

MATHEMATICS, BA

Mathematics is the international language of science and technology. Much of the subject matter in engineering and the natural sciences, as well as some social sciences such as economics, is presented in mathematical terms. Mathematical and statistical techniques are vital in fields that usually are not considered mathematical, such as biology, psychology, and political science.

Some students come to mathematical sciences with the intention of teaching in high school or college or pursuing research in mathematics. Some are attracted to mathematics for its own sake, for the beauty, discipline, logic, and problem-solving challenges. Other students pursue mathematics in order to achieve deeper understanding in their own areas of study.

Many students assume that most math majors become teachers. While many do, there are many other opportunities for math majors. The United States National Security Agency is the largest employer of math majors in the country. Math majors will also be found at NASA; in engineering firms; at insurance and risk management firms; in robotics and computer science companies; at large and small corporations working in market research, data management and web management; at social media start ups and established firms like YouTube; and any place that needs to make decisions based on numerical facts.

At UWM, the Math major has been designed to be flexible so that students could complete their major requirements via courses that match their interests and goals. Many students should find it relatively easy to complete double majors in mathematics and another subject.

Most mathematics courses belong in one of the following four groups: applied mathematics, computational mathematics, pure mathematics, and statistics.

- Applied Mathematics is a discipline using mathematical analysis to solve problems coming from outside the field of mathematics.
- Computational mathematics is closely related to applied mathematics. It emphasizes techniques of scientific computing and other computational analysis.
- Pure mathematics emphasizes the theory and structure underlying all areas of mathematics.
- Statistics is a field of mathematics that provides strategies and tools for using data to gain insight into real-world and experimental problems.

Students of the sciences, engineering, computer science, economics, and business often complete a significant number of mathematical sciences credits. These students are encouraged to take a mathematics major or minor, which adds an official recognition of important analytical skills valued by employers and graduate schools.

Students interested in teaching mathematics at the K-12 level should examine the School of Education (<https://catalog.uwm.edu/community-engagement-professions/education/>) programs.

Some students with an interest in computer science choose to enroll in the Applied Math and Computer Science (<https://catalog.uwm.edu/letters-science/mathematical-sciences/applied-math-computer-science-bs/>) program. This program is ideal for the student who might have considered double majoring in both math and computer science; it

combines applied math courses with computer science classes for you into one program.

Course of Study – Bachelor of Arts Degree

Complete 120 credits including 75 credits in the College of Letters & Science and with 36 of the 75 credits in L&S upper-level (numbered above 300) courses.

The College requires that students must complete in residence at UWM at least 15 credits in upper-division (numbered 300 or above) courses in their major. The College also requires that students complete at least 30 credits overall in residence at UWM. For additional residency and transfer credit limitations, see L&S Undergraduate Policies and Regulations (<https://catalog.uwm.edu/letters-science/#policiesandregulationstext>).

Students are also required to complete University-wide General Education Requirements (<https://catalog.uwm.edu/policies/undergraduate-policies/#bachelorsdegreegeneraleducation>) and the specific L&S requirements listed below.

To complete a major, students must satisfy all the requirements of the major as stated in this catalog. Students who declare their majors within five years of entering the UW System as a degree candidate may satisfy the requirements outlined in any catalog issued since the time they entered. Credits used to satisfy the major also may be used to satisfy other degree requirements.

University General Education Requirements (GER)

Code	Title	Credits
Oral and Written Communication		
<i>Part A</i>		
Achieve a grade of C or better in the following course:		
ENGLISH 102	College Writing and Research (or equivalent)	
<i>Part B</i>		
Course designated as OWC-B; may be completed through a major-specific course requirement		
Quantitative Literacy		
<i>Part A</i>		
Earn at least 3 credits with a grade of C or higher in one of the following courses or an equivalent course, or achieve a placement code of at least 30 on the mathematics placement test (or other appropriate test, as determined by the Mathematical Sciences Department)		
MATH 102	Mathematical Literacy for College Students II	
MATH 103	Contemporary Applications of Mathematics	
MATH 105	Introduction to College Algebra	
MATH 108	Algebraic Literacy II	
MATH 111	Introduction to Logic - Critical Reasoning ¹	
or PHILOS 111	Introduction to Logic - Critical Reasoning	
MATH 116	College Algebra	
Or equivalent course		
<i>Part B</i>		
Course designated as QL-B; may be completed through a major-specific course requirement		

Arts

Select 3 credits	3
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Humanities

Select 6 credits	6
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Social Sciences

Select 6 credits	6
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Natural Sciences

Select 6 credits (at least two courses including one lab)	6
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UWM Foreign Language Requirement

Complete Foreign Language Requirement through:

Two years (high school) of a single foreign language

Two semesters (college) of a single foreign language

Or equivalent

UWM Cultural Diversity Requirement

One course from the Arts, Humanities, or Social Sciences must also satisfy UWM's Cultural Diversity requirement

¹ Math 111 and Philosophy 111 are jointly offered and count as repeats of one another. Students cannot receive credit for both courses.

