Mathematics and Statistics

Web Site: http://www.odu.edu/math

Gordon Melrose, Chair
Robert Strozak, Chief Departmental Advisor

Bachelor of Science in Mathematics

The Department of Mathematics and Statistics offers programs of study that lead to the degree of Bachelor of Science in Mathematics. A student can earn the degree by completing a major in Applied Mathematics, a major in Statistics/Biostatistics, a major in Actuarial Mathematics, or a major in Big Data Analytics. Students can also earn a degree of Bachelor of Science in Mathematics with Teaching Licensure, which is intended for those who wish to pursue a career in teaching mathematics at the high school level and leads to teaching licensure in the Commonwealth of Virginia. The applied mathematics major is intended for students wishing to pursue graduate work in mathematics or otherwise obtain employment in a mathematics field. Similarly, the statistics/biostatistics major is intended for those who wish to pursue graduate work in statistics or otherwise obtain employment in a statistics-related field, especially biostatistics. The actuarial mathematics major is specifically designed for students who wish to pursue an actuarial field, pursue graduate work in financial mathematics, or employment in a mathematics or statistics-related field. The big data analytics major is designed for students wishing to pursue one of the many jobs that require solving important large-scale problems in applied science, engineering, business, industry and government as well as pursue graduate work in big data analytics. Teaching licensure can also be added to any of the majors above, which automatically fulfills the University’s upper-division general education requirement under Option C. A double major within the Department of Mathematics and Statistics will not satisfy the University’s upper-division general education requirement under option A except for a double major in applied mathematics and statistics/biostatistics. The requirements of each major along with the professional education courses needed for teacher licensure in the Commonwealth of Virginia are listed below. All students earning a Bachelor of Science in Mathematics have to successfully complete the mathematics core course requirements.

Four-Year Plan - Mathematics Major - BS (http://catalog.odu.edu/undergraduate/collegeofsciences/mathematicsstatistics/mathematics-bs-fouryearplan/)

- The four-year plan is a suggested curriculum to complete this degree program in four years. It is just one of several plans that will work and is presented only as broad guidance to students. Each student is strongly encouraged to develop a customized plan in consultation with their academic advisor. Additional information can also be found in Degree Works.

Requirements

Lower-Division General Education

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composition *</td>
<td>6</td>
</tr>
<tr>
<td>Oral Communication</td>
<td>3</td>
</tr>
<tr>
<td>Mathematics (met in the major by MATH 211)</td>
<td>0-6</td>
</tr>
<tr>
<td>Language and Culture</td>
<td></td>
</tr>
<tr>
<td>Information Literacy and Research</td>
<td>3</td>
</tr>
<tr>
<td>CS 121G Introduction to Information Literacy and Research for Scientists (preferred)**</td>
<td></td>
</tr>
<tr>
<td>Human Creativity</td>
<td>3</td>
</tr>
<tr>
<td>Interpreting the Past</td>
<td>3</td>
</tr>
<tr>
<td>Literature</td>
<td>3</td>
</tr>
<tr>
<td>Human Behavior</td>
<td>3</td>
</tr>
<tr>
<td>Philosophy and Ethics (PHIL 120P recommended)</td>
<td>3</td>
</tr>
<tr>
<td>The Nature of Science *</td>
<td>8</td>
</tr>
</tbody>
</table>

* Mathematics and Statistics

Total Hours: 38-44

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 150 Problem Solving and Programming I</td>
<td>4</td>
</tr>
<tr>
<td>MATH 211 Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>MATH 212 Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 307 Ordinary Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>MATH 311W Abstract Algebra</td>
<td>3</td>
</tr>
<tr>
<td>MATH 312 Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>MATH 316 Introductory Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>MATH 317 Calculus IV: Introductory Analysis</td>
<td>3</td>
</tr>
<tr>
<td>STAT 310 Introductory Data Analysis</td>
<td>3</td>
</tr>
<tr>
<td>STAT 330 An Introduction to Probability and Statistics ** or STAT 331 Theory of Probability</td>
<td>3</td>
</tr>
</tbody>
</table>

** Statistics/Biostatistics majors and Actuarial Mathematics majors take STAT 331.

* A grade of C or better is required in both courses.
** IT 150G is an acceptable substitute for the Actuarial Mathematics major or the Big Data Analytics major.
*** ECON 202S is required for the Actuarial Mathematics major.
+ The eight credit hours of Nature of Science with labs need not be in the same science. However, PHYS 231N-PHYS 232N are recommended for the Applied Mathematics major; and BIOL 110N/BIOL 111N; BIOL 112N/BIOL 113N; BIOL 117N/BIOL 118N or BIOL 121N/BIOL 122N-BIOL 123N/BIOL 124N are recommended for the Statistics/Biostatistics major.
++ IT 360T is suggested for the Actuarial Mathematics major.

Additional Course Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 401 Partial Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>MATH 408 Applied Numerical Methods I</td>
<td>3</td>
</tr>
<tr>
<td>MATH 422 Applied Complex Variables</td>
<td>3</td>
</tr>
<tr>
<td>MATH 400-level electives (or approved BDA courses):</td>
<td>9</td>
</tr>
<tr>
<td>MATH 400 History of Mathematics</td>
<td></td>
</tr>
<tr>
<td>MATH 404 Fundamental Concepts of Geometry</td>
<td></td>
</tr>
<tr>
<td>MATH 406 Number Theory and Discrete Mathematics</td>
<td></td>
</tr>
</tbody>
</table>

Total Hours: 18

Major in Applied Mathematics

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 405 Introduction to Data Handling</td>
<td>3</td>
</tr>
<tr>
<td>STAT 431 Theory of Statistics</td>
<td>3</td>
</tr>
<tr>
<td>MATH 400-level electives (or approved BDA courses):</td>
<td>12</td>
</tr>
</tbody>
</table>

Total Hours: 18

Major in Statistics/Biostatistics

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 405 Introduction to Data Handling</td>
<td>3</td>
</tr>
<tr>
<td>STAT 431 Theory of Statistics</td>
<td>3</td>
</tr>
<tr>
<td>MATH 400-level electives (or approved BDA courses):</td>
<td>12</td>
</tr>
</tbody>
</table>

Total Hours: 18
**Major in Actuarial Mathematics**

The upper-division general education requirement must be satisfied by completing a Finance major with Risk Management and Insurance concentration (Option A) or by completing a Finance minor in Risk Management and Insurance (Option B).

