

# Mathematics and Statistics

## CHAIR

Jonathan Bell  
Professor  
Biomathematics

## PROFESSORS

Thomas E. Armstrong  
Functional analysis, measure theory, probability, mathematical economics

Abdul Aziz  
Emeritus  
Functional and numerical analysis, partial differential equations

Nam P. Bhatia  
Emeritus  
Differential equations, stability and chaos

M.S. Gowda  
Applied analysis, mathematical programming

Fred Gross  
Emeritus  
Functional equations, complex function theory, meromorphic functions

James T. Lo  
Optimal filtering, stochastic systems, signal processing

Yen-Mow Lynn  
Fluid dynamics, mathematical physics

Thomas Mathew  
Linear models, multivariate analysis

Nagaraj K. Neerchal  
Time series analysis, general statistical methodology, environmental statistics

Arthur O. Pittenger  
General Markov processes, probability theory

Florian Potra  
Numerical optimization, mathematical modeling, parallel computing

Richard C. Roberts  
Emeritus  
Numerical analysis

Rouben Rostamian  
Partial differential equations, continuum mechanics

Andrew Rukhin  
Decision theory, estimation theory, mathematical statistics

Thomas I. Seidman  
Control theory, non-linear partial differential equations

Bimal K. Sinha  
Multivariate analysis, decision theory

Manil Suri  
Numerical analysis, partial differential equations

## ASSOCIATE PROFESSORS

Matthias K. Gobbert  
Computational and industrial mathematics

Osman Guler  
Optimization, mathematical programming, convex programming, complexity

Kathleen Hoffman  
Calculus of variations, differential equations, mathematical biology, singular perturbation theory

Jacob Kogan  
Calculus of variations, optimal control theory, optimization

## ASSISTANT PROFESSORS

Taeryon Choi  
Bayesian statistics, Hierarchical modeling, multiple comparisons, non-parametric statistics

Susan E. Minkoff  
Scientific computing, multi-physics simulations in seismology, mechanics

Muruhan Rathinam  
Non-linear control theory, dynamical systems

Anindya Roy  
Time series, econometrics, multivariate methods, mathematical finance

Xiao Wang  
Non-parametric estimation, statistics in engineering, statistics in astronomy

John Zweck  
Modeling and simulation, photonics, differential geometry, computational anatomy, vision and image processing

## INSTRUCTORS

Bonny Tighe  
Mathematics education

Rajalakshmi Baradwaj  
Developmental mathematics

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 Blue-Cross/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

engineering. Graduates have gone on to the graduate programs at such institutions as The Johns Hopkins university; University of Maryland, College Park; California Institute of Technology; Rice University; University of Illinois; University of Wisconsin; Syracuse University; Indiana University; and Oxford University.

### Concentration for Graduate Study

This is particularly appropriate for those who wish to pursue further study in mathematics at the graduate level. For those who intend to pursue graduate study, French, German or Russian should be used to satisfy Language General Foundation Requirements, because these languages are a requirement of some graduate institutions.

### 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.

### 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 second 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.

**Note,** continued: And c) Students may need to take CMSC 104 prior to CMSC 201.

### Core Requirements for the Bachelor of Science Degree

In addition to the core requirements listed above, the Bachelor of Science degree requires the following:

MATH 302  
Introduction to  
Mathematical Analysis II  
**OR**  
MATH 401  
Mathematical Analysis

PHYS 121  
Introductory Physics I

PHYS 122  
Introductory Physics II

The above cannot be used to fulfill mathematics elective requirements or supplementary elective requirements.

### Mathematics/Statistics Elective Requirements

After completion of the core requirements, each major or minor is required to take a certain number of additional three- or four-credit mathematics or statistics courses numbered 300 or higher. MATH 380, STAT 350 and STAT 351, designed for other majors, are not allowed to meet the requirements below. MATH 432 may not be used as a mathematics elective, but it may be used as a supplementary elective.

