

# MATHEMATICAL SCIENCES, BACHELOR OF SCIENCE (B.S.) WITH A CONCENTRATION IN STATISTICS

The curriculum in mathematical sciences promotes understanding of the mathematical sciences and their structures, uses and relationships to other disciplines. To this end, the scholarly growth of the faculty and students in the mathematical sciences is nurtured through study, research and a high standard of teaching. The curriculum provides a sound foundation for the student seeking to enter a career with a technological orientation or for the student who wishes to pursue graduate study in applied mathematics, biomathematics, mathematics, operations research, statistics, teaching mathematics in secondary schools or related fields.

A Bachelor of Science is offered jointly by the Department of Mathematics and Applied Mathematics and the Department of Statistical Sciences and Operations Research. In the Department of Statistical Sciences and Operations Research, students pursuing the Bachelor of Science in Mathematical Sciences can choose a concentration of statistics, which teaches students how mathematical models used in the investigation of uncertain phenomena are developed and applied to experimental and nonexperimental data.

## Student learning outcomes

Upon completing this program, students will know how to do the following:

### Bachelor of Science in Mathematical Sciences core outcomes

- Solve mathematical problems
- Solve and interpret mathematical problems which originate from applications outside of mathematics
- Use technology to solve and/or explore mathematical problems

### Statistics concentration-specific outcomes

Upon completing a concentration in statistics, students will know how to do the following:

- Demonstrate a comprehensive understanding of basic statistical concepts and terminology
- Recognize and execute appropriate sample/experimental data collection methods
- Effectively analyze data that has been collected and evaluate the assumptions associated with those procedures
- Apply appropriate statistical software packages to solve/model various problems
- Evaluate situations related to probability, statistical uncertainty, distributions and statistical inference
- Apply calculus and/or linear algebra concepts and techniques to statistical problems in both theory and application
- Clearly and concisely present technical information in writing
- Clearly and concisely present technical information through oral presentations

- Explain the general linear model and analyze data using the general linear model

## Special requirements

The B.S. in Mathematical Sciences requires a minimum of 120 credits. Along with the general education requirements of the College of Humanities and Sciences and the undergraduate degree requirements, students are required to take core courses and fulfill specific requirements for the degree.

Based on the results of the Mathematics Placement Test, students may be required to take MATH 151. No more than one course in mathematics (MATH) at the 100 level can count for the general requirements toward the degree. Credit for 100-level mathematical sciences courses cannot be applied toward the mathematical sciences courses required for the major in mathematical sciences.

## Double major

Students who meet the requirements for two of the concentrations within the mathematical sciences curriculum can receive a double major. To initiate a double major, students must obtain the appropriate form from the Office of Records and Registration.

## Second baccalaureate degree

For students possessing a bachelor's degree and wishing to gain undergraduate preparation in an area of mathematical sciences, second baccalaureate degrees are offered through the department. For detailed information about these programs, refer to the "Academic regulations and general degree requirement" section of this bulletin

## Degree requirements for Mathematical Sciences, Bachelor of Science (B.S.) with a concentration in statistics

Course	Title	Hours
<b>General education (<a href="https://bulletin.vcu.edu/undergraduate/undergraduate-study/general-education-curriculum/">https://bulletin.vcu.edu/undergraduate/undergraduate-study/general-education-curriculum/</a>)</b>		
Select 30 credits of general education courses in consultation with an adviser.		30
<b>Major requirements</b>		
• Major core requirements		
MATH 201	Calculus with Analytic Geometry II <sup>1</sup>	4
MATH 307	Multivariate Calculus <sup>1</sup>	4
MATH 310	Linear Algebra <sup>1</sup>	3
• Additional major requirements		
MATH 211 or MATH 300	Mathematical Structures <sup>1</sup> Introduction to Mathematical Reasoning	3
SSOR 480	Consulting Using Advanced Analytics <sup>1</sup>	3
SSOR 485	Career Planning and Professional Development for Statistics and Operations Research <sup>1</sup>	1
STAT 309	Introduction to Probability Theory <sup>1</sup>	3
• Concentration requirements		
STAT 305	Intermediate Statistics <sup>1</sup>	3
STAT 310	Introduction to Statistical Inference <sup>1</sup>	3
STAT 321	Introduction to Statistical Computing for Data Science <sup>1</sup>	3