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 405</td>
<td>Introduction to Data Handling</td>
<td>3</td>
</tr>
<tr>
<td>STAT 431</td>
<td>Theory of Statistics</td>
<td>3</td>
</tr>
<tr>
<td>STAT 437</td>
<td>Applied Regression and Time Series Analysis</td>
<td>3</td>
</tr>
<tr>
<td>MATH 408</td>
<td>Applied Numerical Methods I</td>
<td>3</td>
</tr>
</tbody>
</table>

Two courses from the following list with at least one being a STAT course

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 401</td>
<td>Partial Differential Equations</td>
<td></td>
</tr>
<tr>
<td>MATH 409</td>
<td>Applied Numerical Methods II</td>
<td></td>
</tr>
<tr>
<td>MATH 417</td>
<td>Intermediate Real Analysis I</td>
<td></td>
</tr>
<tr>
<td>STAT 432</td>
<td>Sampling Theory</td>
<td></td>
</tr>
<tr>
<td>STAT 449</td>
<td>Nonparametric Statistics</td>
<td></td>
</tr>
<tr>
<td>STAT 450</td>
<td>Categorical Data Analysis</td>
<td></td>
</tr>
</tbody>
</table>

Or approved BDA courses

**Total Hours**: 18

**Major in Big Data Analytics**

The upper-division general education requirement must be satisfied by completing a minor or second major in computer science, which includes CS 361 Advanced Data Structures and Algorithms.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 405</td>
<td>Introduction to Data Handling</td>
<td>3</td>
</tr>
<tr>
<td>BDA 411</td>
<td>Introduction to Machine Learning</td>
<td>3</td>
</tr>
<tr>
<td>BDA 431</td>
<td>Modern Statistical Methods for Big Data Analytics</td>
<td>3</td>
</tr>
<tr>
<td>BDA 432</td>
<td>Introduction to Optimization in Data Science</td>
<td>3</td>
</tr>
<tr>
<td>BDA 450</td>
<td>Senior Project in Big Data Analytics I</td>
<td>3</td>
</tr>
</tbody>
</table>

At least three of the following courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 431</td>
<td>Theory of Statistics</td>
<td>9</td>
</tr>
<tr>
<td>STAT 437</td>
<td>Applied Regression and Time Series Analysis</td>
<td></td>
</tr>
<tr>
<td>MATH 401</td>
<td>Partial Differential Equations</td>
<td></td>
</tr>
<tr>
<td>MATH 408</td>
<td>Applied Numerical Methods I</td>
<td></td>
</tr>
<tr>
<td>MATH 421</td>
<td>Applied Mathematics II: Mathematical Model</td>
<td></td>
</tr>
</tbody>
</table>

**Total Hours**: 24

**Elective Credit**

Elective credit may be needed to meet the minimum requirement of 120 credit hours for all students earning a BS in Mathematics.

**Bachelor of Science in Mathematics with Teaching Licensure**

Due to changing University requirements, national accreditation standards, and the Virginia Board of Education licensure regulations, the teacher preparation programs in the College of Sciences are under constant revision. Any changes resulting from these factors supersede the program requirements described in this Catalog. Students are encouraged to obtain current program information from their advisors and the Office of Clinical Experiences website at www.odu.edu/orce (http://www.odu.edu/orce/).

**Admission**

Students must first declare mathematics with teaching licensure as their program with the mathematics departmental advisor. All students must apply for and be admitted into the approved mathematics teacher preparation program. Students must meet the required criteria for admission by earning the minimum required grade point averages (GPA).

**Virginia Board of Education Prescribed Assessments for Admission to an Approved Teacher Education Program**

Old Dominion University students seeking admission to an approved teacher education program must satisfy the Virginia Board of Education required assessment for admission into an approved teacher education program. The requirement can be satisfied by meeting a passing score in the following:

- Virginia Communication and Literacy Assessment (VCLA): Scaled passing score of 235 for the reading subtest and score of 235 for the writing subtest OR a composite score of 470 for the assessment.

For the most current information on prescribed Virginia Board of Education admission assessment, visit the Virginia Department of Education at https://www.doe.virginia.gov/.

**Required grade point averages (GPA)**

- A cumulative GPA of 2.75 is required.
- A major/content GPA of 2.75 is required. The mathematics core must be successfully completed. A grade of C+ or higher is required in MATH 211 and MATH 212, and a cumulative GPA of 2.3 or higher is required in all 300 and 400 level core courses with no grade lower than a C. No grade lower than C- is accepted for the remaining math courses.
- A professional education GPA of 2.75 is required. All professional education courses must be passed with a grade of C- or higher.

Although students may enroll in a limited number of education courses, students must be admitted into the approved mathematics teacher preparation program prior to enrolling in any instructional strategies practicum education course. Students must also meet with an education advisor in the MonarchTeach Office.

**Continuance**

Students must maintain a cumulative GPA of 2.75, a major/content GPA of 2.75 and a professional education GPA of 2.75. The mathematics core must be successfully completed. A grade of C+ or higher is required in MATH 211 and MATH 212, and a cumulative GPA of 2.3 or higher is required in all 300 and 400 level mathematics core courses with no grade lower than a C. The remaining courses required for the major and in the professional education core must be completed with a grade of C- or higher for continuance. A professional education GPA of 2.75 is required for continuance. Students must take and pass the Praxis Subject Assessment, Mathematics content knowledge (formerly Praxis II) prior to or while enrolled in the instructional strategies course. All assessments must be passed prior to the start of the Teacher Candidate Internship Orientation session.

