Mathematics and Statistics

The Department of Mathematics and Statistics offers major programs leading to both the B.A. and B.S. in Mathematics and the B.S. in Statistics. Students in other departments may pursue a minor or a second major in mathematics or statistics. Students in mathematics or statistics may not obtain a minor in the other although a second major is possible. Further details below.

The Program in Mathematics

The educational program is designed to give students a broad perspective on various fields of mathematics. Special emphasis is placed on areas closely associated with applications, such as mathematical modeling, differential equations, numerical algorithms and statistical analysis. The university’s state-of-the-art computing facilities are available to all students and often are used in conjunction with instruction.

Career and Academic Paths

Through their choice of mathematics and statistics electives, students may tailor their program for a wide variety of career goals. Current careers for those with an undergraduate degree in mathematics and/or statistics include secondary school teaching, applied design in industry, actuarial services in insurance and research in government agencies.

UMBC successfully places students at many nearby employers of mathematicians and statisticians, including BlueCross/BlueShield, Alexander & Alexander, the Social Security Administration, the National Security Agency, NASA’s Goddard Space Flight Center, the Naval Research Lab, the U.S. Census Bureau, Northrop Grumman and Lockheed Martin.

Many mathematics majors also pursue graduate degrees in mathematics and statistics, computer science, physics and

Courses in these programs are listed under MATH and STAT.
Concentration for Mathematics Education
This has been developed in cooperation with the UMBC Department of Education and is specifically designed for students who wish to become certified as secondary school mathematics teachers. Students should consult with an advisor in the Department of Education for specific requirements for certification.

Concentration in Statistical Sciences
This is designed for students who wish to prepare for careers as statisticians or for other careers heavily using probability and statistics. This concentration is appropriate for students who pursue graduate study in statistics.

B.S. in Statistics
The B.S. in Statistics is described following the description of the major in mathematics. Majors in mathematics also may pursue a secondary major in statistics to obtain greater depth than the concentration in statistical sciences provides. At least five upper-division electives beyond core requirements in mathematics must be mathematics courses if a student is to receive a double major or dual degree in mathematics and statistics. Statistics majors may not obtain a minor in mathematics.

Academic Advising
Subsequent to the freshman year and declaration of a major in mathematics, each student will be assigned an advisor from the faculty of the department. Students must consult with their advisor prior to each registration. This is the case even if a student has another major and advisor in that major. Mathematics minors should consult with the undergraduate director at least once a year. Mathematics majors obtaining certification in education should consult advisors in the Department of Education in addition to their advisors in the Department of Mathematics and Statistics.

Degree Requirements
The Bachelor of Science degree requires a minimum of 61 credits. The Bachelor of Arts degree requires a minimum of 50 credits, and a minor in mathematics requires a minimum of 31 credits. These are allocated below between core requirements, upper-division mathematics/statistics elective requirements and supplementary elective requirements.

For all mathematics majors and minors, a common core of courses is required. These core requirements are the same for candidates for the Bachelor of Arts and for mathematics minors. Candidates for the Bachelor of Science degree must complete three additional courses for their core requirements.

Core Requirements for the Bachelor of Arts Degree and for Minors
MATH 151
Calculus and Analytic Geometry I
MATH 152
Calculus and Analytic Geometry II
MATH 221
Introduction to Linear Algebra
MATH 225
Introduction to Differential Equations
MATH 251
Multivariable Calculus
MATH 301
Introduction to Mathematical Analysis I
CMSC 201
Computer Science I

Note: a) Core requirements MATH 151, MATH 152, CMSC 201 are fulfilled by sufficiently high scores on AP or CLEP or IB examinations. See Appendices II, III and IV of this catalog for details.
b) The sequence MATH 140, 141, 142 is equivalent to MATH 151, 152. Students may not receive credit for both sequences.

Concentration in Applied Mathematics
This is recommended for students who wish to prepare for industrial employment with engineering or physical science applications. The emphasis in this concentration is applications in which physical phenomena and processes are modeled with differential equations and the numerical solutions of these systems.