College of Letters & Science Requirements

The degree requirements in the College of Letters and Science build on the University General Education Requirements to provide a broad base of knowledge as well as an array of skills cited by employers as critical to professional success: critical thinking, problem solving, oral and written communication, ability to work well with others, and adaptability to change.

For the Bachelor of Arts (B.A.), you must complete the UWM General Education Requirements as well as these L&S requirements: the International requirement, the Breadth requirement, and the Research requirement. The International requirement develops your potential for cross-cultural understanding in a globalizing world. The Breadth requirement ensures that you take classes in a wide variety of subjects, across humanities, natural sciences, and social sciences. The Research requirement calls for you to build your critical thinking and oral and written communication skills through conducting an independent research project, usually in your major.

For the Bachelor of Arts (B.A.) you will also complete the Language other than English requirement, to further develop your understanding of cultures through language.

I. Total Credits and Upper-Division Courses Requirement

Students must complete 120 credits including 75 credits in the College of Letters & Science and with 36 of the 75 credits in L&S upper-level (numbered above 300) courses.

II. Language other than English Requirement

Students doing the BA must fulfill the language other than English requirement by either successfully completing the fourth semester of university work or equivalent in one language other than English, or by successfully completing the second semester of university work or equivalent in two languages other than English (including all world languages and American Sign Language).

Language courses (including American Sign Language) other than English taken in high school may be used to satisfy all or part of this requirement. One year of high school language equates to one semester

of college work. Proficiency tests approved by the Languages faculty may be used to satisfy all or part of this requirement.

Completion of the L&S Language Requirement also satisfies the university-wide Language other than English GER, but not vice versa.

III. International Requirement

To meet the International Requirement, students must successfully complete some three course (minimum 9 credits) combination of

1. language other than English (*not* including American Sign Language) at 3rd semester level or above, *and/or*
2. non-language courses with L&S approved international content (see Courses Approved for the L&S International Requirement (<https://catalog.uwm.edu/letters-science/approved-courses-international-requirement/>) for course options).

IV. Breadth Requirement

In addition to completing the University General Education Requirements, L&S students must complete the Breadth requirement.

The L&S Breadth requirement calls for 6 credits each in L&S courses designated L&S Humanities, L&S Natural Sciences, and L&S Social Sciences breadth. One of the L&S Natural Science breadth courses must be a laboratory or fieldwork course. These courses must be beyond and in addition to courses in those areas used to satisfy General Education Requirements.

Please refer to the list of Courses Approved for the L&S Breadth Requirement (<https://catalog.uwm.edu/letters-science/breadth-requirement-course-list/>).

V. The Major

The College of Letters and Science requires that students attain at least a 2.0 GPA in all credits in the major attempted at UWM. In addition, students must attain a 2.0 GPA on all major credits attempted, including any transfer work. Individual departments or programs may require higher GPAs for graduation. Some departmental majors require courses from other departments. Contact your major department for information on whether those credits will count as part of the major GPA. The College requires that students must complete in residence at UWM at least 15 credits in upper-division (numbered 300 or above) courses in their major.

Research Requirement

Within their majors, students must complete a research experience approved by the L&S faculty. A list of courses satisfying the research requirement in each major can be found here (<https://catalog.uwm.edu/letters-science/approved-courses-research-requirement/>).

VI. The Minor

Students are encouraged to consider completing a minor, but it is not required. To complete a minor, the College of Letters and Science requires that students attain at least a 2.0 GPA in all credits in the minor attempted at UWM. In addition, students must attain a 2.0 GPA on all minor credits attempted, including any transfer work. The minor must contain at least 9 credits in upper-division (numbered 300 and above) courses.

Mathematics Major Requirements

Preparatory Curriculum

Students in all majors in the Department of Mathematical Sciences must complete MATH 231 (or MATH 213), MATH 232, and MATH 233 (or equivalent). MATH 221 and MATH 222 are equivalent

to MATH 231, MATH 232, and MATH 233. Students majoring in mathematics must have an average GPA of at least 2.500 in these courses. All majors must take either MATH 234 or MATH 240, as well as a course in computer programming in a modern, high-level language (e.g., COMPSCI 151, COMPSCI 202, COMPSCI 240, COMPSCI 250, or COMPSCI 251). The department also recommends strongly one year of calculus-based physics.