**Background Clearance Requirement**

Old Dominion University requires a background clearance check of candidates interested in many of the professional education programs. Professional education programs have several field experiences that are required for continuance and graduation from the program. The background clearance must be successfully completed prior to field experience placement. Candidates will be provided a field experience placement when the background check process is completed with resolution of any issues. The process to complete the ODU clearance background check is located at: http://www.odu.edu/success/academic/teacher-education/placement/background-checks (http://www.odu.edu/success/academic/teacher-education/placement/background-checks/). The ODU clearance process includes: an FBI fingerprint, a child protective service/social service review, and a Virginia State Police sex offender registry review. Candidates interested in the professional education programs are advised to complete this clearance process immediately upon entry into the program since the clearance process takes a minimum of eight weeks to complete.

**Virginia Board of Education Prescribed Assessments for Licensure**

Praxis Subject Assessment, Mathematics content knowledge (formerly Praxis II). Test code: 5161 – passing score of 160 is required.
To review more information on the Virginia Board of Education prescribed assessments visit the Office of Clinical Experiences website, www.odu.edu/oce (http://www.odu.edu/oce/).

Graduation

Requirements for graduation with a BS in Mathematics with Teaching Licensure include completion of ENGL 110C and ENGL 211C or ENGL 221C or ENGL 231C with a grade of C or better, completion of the Senior Assessment, a minimum cumulative 2.75 GPA, in the major area, and in the professional education core, successful completion of the mathematics core, no grade lower than C in the remaining courses in the major and the professional education core, successful completion of the Apprentice Teaching, and a minimum of 120 credit hours to include a minimum of 30 credit hours overall and 12 credit hours in upper-level courses in the major program from Old Dominion University. Successful completion of the core requires a grade of C+ or higher in MATH 211 and MATH 212, and a cumulative GPA of 2.3 or higher is required in all 300 and 400 level mathematics core courses with no grade lower than a C.

Four-Year Plan - Mathematics with Teaching Licensure - BS (http://catalog.odu.edu/undergraduate/collegeofsciences/mathematicsstatistics/mathematics-mathed-bs-fouryearplan/)

The four-year plan is a suggested curriculum to complete this degree program in four years. It is just one of several plans that will work and is presented only as broad guidance to students. Each student is strongly encouraged to develop a customized plan in consultation with their academic advisor. Additional information can also be found in Degree Works.

Course Requirements for the BS in Mathematics with Teaching Licensure

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 375</td>
<td>Advanced Concepts for Secondary Educators: Function and Modeling</td>
<td>3</td>
</tr>
<tr>
<td>MATH 400</td>
<td>History of Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>MATH 404</td>
<td>Fundamental Concepts of Geometry</td>
<td>3</td>
</tr>
<tr>
<td>MATH 406</td>
<td>Number Theory and Discrete Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>MATH 417</td>
<td>Intermediate Real Analysis I</td>
<td>3</td>
</tr>
<tr>
<td>or MATH 422</td>
<td>Applied Complex Variables</td>
<td>3</td>
</tr>
<tr>
<td>MATH 400-level electives (or approved BDA courses)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Total Hours</td>
<td></td>
<td>21</td>
</tr>
</tbody>
</table>

Professional Education core courses and requirements

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM 101</td>
<td>Step 1 – Inquiry Approaches to Teaching STEM</td>
<td>1</td>
</tr>
<tr>
<td>STEM 102</td>
<td>Step 2 - Inquiry Based STEM Lesson Design</td>
<td>1</td>
</tr>
<tr>
<td>STEM 201</td>
<td>Knowing and Learning in STEM Education</td>
<td>3</td>
</tr>
<tr>
<td>STEM 202</td>
<td>Classroom Interactions in STEM Education</td>
<td>3</td>
</tr>
<tr>
<td>STEM 401</td>
<td>Project Based Instruction in STEM Education</td>
<td>3</td>
</tr>
<tr>
<td>STEM 402</td>
<td>Perspectives on STEM</td>
<td>3</td>
</tr>
<tr>
<td>STEM 485</td>
<td>Apprentice Teaching</td>
<td>9</td>
</tr>
<tr>
<td>SCI 468</td>
<td>Research Methods in Math and Sciences</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(Satisfied by BIOL 468W, CHEM 468, OEAS 468W, or PHYS 468W)</td>
<td></td>
</tr>
<tr>
<td>Total Hours</td>
<td></td>
<td>26</td>
</tr>
</tbody>
</table>

Upper-Division General Education

The professional education core satisfies this requirement for students earning a BS in Mathematics with Teaching Licensure. Students majoring in Actuarial Mathematics must complete a major or a minor in Finance with a concentration in Risk Management and Insurance to meet upper-division general education requirements. Students majoring in Big Data Analytics must complete a major or a minor in Computer Science, which includes CS 361 in order to meet upper-division general education requirements.

- Option A. Approved Disciplinary Minor (a minimum of 12 hours determined by the department), or second degree or second major. A double major within the Department of Mathematics and Statistics will not satisfy the University’s upper-division general education requirement under option A except for a double major in applied mathematics and statistics/biostatistics.
- Option B: Interdisciplinary Minor (specifically 12 hours, 3 of which may be in the major)
- Option C. An approved Certification Program such as teaching licensure
- Option D. Two Upper-Division Courses from outside the College of Sciences and not required by the major (6 hours)

Requirements for Graduation

Requirements for graduation for students majoring in applied mathematics, statistics/biostatistics, big data analytics and actuarial mathematics include a minimum cumulative grade point average of 2.00 overall and in the major with successful completion of the mathematics core, 120 credit hours, which must include both a minimum of 30 credit hours overall and 12 credit hours in upper-level courses in the major program from Old Dominion University, completion of ENGL 110C and ENGL 211C or ENGL 221C or ENGL 231C with a grade of C or better, and completion of the Senior Assessment.

Practicum

Any student who wishes to receive a practicum or internship experience may do so as an integral part of the degree program. Students in the secondary school teacher track are required to complete both a practicum and a student teaching internship as part of the degree requirements. Otherwise, students may substitute the practicum experience for one of the optional courses listed in the other majors.

Minor in Mathematics

Students may pursue a minor in mathematics with an emphasis in one of the following areas: applied mathematics, statistics/biostatistics or actuarial mathematics.