Concentration in Optimization and Operations Research
This is recommended for students who wish to prepare for industrial employment as applied mathematicians/operations researchers. It is also particularly appropriate for those interested in the optimization techniques applicable to economics, management science, engineering and physical sciences.

Concentration in Actuarial Science
This is designed for students who wish to prepare for a career in actuarial mathematics. Courses in this concentration will prepare a student for the first examinations administered by the Society of Actuaries.
For the B.S. in Mathematics, at least three of the mathematics/statistics electives must be at the 400 level; for the B.A., at least two of the mathematics/statistics electives must be at the 400 level. Listed below are suggested electives for each concentration mentioned previously.

**Concentration for Graduate Study**
- MATH 302 Introduction to Mathematical Analysis II
  - OR MATH 401 Mathematical Analysis

- MATH 306 Geometry
- MATH 404 Introduction to Partial Differential Equations
- MATH 407 Introduction to Modern Algebra and Number Theory
- MATH 408 Abstract Algebra
- MATH 410 Introduction to Complex Analysis
- MATH 411 Linear Algebra
- MATH 421 Introduction to Topology
- MATH 423 Differential Geometry
- MATH 441 Introduction to Numerical Analysis
- MATH 430 Matrix Analysis
- STAT 451 Introduction to Probability Theory

**Concentration in Applied Mathematics**
- MATH 302 Introduction to Mathematical Analysis II
  - OR MATH 401 Mathematical Analysis

- MATH 341 Computational Methods
- MATH 385 Introduction to Mathematical Modeling
- MATH 404 Introduction to Partial Differential Equations
- MATH 410 Introduction to Complex Analysis
- MATH 423 Differential Geometry
- MATH 430 Matrix Analysis
- MATH 441 Introduction to Numerical Analysis

**Concentration in Actuarial Science**
- STAT 417 Introduction to Time Series Data Analysis
- STAT 451 Introduction to Probability Theory

**Concentration in Statistical Sciences**
- STAT 451 Introduction to Probability Theory
- STAT 453 Introduction to Mathematical Statistics
- STAT 454 Applied Statistics
- MATH 430 Matrix Analysis
- MATH 452 Introduction to Stochastic Processes

**Concentration in Actuarial Science**
- STAT 417 Introduction to Time Series Data Analysis

**Concentration in Mathematics Education**
- MATH 306 Geometry
- MATH 407 Introduction to Modern Algebra and Number Theory

**One course with heavy computational emphasis:**
- MATH 341 Computational Methods
  - OR MATH 441 Introduction to Numerical Analysis

**One course in mathematical modeling:**
- MATH 385 Introduction to Mathematical Modeling
  - OR MATH 481 Mathematical Modeling

**At least one semester of probability and statistics:**
- STAT 355 Introduction to Probability and Statistics for Scientists and Engineers

**Note:** Students preparing for graduate study should take as many courses beyond those mathematics/statistics electives required for the B.A. or B.S. as possible. This will increase both their depth and breadth of mathematical knowledge.

**Concentration for Graduate Study**
- MATH 302 Introduction to Mathematical Analysis II
  - OR MATH 401 Mathematical Analysis

- MATH 306 Geometry
- MATH 404 Introduction to Partial Differential Equations
- MATH 407 Introduction to Modern Algebra and Number Theory
- MATH 408 Abstract Algebra
- MATH 410 Introduction to Complex Analysis
- MATH 423 Differential Geometry
- MATH 441 Introduction to Numerical Analysis

**Concentration in Applied Mathematics**
- MATH 302 Introduction to Mathematical Analysis II
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- MATH 341 Computational Methods
- MATH 385 Introduction to Mathematical Modeling
- MATH 404 Introduction to Partial Differential Equations
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- MATH 423 Differential Geometry
- MATH 430 Matrix Analysis
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**Concentration in Actuarial Science**
- STAT 417 Introduction to Time Series Data Analysis
- STAT 451 Introduction to Probability Theory