Capstone Experience

Students in all majors and major options in the Department of Mathematical Sciences must complete a "Capstone Experience." The aim of the department's capstone experience is to encourage independent learning. Students complete a research paper in the context of this course, which satisfies the L&S research requirement. Mathematics majors may choose either MATH 599 or MATH 575. Students must obtain consent of a professor to enroll in MATH 599.

Requirements

The following courses are required for the Mathematics major:

Code	Title	Credits
MATH 341	Seminar: Introduction to the Language and Practice of Mathematics	3
Select 24 credits in upper-division math courses (those numbered 300 and above, and in curricular areas MATH or MTHSTAT or ACTSCI). Required among these 24 upper-division math credits are at least six credits in math courses numbered 500 and above, excluding MATH 591, MATH 599, MATH 699, ACTSCI 490, or ACTSCI 599.		24
Total Credits		27

Additional Requirements

- Note that MATH 381 is not open for credit in the Mathematics major.
- Actuarial Science majors wishing to complete Math as a second major must take 9 cr of upper div Math/MthStat courses beyond the major requirements of Actuarial Science.
- Students completing an AMCS degree who wish to add Mathematics as a second major must take 9 cr of additional upper division Math/MthStat/ActSci courses beyond those used to fulfill the AMCS degree Math/MthStat/ActSci requirements.
- Students must complete at least 15 upper-division (numbered 300 and above) credits in the major in residence at UWM.
- The College requires that students attain at least a 2.0 GPA on all credits in the major attempted at UWM. In addition, students must attain a 2.0 GPA on all major credits attempted, including transfer work.

Recommendations

Mathematics courses fall naturally into the following groups (see below for individual courses):

1. Applied Mathematics
2. Computational Mathematics
3. Probability and Statistics
4. Pure Mathematics

For students planning to pursue graduate studies in mathematics, we recommend students take at least 36 cr upper division mathematics courses, with as many courses as possible from Pure Mathematics,

Group 1. Many PhD programs require reading knowledge of French, German, or Russian.

For students planning to pursue graduate studies in statistics or economics, we recommend MATH 523, MATH 524, and as many as possible of MTHSTAT 361, MTHSTAT 362, and MTHSTAT 562-MTHSTAT 568.

For students seeking employment in statistics after the bachelor's degree, we recommend MTHSTAT 361, MTHSTAT 362, and as many as possible of MTHSTAT 562-MTHSTAT 568, as well as courses in computer programming (COMPSCI 250, COMPSCI 251, etc.).

For students seeking general non-academic employment after the bachelor's degree, we recommend courses from the Probability and Statistics group (including MTHSTAT 362), the Applied Mathematics group (including both modeling and differential equations), the Computational Mathematics group, Linear Algebra (MATH 535), and courses in computer programming (COMPSCI 240, COMPSCI 250, COMPSCI 251, etc.).

For students intending to become high school mathematics teachers, we recommend courses in algebra (MATH 431, MATH 531), geometry (MATH 451), linear algebra (MATH 535), numerical methods (MATH 413), advanced calculus (MATH 523, MATH 524), the math education capstone (MATH 575), and probability and statistics (MTHSTAT 361 & MTHSTAT 362).

For students pursuing a major in mathematics as a liberal art, for general logical and critical thinking skills, we recommend the Pure Mathematics courses.

Mathematics Groups

Applied Mathematics

Code	Title	Credits
MATH 305	Introduction to Mathematical and Computational Modeling	3
MATH 320	Introduction to Differential Equations	3
MATH 325	Vector Analysis	3
MATH 322	Introduction to Partial Differential Equations	3
MATH 405	Mathematical Models and Applications	3
MATH 431	Modern Algebra with Applications	3
MATH 603	Advanced Engineering Mathematics I	3
MATH 604	Advanced Engineering Mathematics II	3

Computational Mathematics

Code	Title	Credits
MATH 313	Linear Programming and Optimization	3
MATH 315	Mathematical Programming and Optimization	3
MATH 413	Introduction to Numerical Analysis	3
MATH 415	Introduction to Scientific Computing	3
MATH 417	Computational Linear Algebra	3
MATH 610	Numerical Solution of Partial Differential Equations	3
MATH 617	Optimization	3

Probability and Statistics

Code	Title	Credits
MATH 583	Introduction to Probability Models	3
MTHSTAT 361	Introduction to Mathematical Statistics I	3
MTHSTAT 362	Introduction to Mathematical Statistics II	3
MTHSTAT 562	Design of Experiments	3
MTHSTAT 563	Regression Analysis	3
MTHSTAT 564	Time Series Analysis	3
MTHSTAT 565	Nonparametric Statistics	3
MTHSTAT 566	Computational Statistics	3
MTHSTAT 568	Multivariate Statistical Analysis	3