The applied mathematics option consists of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 307</td>
<td>Ordinary Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>MATH 312</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>MATH 317</td>
<td>Calculus IV: Introductory Analysis</td>
<td>3</td>
</tr>
</tbody>
</table>

Select two of the following: 6

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 316</td>
<td>Introductory Linear Algebra</td>
<td></td>
</tr>
<tr>
<td>MATH 401</td>
<td>Partial Differential Equations</td>
<td></td>
</tr>
<tr>
<td>MATH 408</td>
<td>Applied Numerical Methods I</td>
<td></td>
</tr>
<tr>
<td>MATH 409</td>
<td>Applied Numerical Methods II</td>
<td></td>
</tr>
<tr>
<td>MATH 417</td>
<td>Intermediate Real Analysis I</td>
<td></td>
</tr>
<tr>
<td>MATH 420</td>
<td>Applied Mathematics I: Biomathematics</td>
<td></td>
</tr>
<tr>
<td>MATH 421</td>
<td>Applied Mathematics II: Mathematical Modeling</td>
<td></td>
</tr>
<tr>
<td>MATH 422</td>
<td>Applied Complex Variables</td>
<td></td>
</tr>
<tr>
<td>MATH 427</td>
<td>Applied Mathematics III: Elasticity</td>
<td></td>
</tr>
<tr>
<td>MATH 428</td>
<td>Applied Mathematics IV: Fluid Mechanics</td>
<td></td>
</tr>
<tr>
<td>MATH 457</td>
<td>Mathematics in Nature</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(or approved topics or BDA courses)</td>
<td></td>
</tr>
<tr>
<td>Total Hours</td>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>

The statistics/biostatistics option consists of 12 hours of statistics at the 300/400 level, of which at most six hours can be at the 300 level. STAT 306 cannot be applied to this option.

The actuarial mathematics option consists of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 312</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>MATH 316</td>
<td>Introductory Linear Algebra</td>
<td>3</td>
</tr>
</tbody>
</table>
At least nine credit hours in the chosen option must be taken through courses offered by Old Dominion University. Students must have an overall grade point average of at least 2.00 in all courses specified as a requirement for the minor in their chosen option exclusive of 100/200-level courses and prerequisite courses.

**Advanced Placement**

Advanced placement credit is awarded to students who earn qualifying scores on AP and IB subject examinations. See the equivalency charts on the Office of Undergraduate Admissions website at https://www.odu.edu/admission/undergraduate/credit/. Credit for MATH 162M and MATH 163 is also given for qualifying scores on the placement tests administered by the University Testing Center. Refer to the Academic Testing and the Prior Learning Assessment Credit Options at the Undergraduate Level sections of this Catalog. Advanced placement credit is not available for MATH 102M, but credit may be awarded with a qualifying IB score.

**Linked Bachelor of Science in Mathematics and Master of Science in Computational and Applied Mathematics**

The linked program allows students to count up to 12 credits of graduate coursework toward both their undergraduate and master's degrees. Students must earn a minimum of 150 credits (120 discrete credit hours for the undergraduate degree and 30 discrete credit hours for the graduate degree).

**Admission**

To be admitted to the linked program, students must have completed at least 60 undergraduate credit hours with at least 24 credit hours from ODU. Students must have completed MATH 307, MATH 312, MATH 317 and all prerequisites for those courses. At the time of admission, they must have an overall GPA of 3.00 or better and a GPA of 3.00 or better in MATH and STAT courses.

Interested students who meet the admission requirements should apply to the graduate program director, after consulting with the undergraduate chief departmental advisor, as soon as possible upon completing the required courses and 60 credit hours. In consultation with the graduate program director, a student will:

1. Officially declare an undergraduate Mathematics major with the undergraduate chief departmental advisor.
2. Draft a schedule of graduate courses to be taken as an undergraduate to be presented to the undergraduate chief departmental advisor.
3. Apply, during their senior year, to the Office of Graduate Admissions for admission to the master's in computational and applied mathematics program.

Students who have completed at least six hours of graduate courses upon attaining senior standing (completion of 90 credit hours) and who have earned a GPA of 3.00 or better in those courses will not be required to take the Graduate Record Exam (GRE) for admission to the master's program. Otherwise, in keeping with normal admission requirements for the MS in computational and applied mathematics, students will take the GRE as an undergraduate and will subsequently be reevaluated for continuation into the master's program.

Once students have been awarded their bachelor's degree and fulfilled all regular admission requirements for the MS in computational and applied mathematics, they will be officially admitted into the MS program.

**Program Requirements**

Students in the program will fulfill all normal admission and curricular requirements for both a BS in mathematics and an MS in computational and applied mathematics with the following exceptions:

1. Students in the program may count up to 12 hours of 500 or 600 level graduate courses, excluding independent study, taken as an undergraduate for which they have earned a grade point average of 3.0 or greater with no course grade lower than a B- toward both the BS in mathematics and the MS in computational and applied mathematics.
2. Students in the program may substitute mathematics or statistics graduate courses for undergraduate courses according to the following schema. All students must complete an undergraduate writing intensive course in the major.

   a. All students must complete the prescribed undergraduate program including all 400-level required courses and electives.
   b. All students may substitute 500- and 600-level courses for the remaining credit hours in the 120-hour requirement in the undergraduate program so long as they have the prerequisites for those courses. 700- or 800-level courses may not be used.
   c. Students will not receive credit for both the 400 and 500 level version of the same course.
   d. Students in the program may make a written petition for other substitutions to the graduate program director, who will consider them in consultation with the chief departmental advisor and the instructor(s) of the courses involved.

**NOTES:**

1. In accordance with University policy, up to 21 hours of graduate courses taken as an undergraduate may be counted toward the bachelor's degree; however, only 12 hours of graduate courses taken as an undergraduate may also be counted toward the MS degree. This will limit students' scheduling flexibility subsequently.

**BIG DATA ANALYTICS Courses**

**BDA 200T. Elements of Data Science. 3 Credits.**

This course offers a non-technical introduction to the emerging and interdisciplinary area of data science. Students will be introduced to the development, fundamental tools, and the impact of data science in a wide range of disciplines such as business, the sciences and engineering. Fundamental data visualization techniques and basic concepts of machine learning will be applied through real-life data science projects. Moreover, students will explore the general framework for ethical thinking and practicing data science, the current challenges, the benefits, the potential harms and risks posed by developing data science models and technology. Prerequisites: MATH 102M or MATH 103M.