Concentration electives		
Select from concentration electives below. <sup>1</sup>		18
<b>Ancillary requirements</b>		
HUMS 202	Choices in a Consumer Society	1
MATH 200	Calculus with Analytic Geometry I <sup>1</sup>	4
STAT 212	Concepts of Statistics (satisfies general education quantitative foundations)	3
Experiential fine arts <sup>2</sup>		1-3
Foreign language through the 102 level (by course or placement)		0-6
Natural science sequence: Select one sequence from list below (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)		8-10
Natural science elective (different from chosen science sequence)		3-5
<b>Open electives</b>		
Select any course.		18-29
<b>Total Hours</b>		<b>120</b>

1

These courses/credits require a minimum grade of C.

2

Course offered by the School of the Arts

The minimum number of credit hours required for this degree is 120.

### Natural science sequence

Course	Title	Hours
Select one of the following sequences: 8-10		
<b>Sequence 1</b>		
BIOL 151	Introduction to Biological Sciences I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	3
BIOZ 151	Introduction to Biological Science Laboratory I	1
BIOL 152	Introduction to Biological Sciences II	3
BIOZ 152	Introduction to Biological Science Laboratory II	1
<b>Sequence 2</b>		
CHEM 101	General Chemistry I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	3
CHEZ 101	General Chemistry Laboratory I	1
CHEM 102	General Chemistry II	3
CHEZ 102	General Chemistry Laboratory II	1
<b>Sequence 3</b>		
PHYS 201	General Physics I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	4
PHYS 202	General Physics II	4
<b>Sequence 4</b>		

PHYS 207	University Physics I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	5
PHYS 208	University Physics II	5

### Electives

For the statistics concentration, at least 18 credits of electives must be chosen from the following list. A minimum grade of C is required in these courses.

Course	Title	Hours
STAT 403	Introduction to Stochastic Processes	3
STAT 421	Statistical Computing for Machine Learning and Artificial Intelligence	3
STAT 423	Nonparametric Statistics	3
STAT 425	Multivariate Statistics	3
STAT 435	Industrial Statistics	3
STAT 443	Regression	3
STAT 447	Introduction to Statistical Data Science	3
STAT 475	Time Series	3
SSOR 492	Independent Study	2-4
SSOR 493	Internship	3

What follows is a sample plan that meets the prescribed requirements within a four-year course of study at VCU. Please contact your adviser before beginning course work toward a degree.

### Recommended course sequence/plan of study

Freshman year		
Fall semester		Hours
MATH 200	Calculus with Analytic Geometry I	4
STAT 212	Concepts of Statistics (satisfies general education quantitative foundations) <sup>1</sup>	3
UNIV 101	Introduction to the University	1
UNIV 111	Introduction to Focused Inquiry: Play course	3
Investigation and Communication (satisfies general education UNIV foundations) <sup>1</sup>		
Introduction to Focused Inquiry: Investigation and Communication		
General education course <sup>2</sup>		3
<b>Term Hours:</b>		<b>14</b>
Spring semester		
HUMS 202	Choices in a Consumer Society	1
MATH 201	Calculus with Analytic Geometry II	4
MATH 211	Mathematical Structures	3
UNIV 112	Focused Inquiry II (satisfies general education UNIV foundations) <sup>1</sup>	3
Play course		
video for Focused Inquiry II		
General education course <sup>2</sup>		3
<b>Term Hours:</b>		<b>14</b>

**Sophomore year**
**Fall semester**

MATH 307	Multivariate Calculus	4
STAT 305	Intermediate Statistics	3
UNIV 200	Advanced Focused Inquiry: Literacies, Research and Communication (satisfies general education UNIV foundations) <sup>1</sup>	3
Foreign language 101		3
General education course <sup>2</sup>		3
<b>Term Hours:</b>		<b>16</b>