Pure Mathematics

Code	Title	Credits
MATH 523	Advanced Calculus I	3
MATH 524	Advanced Calculus II	3
MATH 531	Modern Algebra	3
MATH 535	Linear Algebra	3
MATH 551	Elementary Topology	3
MATH 623	Introduction to Analysis I	3
MATH 624	Introduction to Analysis II	3
MATH 635	Modern Algebra I	3
MATH 636	Modern Algebra II	3
MATH 451	Axiomatic Geometry	3
MATH 511	Symbolic Logic	3
MATH 537	Number Theory	3
MATH 553	Differential Geometry	3

Mathematics BA/BS Learning Outcomes

Students graduating from this program will be able to:

1. **integrate** applications, problem-solving and theory.
2. **apply** the analytical and critical thinking skills required for efficient use, appreciation, and understanding of the mathematical sciences.
3. **communicate** mathematical sciences in technical and non-technical terms.
4. **engage** in continuing study and application of the mathematical sciences.
5. **associate** and **synthesize** knowledge from different areas of the mathematical sciences.

Mathematics Advising

Students considering a major in the Department of Mathematical Sciences need to come to the department to declare their major and be assigned a faculty advisor. All courses selected for the major must be approved by the advisor, and students should check regularly with their advisors to plan their courses of study in a coherent and timely fashion.

Letters & Science Advising

During your time at UWM, you may have multiple members of your success team, including advisors, peer mentors and success coaches. Letters & Science students typically work with at least two different types of advisors as they pursue their degrees: professional college advisors

and faculty advisors. L&S college advisors advise across your entire degree program while departmental faculty advisors focus on the major.

College advisors are located in Holton Hall (or virtually for online students) and serve as your primary advisor. They are your point person for your questions about navigating college and completing your degree. College advisors will:

- Assist you in defining your academic and life goals.
- Help you create an educational plan that is consistent with those goals.
- Assist you in understanding curriculum, major and degree requirements for graduation, as well as university policies and procedures.
- Provide you with information about campus and community resources and refer you to those resources as appropriate.
- Monitor your progress toward graduation and completion of requirements.

Faculty advisors mentor students in the major and assist them in maximizing their development in the program. You will begin working with a faculty advisor when you declare your major. Faculty advisors are an important partner and will:

- Help you understand major requirements and course offerings in the department.
- Explain opportunities for internships and undergraduate research and guide you in obtaining those experiences.
- Serve as an excellent resource as you consider potential graduate programs and career paths in your field.

Students are encouraged to meet with both their college advisor and faculty advisor at least once each semester. Appointments are available in-person, by phone or by video.

Currently enrolled students should use the Navigate360 website (<https://uwm.navigate.eab.com/>) to make an appointment with your assigned advisor or call (414) 229-4654 if you do not currently have an assigned Letters & Science advisor. Prospective students who haven't enrolled in classes yet should call (414) 229-7711 or email let-sci@uwm.edu.

Honors in the Major

Students in Mathematics who meet all of the following criteria can be awarded honors in the major upon graduation:

1. A 3.000 cumulative GPA in all UWM graded credits;
2. A 3.500 GPA over all UWM courses counting toward the Mathematics major;
3. A 3.500 GPA over all upper-division UWM courses counting toward the Mathematics major; and
4. At least one of the following:
 - Successful completion of at least two semesters of research and/or internship experiences. These may include one or more of the Capstone Experience (MATH 599), a directed independent study for credit (MATH 699), an internship for credit (MATH 489), and undergraduate research for compensation.
 - Successful completion of at least 6 credits in Mathematical Sciences (curricular areas Math or MthStat) courses numbered 600 or above.
 - A score of at least the 50th percentile on the Math Subject GRE.

Students who believe they may qualify for honors in Mathematics should apply to the Mathematical Sciences Department during their last semester of study.

College of Letters and Science Dean's Honor List

GPA of 3.750 or above, earned on a full-time student's GPA on 12 or more graded credits in a given semester.

Honors College Degree and Honors College Degree with Distinction

Granted to graduating seniors who complete Honors College requirements, as listed in the Honors College (<https://catalog.uwm.edu/honors-college/>) section of this site.

Commencement Honors

Students with a cumulative GPA of 3.500 or above, based on a minimum of 40 graded UWM credits earned prior to the final semester, will receive all-university commencement honors and be awarded the traditional gold cord at the December or May Honors Convocation. Please note that for honors calculation, the GPA is **not** rounded and is truncated at the third decimal (e.g., 3.499).

Final Honors

Earned on a minimum of 60 graded UWM credits: Cum Laude - 3.500 or above; Magna Cum Laude - 3.650 or above; Summa Cum Laude - 3.800 or above.