**BDA 401/501. Programming Languages for Data Science. 3 Credits.**

An introductory course on programming languages and tools which are relevant to data analytics. Each language or tool is introduced as a separate module and incorporates applications in mathematics and statistics. Examples of included programming languages and tools are MATLAB, Python, R and SAS. Additional languages and tools may be covered based on current trends in data analytics. Students will complete hands-on programming assignments throughout the course. Prerequisites: MATH 312, MATH 316 and STAT 330 or STAT 331.

**BDA 411/511. Introduction to Machine Learning. 3 Credits.**

An introductory course on machine learning. Machine Learning is the science of discovering pattern and structure and making predictions in data sets. It lies at the interface of mathematics, statistics and computer science. The course gives an elementary summary of modern machine learning tools. Topics include regression, classification, regularization, resampling methods, and unsupervised learning. Students enrolled are expected to have some ability to write computer programs, some knowledge of probability, statistics and linear algebra. Prerequisites: MATH 312, MATH 316, and STAT 330 or STAT 331.
BDA 431/531. Modern Statistical Methods for Big Data Analytics. 3 Credits.
The statistical perspective of data mining is emphasized for majority of the
course. Both applied aspects (programming, problem solving, and
data analysis) and theoretical concepts (learning, understanding, and
evaluating methodologies) of data mining will be covered. Topics include
Regularization and Kernel Smoothing Methods, Tree-based Methods, Neural
Networks and optional topics such as deep learning. Prerequisites: BDA 411
and STAT 405.

BDA 432/532. Introduction to Optimization in Data Science. 3 Credits.
Topics considered include the solution of non-smooth optimization problems
arising in data science, including unconstrained and constrained optimization
problems, Lagrange multiplier methods, inequality constraints, Kuhn-Tucker
conditions, and applications. Also considered are linear and nonlinear
inverse problems, regularization of ill-posed problem including singular
value decomposition, and Tikhonov regularization methods and sparse
regularization methods, inverse eigenvalue problems and applications
such as compressed sensing, image reconstruction and machine learning.
Prerequisites: MATH 307, MATH 312 and MATH 316.

BDA 450. Senior Project in Big Data Analytics I. 3 Credits.
This course introduces students to practical applications of big data
analytics. Lecture topics include an overview of the various topics in
business, engineering, and government currently using big data analytics.
Students will choose a project involving a real world application to explore
techniques learned during other course work. Course involves written and
oral presentations for students to improve communication and teamwork
skills. Prerequisites: A grade of C or better in STAT 331 and STAT 405.
Pre- or corequisite: BDA 431.

BDA 451. Senior Project in Big Data Analytics II. 3 Credits.
This course allows the student to pursue an in-depth exploration of a project
initiated in BDA 450. The course involves written and oral presentations
for students to improve communication and teamwork skills. Prerequisites:
BDA 450 and permission of instructor.

MATHMATICAL SCIENCES Courses

MATH 100. The Math Cooperative. 1 Credit.
This course is to prepare students who did not meet the prerequisites for
MATH 102M or MATH 103M.

MATH 101M. An Introduction to Mathematics for Critical Thinking. 3
Credits.
This course fulfills the math general education requirement for some
majors in the College of Arts and Letters and the College of Education and
Professional Studies. It can also be used as a preparation for STAT 130M.
An introduction to the ways in which modern mathematics can be used to
analyze the modern world and make logical decisions. Topics include
problem solving, sets, logic, consumer mathematics (loans, mortgages,
annuities), probability, and elementary statistics.

MATH 102M. College Algebra. 3 Credits.
A basic course in algebra that emphasizes applications and problem-solving
skills. Topics include finding solutions, graphing of linear equations and
inequalities, graphs and functions, combining polynomials and polynomial
functions, factoring polynomials, simplifying and combining rational
expressions and equations, simplifying roots and radicals, solving radical
equations, and an introduction to quadratic functions and equations. This
course fulfills the math general education requirement and can be used as
a preparation for MATH 126M. MATH 101M is not a prerequisite
for MATH 102M. Not open to students with credit for MATH 162M.
Prerequisite: SAT score of 540 or above, or ACT score of 22 or above, or
qualifying score on the ALEKS placement exam.

MATH 103M. College Algebra with Supplemental Instruction. 3
Credits.
This course covers the same content as MATH 102M. It is designed for
students who must complete MATH 102M as part of their degree program,
but who do not meet the prerequisites for MATH 102M. MATH 103M
may be used interchangeably with MATH 102M and may be used as a
prerequisite requirement for any course that requires MATH 102M as a
prerequisite. MATH 103M will require registration for a supplemental
instruction session each week. Prerequisite: High school GPA of 3.4 or
above, or qualifying score on the ALEKS placement exam, or MATH 100.

MATH 162M. Precalculus I. 3 Credits.
The first course in a two-semester sequence designed to provide a strong
preparation for calculus. Topics include algebraic operations, equations
and inequalities, graphs and functions, polynomial functions, theory of
equations, systems of equations, exponential functions, and logarithmic
functions. Prerequisite: qualifying score on SAT or ACT, or qualifying score
on a placement test administered by the University Testing Center or a grade
of C or better in MATH 102M or MATH 103M.

MATH 163. Precalculus II. 3 Credits.
The second course in a two-semester sequence designed to provide strong
preparation for calculus. Topics include exponential and logarithmic
functions/equations, trigonometric functions/equations, trigonometric
identities, laws of sines and cosines, vectors, polar representation of complex
numbers, binomial theorem, and conic sections. Prerequisite: A grade of C
or better in MATH 162M.

MATH 166. Precalculus I and II. 4 Credits.
A one-semester precalculus course covering the topics of MATH 162M
and MATH 163 at an accelerated pace. Not available to students with credit
in MATH 163. Prerequisites: A grade of C or better in MATH 102M or
MATH 103M.

MATH 197. Undergraduate Research Experience in Mathematics. 0
Credits.
Student participation in a supervised, undergraduate research experience for
which credit will not apply to the degree. Experience must be related to the
student's major, minor or career area of interest. Prerequisites: permission
of the instructor.