**Concentration in Statistical Sciences**
- STAT 451 Introduction to Probability Theory
- STAT 453 Introduction to Mathematical Statistics
- STAT 454 Applied Statistics
- MATH 430 Matrix Analysis
- MATH 452 Introduction to Stochastic Processes

**Concentration in Actuarial Science**
- STAT 417 Introduction to Time Series Data Analysis

**Concentration in Mathematics Education**
- MATH 306 Geometry
- MATH 407 Introduction to Modern Algebra and Number Theory

**One course with heavy computational emphasis:**
- MATH 341 Computational Methods
  - OR MATH 441 Introduction to Numerical Analysis

**One course in mathematical modeling:**
- MATH 385 Introduction to Mathematical Modeling
  - OR MATH 481 Mathematical Modeling

**At least one semester of probability and statistics:**
- STAT 355 Introduction to Probability and Statistics for Scientists and Engineers

**Note:** Students preparing for graduate study should take as many courses beyond those mathematics/statistics electives required for the B.A. or B.S. as possible. This will increase both their depth and breadth of mathematical knowledge.
or the sequence:

STAT 451
Introduction to Probability Theory

AND

STAT 453
Introduction to Mathematical Statistics

Supplementary Requirements for Mathematics Education

MATH 432
History of Mathematics

CMSC 203
Discrete Structures

EDUC 320
Teaching Mathematics in the Elementary School

or

EDUC 322
Teaching Mathematics in the Secondary School

Note: None of the mathematics electives nor the supplementary electives are elective except for choices within categories; all are required by the certificate program in mathematics education.

Note: One science course (e.g., PHYS 121) is also required by this program. For a B.S. in Mathematics, students earning the certificate in Mathematics Education should take MATH 302 or 401, PHYS 121, 122, and the sequence STAT 451-453 or a second course from MATH 341 or 441.

Supplementary Requirements

Mathematics and statistics have proven indispensable in many disciplines in the physical sciences, the social sciences, and even in the humanities and arts. Much of mathematics and statistics has developed with a view toward its applications in other fields. To develop an appreciation of the connection, mathematics majors are required to take three courses for the B.A. and two courses for the B.S. from other departments reflecting these interconnections. These are listed below. From time to time, special topics courses offered by other departments may be used to satisfy supplementary requirements, subject to departmental approval. Occasionally mathematics or statistics courses are cross-listed in other departments. Taken under the other department these count as supplementary electives.

Mathematics minors are not subject to these supplementary requirements.

Courses for Supplementary Requirements

BIOL 463
Theoretical and Quantitative Biology

CHEM 401
Chemical and Statistical Thermodynamics

CHEM 415
Statistical Mechanics and Theory of Rate Processes

CMPE 320
Probability Statistics and Random Processes

CMPE 323
Signal and System Theory

CMSC 203
Discrete Structures (Must be taken before MATH 301 to be accepted as a supplementary elective)