**Spring semester**

MATH 310	Linear Algebra	3
STAT 321	Introduction to Statistical Computing for Data Science	3
Foreign language 102		3
General education course <sup>2</sup>		3
General education course <sup>2</sup>		3
<b>Term Hours:</b>		<b>15</b>

**Junior year**
**Fall semester**

STAT 309	Introduction to Probability Theory	3
Concentration elective		3
Experiential fine arts		1-3
Natural sciences sequence (select one of the following) <sup>1</sup>		4-5
BIOL 151 & BIOZ 151	Introduction to Biological Sciences I and Introduction to Biological Science Laboratory I	-
CHEM 101 & CHEZ 101	General Chemistry I and General Chemistry Laboratory I	-
PHYS 201	General Physics I	-
PHYS 207	University Physics I	-
Open elective		3
<b>Term Hours:</b>		<b>14-17</b>

**Spring semester**

STAT 310	Introduction to Statistical Inference	3
Concentration electives		6
Natural sciences sequence (Select one of the following with appropriate matching course from previous semester.)		4-5
BIOL 152 & BIOZ 152	Introduction to Biological Sciences II and Introduction to Biological Science Laboratory II	-
CHEM 102 & CHEZ 102	General Chemistry II and General Chemistry Laboratory II	-
PHYS 202	General Physics II	-
PHYS 208	University Physics II	-
Open elective		3
<b>Term Hours:</b>		<b>16-17</b>

**Senior year**
**Fall semester**

SSOR 480	Consulting Using Advanced Analytics	3
SSOR 485	Career Planning and Professional Development for Statistics and Operations Research	1

Concentration electives	6
Natural sciences elective <sup>3</sup>	3-5
Open elective	3
<b>Term Hours:</b>	<b>16-18</b>

**Spring semester**

Concentration elective	3
Open electives	12
<b>Term Hours:</b>	<b>15</b>
<b>Total Hours:</b>	<b>120-126</b>

1

Satisfies a general education requirement (excludes BIOZ 151 and CHEZ 101).

2

Select general education courses in consultation with an adviser.

3

Different science than chosen for sequence.

**The minimum number of credit hours required for this degree is 120.**

## Accelerated B.S. and M.S.

The accelerated B.S. and M.S. program allows qualified students to earn both the B.S. and M.S. in Mathematical Sciences with a concentration in statistics in a minimum of five years by completing approved graduate courses during the senior year of their undergraduate program. Students in the program may count up to nine hours of graduate courses toward both the B.S. and M.S. degrees. Thus, the two degrees may be earned with a minimum of 141 credits rather than the 150 credits necessary if the two degrees are pursued separately.

Students holding these degrees will demonstrate a comprehensive understanding of basic statistical concepts, probability and inference, general linear modeling, calculus, and linear algebra. They will know how to select appropriate samples and conduct appropriate experimental data collection methods. Additionally, students will be able to use statistical software packages to perform appropriate analysis of data, including knowledge of the assumptions associated with the procedures and how to determine the appropriate procedure to use. Students will know how to clearly and concisely present technical information in writing and through oral presentations. The program will also provide students with opportunities to participate in research projects, internships and other training programs where they develop the skills to evaluate, refine and apply what they learn in the classroom.

## Entrance to the accelerated program

Interested undergraduate students should consult with their adviser as early as possible to receive specific information about the accelerated program, determine academic eligibility and submit (no later than two semesters prior to graduating with a baccalaureate degree, that is, before the end of the spring semester of their junior year) an Accelerated Program Declaration Form to be approved by the graduate program director. Limited spaces may be available in the accelerated program. Academically qualified students may not receive approval if capacity has been reached.