MATH 200. Calculus for Business and Economics. 3 Credits.
A Calculus course intended for those studying business and economics.
Topics include applications of linear, quadratic, rational, exponential,
and logarithmic business functions, solving applied linear systems using
matrices, limits and continuity, derivatives with applications, and integration
with applications. Prerequisites: A grade of C or better in MATH 162M.

MATH 205. Calculus for Life Sciences. 3 Credits.
This course covers the standard topics of first semester calculus including
limits, derivatives and integrals. All examples for this course are drawn from
biological sciences with specific applications to topics covered in the core
courses of the undergraduate Biology major. Prerequisite: A grade of C
or better in MATH 162M.

MATH 211. Calculus I. 4 Credits.
A first course in calculus and analytic geometry. Topics include
differentiation and integration of algebraic and transcendental functions
of one variable and applications. Prerequisites: A grade of C or better
in MATH 163 or MATH 166.

MATH 212. Calculus II. 4 Credits.
A second course in calculus and analytic geometry. Topics include
techniques of integration, polar coordinates, infinite series, solid geometry,
vectors, lines and planes. Prerequisite: A grade of C or better in MATH 211.

MATH 280. Transfer Credit for Ordinary Differential Equations. 3
Credits.
This course is a VCCS transfer credit vehicle. Students who have earned
transferable credit in MATH 279 or 291 at any member institution of the
VCCS will be granted credit for MATH 280. The course will not be offered
for credit by Old Dominion University. Cannot be used to substitute for
MATH 307 for MATH majors or minors.
MATH 285. Transfer Credit for Calculus III. 4 Credits.
This course is a VCCS transfer credit vehicle. Students who have earned transferable credit for MATH 275 or 277 at any member institution of the VCCS will be granted credit for MATH 285. The course will not be offered for credit by Old Dominion University. Cannot be used to substitute for MATH 312 for MATH majors or minors.

MATH 295. Topics in Mathematics. 1-5 Credits.
Study of selected topics. Prerequisite: departmental permission.

MATH 300. Number Systems. 3 Credits.
Sets and systems of numbers, prime, integer, rational, irrational, real, complex and their properties. Representation of numbers. Divisibility, congruence, modular arithmetic, elementary number theory and symbolic logic. (May not be used to satisfy the upper-division elective requirement of the math majors program.) Prerequisite: A grade of C or better in MATH 102M or MATH 103M or MATH 162M.

MATH 302. Geometry. 3 Credits.
Elementary plane and solid Euclidean geometry with proofs and applications. Topics include angles, triangles, congruence, quadrilaterals, circles, similarity, perimeter, area, volume, polygons, plane and solid constructions. A dynamic geometry visualization software is used to discover geometric properties. (May not be used to satisfy the upper-division elective requirement of the math majors program.) Prerequisite: A grade of C or better in MATH 102M or MATH 103M or MATH 162M.

MATH 305. Discrete Math. 3 Credits.
Topics include vectors and matrices, linear programming, operations on sets, combinatorics, permutations, combinations, elementary probability, logic, relations and functions, induction, graphs and trees, applications. (May not be used to satisfy the upper-division elective requirement of the math majors program.) Prerequisite: A grade of C or better in MATH 102M or MATH 103M or MATH 162M.

MATH 307. Ordinary Differential Equations. 3 Credits.
Topics include first order differential equations and systems, second and higher order linear equations, solution by series and Laplace transform, and applications. Prerequisite: A grade of C or better in MATH 212.

MATH 311W. Abstract Algebra. 3 Credits.
Topics include introduction to logic and methods of proof; sets, relations, and functions; elementary group and ring theory. This is a writing intensive course. Prerequisites: A grade of C or better in ENGL 211C or ENGL 221C or ENGL 231C; MATH 212 or departmental permission.

MATH 312. Calculus III. 4 Credits.
A third course in calculus and analytic geometry. Topics include vector functions, partial derivatives, multiple integrals and an introduction to vector calculus. Prerequisite: A grade of C or better in MATH 212.

MATH 316. Introductory Linear Algebra. 3 Credits.
An introduction to linear algebra. Topics include matrices, vectors, vector spaces, linear transformations, eigenvalues and eigenvectors. Prerequisites: A grade of C or better in MATH 212.

MATH 317. Calculus IV: Introductory Analysis. 3 Credits.
An introduction to real analysis. Topics covered include completeness and topological properties of the real line, theory of sequences, limits of functions, the derivative, the Riemann integral, and the Fundamental Theorem of Calculus. Prerequisites: A grade of C or better in MATH 212.

MATH 335. Number Systems and Discrete Mathematics. 3 Credits.
Estimation and other applications to real world problems, using elementary principles of algebra, geometry, number theory, number systems, and discrete mathematics. (May not be used to satisfy the upper-division elective requirement of the math majors program.) Prerequisite: A grade of C or better in MATH 102M or MATH 103M or MATH 162M.

MATH 367. Cooperative Education. 1-3 Credits.
Student participation for credit based on the academic relevance of the work experience, criteria, and evaluative procedures as formally determined by the department and Career Development Services prior to the semester in which the work experience is to take place. Available for pass/fail grading only. May be repeated for credit. Prerequisite: approval by the department and Career Development Services in accordance with the policy for granting credit for Cooperative Education programs.

MATH 375. Advanced Concepts for Secondary Educators: Function and Modeling. 3 Credits.
This course engages students in explorations and laboratory activities designed to strengthen and expand their knowledge of the topics found in college mathematics, and in particular, students will delve into and illuminate the connections between secondary and college mathematics by exploring and highlighting the basic secondary school topics that need to be mastered in order to solve problems in college mathematics. Through this process, students will achieve mastery of topics they will be teaching in secondary mathematics and understand the connection between the high school curriculum and their students' success in college and in the workplace. Prerequisite: MATH 307.

MATH 395. Topics in Mathematics. 1-3 Credits.
Study of selected topics. Prerequisite: departmental permission.

MATH 399. Putnam Exam Problems and Related Topics. 1 Credit.
This course is designed to help students prepare for the Putnam Exam - an annual national mathematical competition. Problems from previous Putnam Exams and materials related to the solution of such problems will be considered. Prerequisites: A grade of C or better in MATH 212.