CMSC 341
Data Structures

CMSC 441
Algorithms

CMSC 442
Information and Coding Theory

CMSC 443
Cryptography

CMSC 451
Automata Theory and Formal Languages

CMSC 452
Logic for Computer Science

CMSC 453
Applied Combinatorics and Graph Theory

ECON 311
Intermediate Microeconomic Analysis

ECON 374
Fundamentals of Financial Management

ECON 417
The Economics of Strategic Interaction

ECON 421
Introduction to Econometrics

EDUC 320
Teaching Mathematics in the Elementary School

EDUC 322
Teaching Mathematics in the Secondary School

ENCH 300
Chemical Processes and Thermodynamics

ENME 217
Engineering Thermodynamics

ENME 315
Intermediate Thermodynamics

ENME 342
Fluid Mechanics

ENME 410
Operations Research

MATH 432
History of Mathematics

PHIL 248
Introduction to Scientific Reasoning

PHIL 346
Deductive Systems

PHIL 372
Philosophy of Science

PHYS 121
Introductory Physics I

PHYS 122
Introductory Physics II

PHYS 224
Introductory Physics III

PHYS 303
Thermal and Statistical Physics

PHYS 321
Intermediate Mechanics

PHYS 407
Electromagnetic Theory

PHYS 424
Introduction to Quantum Mechanics

PHYS 440
Computational Physics

General Education Requirements for Mathematics Majors

Mathematics majors who are considering courses to satisfy General Education Requirements will satisfy the biological/physical science requirements if they take PHYS 121 and 122 and a lab course. For the social science (SS) General Education Requirement, good choices would be ECON 101 and 102, which are prerequisite to supplementary requirement courses ECON 311, 374, 417 and 421. These are recommended in particular for those pursuing the concentration in actuarial science or, to a lesser extent, concentrations in statistics science or optimization and operations research. PHIL 146 and 248 are recommended as choices for AH General Education Requirement courses. The latter is also a supplementary requirement for the major. Note that those pursuing the Bachelor of Science degree need only take one culture course.

General Education Requirements for Non-Majors

Students who are not planning to major in mathematics should elect the mathematics courses that fulfill their general requirements on the basis of their academic program and goals. Students whose major requires or recommends a specific mathematics course should follow that recommendation. Students whose program does not require any mathematics may wish to consider MATH 100, MATH 115 or STAT 121 as one of the courses satisfying the mathematics General Foundation Requirement.

Note: Before registering in any mathematics course up to MATH 151 or MATH 155, students must have completed a
placement test administered by the Learning Resources Center if they have not completed the prerequisite college-level course with a “C” or better. This is normally done prior to the first semester at UMBC. Otherwise students must MATH 106 with a “C” or better. Even higher algebra skills are recommended for MATH 150 or MATH 155.

The specific courses listed as prerequisites indicate the level of maturity necessary for the course. A student who does not have a formal prerequisite for a particular course must request the consent of the instructor to take that course. Prerequisites for all mathematics courses must be satisfied with a grade of “C” or better.

All courses for major or minor requirements must be passed with a grade of “C” or better.

Honors Program

Students may graduate with departmental honors by completing all major requirements with a GPA of 3.6 or higher and by completing, in addition to other requirements for a major in mathematics, a senior thesis (MATH 497 or STAT 497) with a grade of “A” or “B.” Students wishing to graduate with departmental honors must notify the department by the beginning of their senior year.

Evening and Part-time Options

Almost half of the department’s course offerings are scheduled for the evening hours (after 5 p.m.). Most freshman and sophomore courses and some junior-level courses are offered concurrently in day and evening sections to accommodate working or commuting students. The courses that are not concurrently offered in day and evening sections are rotated between day and evening sections in regular intervals.

It is possible to complete the program of study entirely on a part-time basis. Naturally, the length of study will depend on the number of courses taken each semester. It is possible to accelerate studies by taking some of the courses in the summer. Each summer, the department offers close to 20 undergraduate courses selected from the regular course catalog.

Combined B.S./M.S. Program

For qualified students, the department offers a combined B.S./M.S. program leading to the Bachelor of Science in Mathematics and the Master of Science in Applied Mathematics. By taking advantage of the integrated features of the program, a student can earn, in five years and 144 credits, two degrees, which, if pursued separately, would require at least six years and 150 credits. This allows students to transfer up to nine credits from their undergraduate transcript, beyond 120, to their graduate transcript, which results in a corresponding decrease in the number of credits required for completion of the M.S. degree.

Interested students should apply for this program after they have completed 60 credits, including transfer credits, toward a Bachelor of Arts or Bachelor of Science degree. All applicants who have completed MATH 151, 152, 221, 251 and CMSC 201 at UMBC with a GPA of 3.0 or higher will be accepted into the program. Application during or immediately subsequent to taking MATH 301 is recommended. All other applicants will have their applications reviewed by the department and may be admitted provisionally.

To complete this program in the desired five years, it is strongly recommended that students have completed 126-129 credit hours by the end of their fourth year of study, that they have met all the degree requirements for a bachelor’s degree in mathematics by that time, and that they have a surplus of two or three mathematics courses that were completed at the 600 level or above. It is strongly recommended that students in this program take core graduate courses in their fourth year.