Minimum qualifications for entrance to this accelerated program include completion of 90 undergraduate credit hours including STAT 212,

STAT 305, STAT 321, STAT 309 and STAT 310; an overall minimum GPA of 3.0; and a minimum GPA of 3.3 in mathematics and statistics course work. Students who do not meet the minimum GPA requirements may submit GRE scores to receive further consideration. The adviser of graduate studies for the mathematical sciences master's program with a concentration in statistics will provide guidance of students in this program. Students who are interested in the accelerated program should consult with the faculty adviser to the statistics concentration of the M.S. program before they have completed 90 credits. Successful applicants would enter the program in the fall semester of their senior year.

Once enrolled in the accelerated program, students must meet the standards of performance applicable to graduate students as described in the "Satisfactory academic progress (<https://bulletin.vcu.edu/academic-regs/grad/satisfactory-academic-progress/>)" section of the Graduate Bulletin, including maintaining a 3.0 GPA. Guidance to students admitted to the accelerated program is provided by both the undergraduate mathematical sciences adviser and the faculty adviser to the graduate program.

## Admission to the graduate program

Entrance to the accelerated program enables the student to take the approved shared courses that will apply to the undergraduate and graduate degrees. However, entry into an accelerated program via an approved Accelerated Program Declaration Form does not constitute application or admission into the graduate program. Admission to the graduate program requires a separate step that occurs through a formal application to the master's program, which is submitted through Graduate Admissions no later than a semester prior to graduation with the baccalaureate degree, that is, before the end of the fall semester of the senior year. In order to continue pursuing the master's degree after the baccalaureate degree is conferred, accelerated students must follow the admission to graduate study requirements outlined in the VCU Bulletin. Three reference letters (at least one from a Department of Statistical Sciences and Operations Research faculty member) must accompany the application.

## Degree requirements

The Bachelor of Science in Mathematical Sciences degree with concentration in statistics will be awarded upon completion of a minimum of 120 credits and the satisfactory completion of all undergraduate degree requirements as stated in the Undergraduate Bulletin.

A maximum of 12 graduate credits may be taken prior to completion of the baccalaureate degree. These graduate credits may be used to satisfy required major electives or open elective credits for the undergraduate degree. Nine of these credits are shared credits with the graduate program, meaning that they will be applied to both undergraduate and graduate degree requirements.

The graduate statistics courses that may be taken as an undergraduate, once a student is admitted to the program, are in the table below.

Course	Title	Hours
STAT 513	Mathematical Statistics I	3
STAT 514	Mathematical Statistics II	3
STAT 546	Linear Models	3
600-level STAT course, approved by the graduate adviser		3

## Recommended course sequence/plan of study

What follows is the recommended plan of study for students interested in the accelerated program beginning in the fall of the junior year prior to admission to the accelerated program in the senior year.

Course	Title	Hours
<b>Junior year</b>		
Fall semester		
STAT 309	Introduction to Probability Theory	3
Experiential fine arts		1-3
General education course		3-4
Natural science sequence		4-5
Statistics concentration elective		3
Term Hours:		14-18
Spring semester		
STAT 310	Introduction to Statistical Inference	3
Natural science sequence		4-5
Open elective		3
Statistics concentration electives		6
Term Hours:		16-17
<b>Senior year</b>		
Fall semester		
SSOR 480	Consulting Using Advanced Analytics	3
SSOR 485	Career Planning and Professional Development for Statistics and Operations Research	1
STAT 513	Mathematical Statistics I	3
Natural sciences elective (not from general education science and technology list and different science than chosen for sequence)		3-5
Statistics concentration electives		6
Term Hours:		16-18
Spring semester		
STAT 514	Mathematical Statistics II	3
STAT 546	Linear Models	3
Open elective		3
Statistics concentration elective		3
Term Hours:		12
<b>Fifth year</b>		
Fall semester		
SSOR 690	Research and Communications Seminar	3
STAT 643	Applied Linear Regression	3
Graduate statistics electives		6
Term Hours:		12
Spring semester		
STAT 642	Design and Analysis of Experiments I	3
Graduate statistics electives		3
Term Hours:		9