MATH 400/500. History of Mathematics. 3 Credits.
Seminal ideas in geometry, arithmetic, algebra, analysis and applied mathematics (along with their mathematical representations) from antiquity, the age of exploration, the Promethean age to the present day. Prerequisites: MATH 311W or MATH 316 or MATH 317.

MATH 401/501. Partial Differential Equations. 3 Credits.
Not available to students with credit in MATH 691. Separation of variable techniques, Sturm-Liouville systems, generalized Fourier series, orthogonal functions of the trigonometric, Legendre and Bessel type boundary value problems associated with the wave equation and the heat conduction equation in various coordinate systems, applications to physics and engineering. Prerequisites: A grade of C or better in MATH 307 and MATH 312.

MATH 404/504. Fundamental Concepts of Geometry. 3 Credits.
Fundamentals of Euclidean and non-Euclidean geometry. Alternatives to Euclidean geometry are examined using a variety of mathematical techniques. Special topics such as 'Taxicab' geometry, the hyperbolic plane, the art of M.C. Escher, and the mathematics of maps may be included. Prerequisites: MATH 311W.

MATH 406/506. Number Theory and Discrete Mathematics. 3 Credits.
A survey course. Topics include the prime number theorem, congruences, Diophantine equations, continued fractions, quadratic reciprocity, combinatorics, logic, graphs, trees, algorithms, coding and linear programming. Prerequisites: A grade of C or better in MATH 311W and MATH 316.

MATH 408/508. Applied Numerical Methods I. 3 Credits.
An introduction to the numerical methods commonly used by scientists and engineers. Topics include solutions of equations of one variable, direct methods for solving linear systems, matrix factorization, stability analysis, iterative techniques, polynomial interpolation, numerical differentiation and integration, approximation theory, and initial and boundary value problems for ordinary differential equations. Prerequisites: A grade of C or better in MATH 316; CS 150 or equivalent programming ability also required.
MATH 409/509. Applied Numerical Methods II. 3 Credits.
Topics include least squares problems, the QR factorization, the conjugate gradient method, Householder transformation and the QR method for approximating eigenvalues and singular values of a matrix. For applications, the finite difference method and the finite element method for solving partial differential equations, trigonometric interpolation and FFT as well as introductory study of optimization are discussed. Prerequisites: A grade of C or better in MATH 408/MATH 508.

MATH 417/517. Intermediate Real Analysis I. 3 Credits.
A rigorous course in classical real analysis. Topics include the topology of Euclidean n-space, properties of vector valued functions of several variables such as limits, continuity, differentiability and integrability, pointwise and uniform convergence of sequences and series of functions; Fourier series. Prerequisite: a grade of C or better in MATH 317.

MATH 418/518. Intermediate Real Analysis II. 3 Credits.
A rigorous course in classical real analysis. Topics include the topology of Euclidean n-space, properties of vector valued functions of several variables such as limits, continuity, differentiability and integrability, pointwise and uniform convergence of sequences and series of functions; Fourier series. Prerequisite: A grade of C or better in MATH 417.

MATH 420/520. Applied Mathematics I: Biomathematics. 3 Credits.
Exploring mathematical models in various biological contexts using both difference and differential equations: single and multiple species population growth, predator-prey and competing species (using phase plane analysis), epidemiological models of epidemics and pandemics, tumor growth, pattern formation in animals and insects. Prerequisites: A grade of C or better in MATH 307.

MATH 421/521. Applied Mathematics II: Mathematical Modeling. 3 Credits.
The philosophy and methodology of mathematical modeling, its successes and limitations. Topics include models of climate change and atmospheric and ocean dynamics, models in other physical and biological contexts, and an introduction to deterministic chaos. Prerequisites: A grade of C or better in MATH 307, MATH 312, MATH 316, and MATH 317.

MATH 422/522. Applied Complex Variables. 3 Credits.
Not available to students with credit in MATH 692. Topics include complex numbers, analytical functions and their properties, derivatives, integrals, series representations, residues and conformal mappings. Applications of the calculus of residues and mapping techniques to the solution of boundary value problems in physics and engineering. Prerequisite: A grade of C or better in MATH 312.

MATH 427/527. Applied Mathematics III: Elasticity. 3 Credits.
An introduction to the mathematical theory of linear and non-linear elastic continua. Topics include vectors, tensors, deformation, stress, nonlinear constitutive theory, exact solutions, infinitesimal theory, antiplane strain, plane strain, plane stress, extension, torsion, bending and elastic wave propagation. Prerequisites: A grade of C or better in MATH 307 and MATH 312.

MATH 428/528. Applied Mathematics IV: Fluid Mechanics. 3 Credits.
A mathematical investigation of the differential equations governing fluid flow with an emphasis on steady state incompressible flows. The Navier-Stokes equations are derived and some exact solutions are presented including the potential flow solutions. Topics therefore include classical ideal fluid flow and its complex variable representation, various approximations to the Navier-Stokes equations, boundary layer theory, and also surface and internal gravity wave motion, aspects of hydrodynamic stability theory and convection. Other topics may be introduced by the instructor. Corequisite: MATH 401. Prerequisites: A grade of C or better in MATH 307 and MATH 312.

MATH 457/557. Mathematics in Nature. 3 Credits.
A calculus and differential equations based description of many patterns observable in the natural world including wave motion in the air, oceans, rivers, and puddles; rainbows, halos and other meteorological phenomena; arrangement of leaves, petals and branches; height of trees; river meanders; animal and insect markings; mudcracks; spider webs; and others. Partial differential equations will be discussed as needed but a knowledge of ordinary differential equations will be assumed. Prerequisite: A grade of C or better in MATH 307.

MATH 461. Preparation for Praxis Certification. 3 Credits.
This course will equip students to pass the Praxis 5161 Mathematics: Content Knowledge Exam. This exam is required for teaching licensure at the secondary level in Virginia. Only open to students in the Secondary School Teaching Option in the Math B.S. program who have NOT yet passed the Praxis 5161 Exam. Prerequisites: Instructor approval.

