Option: Mathematics, B.S. at Altoona Campus

The course series listed below provides **only one** of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an **Academic Requirements** or **What If** report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

First Year

| Fall | Credits Spring | Credits |
|--------------------------------|--|-------------|
| MATH 140 | 4 MATH 141 | 4 |
| PSU 3 | 1 ENGL 15, 30H, or ESL 15 [‡] | 3 |
| STAT 200 | 4 General Education Course | 3 |
| General Education Course | 3 General Education Course | 3 |
| General Education Course | 3 General Education Course (GHW) | 1.5 |
| General Education Course (GHW) | 1.5 | |
| 16.5 | | 14.5 |

Second Year

| Fall | Credits Spring | Credits |
|--------------------------------------|--|--------------|
| MATH 220 [*] | 2-3 MATH 250 or 251 [*] | 3-4 |
| MATH 230 | 4 MATH 311W [*] | 3 |
| General Education | 3 CMPSC 101, 121, or 201 | 3 |
| General Education | 3 Supporting Course (Consult with an academic adviser for alternative options) | 3 |
| CAS 100A, 100B, or 100C [‡] | 3 ENGL 202C [‡] | 3 |
| 15-16 | | 15-16 |

Third Year

| Fall | Credits Spring | Credits |
|---|---|-----------|
| MATH 312 [*] | 3 MATH 414 or STAT 415 | 3 |
| MATH 436 or 484 [*] | 3 MATH 310, 451, 485, or 486 [*] | 3 |
| Area of Application Course (Consult with an academic adviser for alternative options) | 3 Area of Application Course (Consult with an academic adviser for alternative options) | 3 |
| Supporting Course (Consult with an academic adviser for alternative options) | 3 General Education Course | 3 |
| General Education | 3 Supporting Course (Chosen in consultation with your academic advisor) | 3 |
| 15 | | 15 |

Fourth Year

| Fall | Credits Spring | Credits |
|---|--|---------|
| MATH 415 or STAT 415 [*] | 3 MATH 310, 451, 485, or 486 | 3 |
| MATH 436 or 484 [*] | 3 400-Level MATH Course expt MATH 401, 405, 406, 470, 471 | 3 |
| Area of Application Course (Consult with an academic adviser for alternative options) | 3 Area of Application (Consult with an academic adviser for alternative options) | 3 |

| | | |
|--|---|-----------|
| Supporting Course (Consult with an academic adviser for alternative options) | 3 Supporting Course (Consult with an academic adviser for alternative options) | 3 |
| General Education Course | 3 Supporting Course (Consult with an academic adviser for alternative options) [†] | 3 |
| 15 | | 15 |

Total Credits 121-123

- * Course requires a grade of C or better for the major
- ‡ Course requires a grade of C or better for General Education
- # Course is an Entrance to Major requirement
- † Course satisfies General Education and degree requirement

University Requirements and General Education Notes:

US and IL are abbreviations used to designate courses that satisfy University Requirements (United States and International Cultures).

W, M, X, and Y are the suffixes at the end of a course number used to designate courses that satisfy University Writing Across the Curriculum requirement.

GWS, GQ, GHW, GN, GA, GH, and GS are abbreviations used to identify General Education program courses. General Education includes Foundations (GWS and GQ) and Knowledge Domains (GHW, GN, GA, GH, GS, and Integrative Studies). Foundations courses (GWS and GQ) require a grade of 'C' or better.

Integrative Studies courses are required for the General Education program. N is the suffix at the end of a course number used to designate an Inter-Domain course and Z is the suffix at the end of a course number used to designate a Linked course.

Career Paths

Students with an undergraduate degree in mathematics pursue graduate study or careers in business and industry. Mathematicians may work in insurance (as actuaries), economics (as analysts), computer programming, science and engineering, the medical and legal fields, education, and other fields which require sophisticated analytical skills.

Careers

Students with an undergraduate degree in Mathematics pursue careers in the fields of science and technology, business and consulting, research and industry, and teaching.

MORE INFORMATION ABOUT POTENTIAL CAREER OPTIONS FOR GRADUATES OF THE MATHEMATICS PROGRAM (<https://math.psu.edu/undergraduate/advising/careers/>)

Opportunities for Graduate Studies

Graduates of the undergraduate degree program in Mathematics often choose to continue their studies in graduate programs (MS or PhD) in mathematics or related fields, such as statistics, economics, finance, computer science, or operations research.

MORE INFORMATION ABOUT OPPORTUNITIES FOR GRADUATE STUDIES (<https://math.psu.edu/undergraduate/advising/careers/>)

Professional Resources

- Mathematical Association of America (<http://www.maa.org/>)
- American Mathematical Society (<http://www.ams.org/home/page/>)
- Society of Industrial and Applied Mathematics (<https://www.siam.org/>)

Contact

Altoona

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<http://altoona.psu.edu/academics/bachelors-degrees/mathematics/request-information> (<http://altoona.psu.edu/academics/bachelors-degrees/mathematics/request-information/>)

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