Special Opportunities

UMBC’s proximity to federal agencies in the Baltimore-Washington area provides ample opportunities for internships and cooperative education experiences during the academic year and the summer. A close relationship exists between UMBC faculty and the staff at the National Security Agency (NSA). Many students have served as interns at NSA and have found employment there.

Upon graduation, others have co-oped at the National Oceanic and Atmospheric Administration, the Environmental Protection Agency and BlueCross/BlueShield.

Student Organizations

Pi Mu Epsilon
National mathematics honors society
Pi Mu Epsilon, the national mathematics honors society, has an active chapter at UMBC and organizes joint activities with the Mathematics and Statistics Council of Majors.

The Statistics Program

Statistics is the science and art of making inferences from data under conditions of uncertainty. The practice of statistics requires not only an understanding of statistical techniques, but also some understanding of the nuances of the problem requiring statistical analysis — whether it is in the social or physical sciences, engineering, medicine or business.

The major program leading to a B.S. in Statistics, offered by the Department of Mathematics and Statistics, is geared toward the above goal. The educational program is designed to give students a broad perspective on the theory and applications of statistics. In particular, the interdisciplinary curriculum structure of the program helps develop skills in the application of statistical methods to a variety of disciplines. The university’s state-of-the-art computing facilities are available to all students and are used in conjunction with instruction.

UMBC is the only institution in Maryland offering an undergraduate major in statistics. Students from other fields (other than mathematics or statistics) also may obtain a minor in statistics.

Career and Academic Paths

The use of statistical methods to address complex problems is pervasive in almost all areas of business, government and science, and this has created a growing demand for statisticians. UMBC’s location puts it at the heart of some of the most exciting statistical work in the nation, carried out at the Census Bureau (Suitland, MD), Bureau of Labor Statistics (Washington, D.C.), U.S. Environmental Protection Agency (Washington, D.C.), National Center for Health Statistics (Hyattsville, MD), the Army Research Laboratory (Aberdeen Proving Ground, MD), National Institutes of
Health (Bethesda, MD), and the Food and Drug Administration (Rockville, MD), along with several other federal agencies, pharmaceutical companies and other industries. The ever-growing demand for statisticians at these places makes our B.S. in Statistics very attractive.

Statisticians working at the U.S. Census Bureau, Bureau of Labor Statistics, National Center for Health Statistics, etc., are required to work on various applications, including design and analysis of surveys, evaluation of non-sampling errors resulting from non-response and research to reduce these errors.

Statisticians working at pharmaceutical companies are required to be knowledgeable in biostatistics. Our B.S. program (applied statistics track) is tailored toward the needs of federal agencies, pharmaceutical companies and industries in general.

In addition, there is a heavy demand for statisticians who have completed graduate degrees (M.S. or Ph.D.). The mathematical statistics track in the B.S. program prepares students to pursue graduate study in statistics.

Academic Advising

Subsequent to the declaration of a major in statistics, each student will be assigned an advisor from the statistics faculty of the department. Students must consult with their advisor prior to course registration. In addition to keeping track of each student’s academic progress through the academic program, the faculty advisor is available to discuss related issues such as career goals, internship opportunities, opportunities for graduate study, etc. The departmental advising process is designed to give each student individual attention and guidance.

The B.S. Program in Statistics

Students may tailor their program of study by choosing one of two tracks: the applied statistics track or the mathematical statistics track. Students in the applied statistics track take courses that help develop skills in the application of statistics to real problems. This track is recommended for students who wish to pursue employment in government or industry. The applied statistics track is also appropriate for those who wish to pursue graduate study in statistics, with an emphasis on applications. The track in mathematical statistics provides the necessary background and stimulation for graduate study in statistics, applied mathematics or other quantitative fields such as computer science or engineering.