MATH 494. Entrepreneurship in Mathematics. 3 Credits.
This course is designed to help students enhance their personal and professional development through innovation guided by faculty members and professionals. It offers students an opportunity to apply their knowledge of mathematics to the development of a new product, business, nonprofit program, or other initiative. The real world experiences that entrepreneurship provide will help students understand how academic knowledge leads to transformations, innovations, and solutions to different types of problems. This course is administered as an independent project for individual students, or as group projects. Prerequisites: 3.0 GPA and permission of the chief departmental advisor.

MATH 496/596. Topics in Mathematics. 1-3 Credits.
Study of selected topics. Prerequisite: permission of the instructor.

MATH 498/598. Tutorial Work in Special Topics in Mathematics. 1-3 Credits.
Independent study under the direction of an instructor including library research and reports. Prerequisite: permission of the instructor.

STATISTICS Courses

STAT 130M. Elementary Statistics. 3 Credits.
Topics include: data description, elementary probability, binomial and normal distributions, interval estimation, hypothesis testing, and correlation. The role of probability in inference is emphasized. Prerequisites: qualifying score on a placement test administered by the University Testing Center, qualifying SAT or ACT score, MATH 100 or a C or better in MATH 101M, or a higher level math course.

STAT 306. Introductory Statistics. 3 Credits.
A general probability and statistics course designed specifically to accommodate the needs of school teachers and health professionals. Topics include: descriptive statistics, basic probability, discrete random variables, continuous random variables, interval estimation, regression and correlation, hypothesis testing, and applications. (May not be used to satisfy the upper-division elective requirement of the math major program.) Prerequisites: A grade of C or better in MATH 102M or MATH 162M.

STAT 310. Introductory Data Analysis. 3 Credits.
Topics include measures of location, dispersion, and strength of relationship; parametric and nonparametric tests of location; one-way analysis of variance; complete block designs; simple and multiple regression; correlation; measures of association for categorical data. Microsoft EXCEL will be used extensively as an aid in data analysis. Written interpretation of results will be a routine component of daily assignments. Prerequisites: A grade of C or better in STAT 130M or MATH 211.

STAT 330. An Introduction to Probability and Statistics. 3 Credits.
Topics include: descriptive statistics, probability theory and probability distributions, mathematical expectation and its role in decision making, hypothesis testing, point and interval estimation, numerous applications. (Not open to students with credit in STAT 331.) Prerequisites: A grade of C or better in MATH 211.
STAT 331. Theory of Probability, 3 Credits.
An introduction to probability theory including probability functions, continuous and discrete random variables, combinatorics, special probability distributions, moment generating functions, and limit laws. Prerequisites: A grade of C or better in MATH 211.

STAT 405/505. Introduction to Data Handling, 3 Credits.
Use of SAS and R to handle data sets. Topics for SAS include data input, creating permanent data sets, merging data sets, creating new variables, sorting, printing, charting, formatting, IML programming, macro programming, and an overview of proc SQL and other statistical procedures. Topics for R include data structure, control structure, writing functions, and graphics. Prerequisites: grade of C or better in STAT 130M or equivalent and a grade of C or better in MATH 316 or equivalent or permission of instructor.

STAT 431/531. Theory of Statistics, 3 Credits.
Topics include point and interval estimation, tests of hypotheses, introduction to linear models, likelihood techniques, and regression and correlation analysis. Prerequisites: A grade of C or better in STAT 331 or departmental permission.

STAT 432/532. Sampling Theory, 3 Credits.
Sampling from finite populations is discussed. Topics such as simple random sampling, stratified random sampling and ratio and regression estimation are included. Also discussed are aspects of systematic sampling, cluster sampling, and multi-stage sampling. Prerequisites: A grade of C or better in STAT 431/STAT 531.

STAT 435/535. Design and Analysis of Experiments, 3 Credits.
Topics include introduction to design of experiments, analysis of variance with a single factor, power and OC curves, and two factors with interactions, random effects models, randomized blocks, Latin square and related designs, introduction to factorial and 2k factorial designs. Statistical software will be used to analyze real life data. Prerequisites: STAT 431/STAT 531 or STAT 437/STAT 537. Pre- or corequisite: STAT 405/STAT 505.

STAT 437/537. Applied Regression and Time Series Analysis, 3 Credits.
Topics include introduction to regression and model building, simple linear regression, multiple regression, logistic regression, and simple time series, residual analysis, selection of variables, model adequacy checking, regression on dummy variables, analysis of covariance, regression analysis of time series data, and applications of these techniques to real life data using statistical software. Prerequisites: A grade of C or better in STAT 330 or STAT 310 or STAT 431/STAT 531. Pre- or corequisites: STAT 405/STAT 505.

STAT 440/540. Clinical Trials, 3 Credits.
This course will introduce basic statistical concepts and methods used in clinical trials. Topics include trial designs, including parallel, group allocation, cross-over, and factorial designs; randomization; sample size and power calculation; survival analysis; and monitoring of trials for safety and efficacy. Prerequisites: A grade of C or better in STAT 431/STAT 531.

STAT 442/542. Environmental Statistics, 3 Credits.
Topics include nonlinear and generalized linear models, quantitative risk assessment, analysis of stimulus-response and spatially correlated data, methods of combining data from several independent studies. Regression settings are emphasized where one or more predictor variables are used to make inferences on an outcome variable of interest. Applications include modeling growth inhibition of organisms exposed to environmental toxins, spatial associations of like species, risk estimation, and spatial prediction. SAS is used extensively in the course. Prerequisites: A grade of C or better in STAT 431/STAT 531 or permission of the instructor; STAT 437 or STAT 537 recommended.

STAT 447/547. Analysis of Longitudinal Data, 3 Credits.
This course introduces statistical methods for analyzing multivariate and longitudinal data. Topics include multivariate normal distribution, covariance modeling, multivariate linear models, principal components, analysis of continuous response repeated measures, and models for discrete longitudinal data. Emphasis will be on the applications to the biological and health sciences and the use of the statistical software. Prerequisites: A grade of C or better in STAT 431/STAT 531. Pre- or corequisite: STAT 405/STAT 505.