**Minors**  
Two courses

**B.A. degree**  
Five courses

**B.S. degree**  
Six courses

For one of the mathematical electives, a major may bundle together three or more credits from courses carrying one or two credits. These include: MATH 426, 427, 479, 480, 490, 496, 499 and STAT 432, 470, 490, 496 and 499.

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

MATH 475  
Combinatorics  
and Graph Theory

MATH 497  
Senior Thesis

**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 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

MATH 456  
Mathematical Methods  
for Science and Engineering

MATH 481  
Mathematical Modeling

MATH 485  
Introduction to the Calculus  
of Variations Concentration  
in Optimization and  
Operations Research

MATH 381  
Linear Methods of  
Operations Research

MATH 411  
Linear Algebra

MATH 430  
Matrix Analysis

MATH 452  
Introduction to  
Stochastic Processes

MATH 470  
Introduction to Mathematical  
Foundations of Actuarial  
Science

MATH 475  
Combinatorics  
and Graph Theory

MATH 481  
Mathematical Modeling

MATH 482  
Non-linear Optimization

MATH 483  
Linear and  
Combinatorial Optimization

MATH 484  
Stochastic Methods in  
Operations Research

MATH 495  
Topics in Mathematics  
of Operations Research

STAT 451  
Introduction to  
Probability Theory

**Concentration in Actuarial Science**

STAT 417  
Introduction to Time  
Series Data Analysis

STAT 451  
Introduction to  
Probability Theory

STAT 453  
Introduction to  
Mathematical Statistics

STAT 454  
Applied Statistics

STAT 470  
Probability for  
Actuarial Science

Students are advised to take the following courses that have been approved by Society of Actuaries to satisfy its Validation by Educational Experience (VEE) requirement in three topics.

VEE – Applied  
Statistical Methods:  
STAT 417 and STAT 454

VEE – Economics:  
ECON 101 and ECON 102

VEE – Corporate Finance:  
ECON 374

**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

Other 400-level STAT courses

**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

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 prepare for 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:

#### All of the following courses:

- 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]

#### One course from:

- STAT 350  
Statistics With Applications in the Biological Sciences [4]
- OR
- STAT 351  
Applied Statistics for Business and Economics [4]
- OR
- 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:

#### Electives in Mathematics and Statistics:

- MATH 301  
Introduction to Mathematical Analysis I [4]
- MATH 302  
Introduction to Mathematical Analysis II [3]
- MATH 341
- MATH 381  
Linear Methods in Operations Research [3]
- MATH 430  
Matrix Analysis [3]
- MATH 441  
Introduction to Numerical Analysis

- MATH 452  
Introduction to Stochastic Processes [3]
- STAT 405  
Survey Sampling [3]
- STAT 414  
Environmental Statistics [3]
- STAT 417  
Introduction to Time Series Data Analysis [3]
- STAT 418  
Applied Multivariate Methods [3]
- STAT 419  
Introduction to Biostatistics [3]
- STAT 455  
Design of Experiments and Quality Control [3]

#### Electives in Other Fields:

- CMSC 201  
Computer Science I for Majors [4]
- OR
- CMSC 202  
Computer Science II for Majors [4]
- CMSC 331  
Principles of Programming Languages [3]
- CMSC 341  
Data Structures [3]
- ECON 421  
Introduction to Econometrics [3]
- ECON 422  
Topics in Econometrics [3]
- ECON 423  
Economic Forecasting [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]

POLI 400  
Qualitative Research Methods  
in Political Science [3]

PSYC 331  
Experimental Psychology –  
Design and Analysis I [4]

PSYC 332  
Experimental Psychology –  
Design and Analysis II [4]

SOCY 419  
Qualitative Methods  
in Social Research [3]

Other electives will be permitted with departmental approval.

## The Mathematical Statistics Track

### Core Requirements for the B.S. Degree

All majors in the mathematical 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]

MATH 301  
Introduction to  
Mathematical Analysis I [4]

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 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.