The Bachelor of Science in Statistics consists of at least 64 credits, distributed as follows:

**The Applied Statistics Track**

**Core requirements for the B.S. degree**

All majors in the applied statistics track must successfully complete:

- MATH 151 Calculus and Analytic Geometry I [4]
- MATH 152 Calculus and Analytic Geometry II [4]
- MATH 221 Introduction to Linear Algebra [3]
- MATH 251 Multivariable Calculus [4]

**Electives in Mathematics and Statistics:**

One course from:

- STAT 350 Statistics With Applications in the Biological Sciences [4]
- STAT 355 Introduction to Probability and Statistics for Scientists and Engineers [4]
- CMPE 320

**All of the following courses:**

- STAT 433 Statistical Computing [3]
- STAT 451 Introduction to Probability Theory [3]
- STAT 453 Introduction to Mathematical Statistics [3]
- STAT 454 Applied Statistics [3]

**Electives**

Majors in the applied statistics track must successfully complete nine elective courses, with at least four courses in statistics. Electives are to be chosen with departmental approval. Some suggested electives are:

- ECON 421 Introduction to Econometrics [3]
- CMSC 431 Principles of Programming Languages [3]
- CMSC 441 Data Structures [3]
- ECON 422 Topics in Econometrics [3]
- IS 410 Introduction to Database Program Development [3]
- IS 420 Advanced Database Project [3]
- IS 427 Artificial Intelligence [3]
- IS 444 Total Quality Management for the Information Systems Department [3]
Electives
Majors in the mathematical statistics track must successfully complete nine elective courses, with at least six courses in mathematics and statistics. The electives may be chosen from the suggested list of electives for the applied statistics track. The electives are to be chosen with departmental approval. Electives other than those among the suggested list will be permitted with departmental approval.

Proficiency in English
All statistics majors in either track must demonstrate their proficiency in English by passing ENGL 393: Technical Writing and by passing a course in speech. (SPCH)

Honors Program
Students may graduate with departmental honors by completing all major requirements with a GPA of 3.6 or higher and by completing, in addition to other requirements for a major in statistics, a senior thesis (STAT 497 or MATH 497) with a grade of “A” or “B.” Students wishing to graduate with departmental honors must notify the department by the beginning of their senior year.

Combined B.S./M.S. Program
A combined B.S./M.S. program is available for qualified students. The program leads to the B.S. and M.S. degrees in Statistics. A total of up to nine credit hours will be allowed, with departmental approval, for combined undergraduate and graduate credit. Application may be made after completing the following courses with a “B” average: MATH 151, 152, 221, 251, and STAT 451, 453, and 454. By the time the student has earned nine graduate credits, he or she must have completed the regular application process for formal admittance to the M.S. program.

Minor in Statistics
The minor in statistics is not available to mathematics majors. The minor program in statistics requires:
- MATH 151
  Calculus and Analytic Geometry I [4]
- MATH 152
  Calculus and Analytic Geometry II [4]
- MATH 221
  Introduction to Linear Algebra [3]

AND One of the following options:
1) One 300 level course from
   - STAT 350
     Statistics With Applications in the Biological Sciences [4]
   OR
   - STAT 351
     Applied Statistics for Business and Economics
   OR
   - STAT 355
     Introduction to Probability and Statistics for Scientists and Engineers [4]

AND Three additional 400-level courses in statistics.

Credit will not be given to STAT 350, 351, or 355 if taken after completing STAT 451. Those students who first complete STAT 451 should choose option two to satisfy the minor requirements.

2) STAT 451
   Introduction to Probability Theory [3]

AND Three additional 400-level courses in statistics.

Those students who follow Option 1 will complete a total of 24 credits of course work in mathematics and statistics toward the minor. Those who follow Option 2 will complete a total of 23 credits of course work in mathematics and statistics toward the minor.

Special Opportunities
UMBC’s proximity to federal agencies, pharmaceutical companies and other industries in the Baltimore-Washington area provides students ample opportunities to gain hands-on experience in applied statistical work through cooperative educational experiences and internships during the academic year and during summer. The department is very proactive in finding internship opportunities for students.