Bachelor of Arts Degree Programs

Mathematics Major

The Mathematics major requires a minimum of 120 total hours to graduate. This total includes Liberal Arts Core requirements and the following specified major requirements, plus electives to complete the minimum of 120 hours. Students are encouraged to discuss Undergraduate Research (MATH 4990) with their adviser.

<table>
<thead>
<tr>
<th>Common core:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1420</td>
</tr>
<tr>
<td>(800:060)</td>
</tr>
<tr>
<td>Calculus I*</td>
</tr>
<tr>
<td>MATH 1421</td>
</tr>
<tr>
<td>(800:061)</td>
</tr>
<tr>
<td>Calculus II</td>
</tr>
<tr>
<td>MATH 2422</td>
</tr>
<tr>
<td>(800:062)</td>
</tr>
<tr>
<td>Calculus III</td>
</tr>
<tr>
<td>MATH 2500</td>
</tr>
<tr>
<td>(800:076)</td>
</tr>
<tr>
<td>Linear Algebra for Applications</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mathematics core:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 2900</td>
</tr>
<tr>
<td>Discrete and Argumentative Mathematics</td>
</tr>
<tr>
<td>MATH 4420/5420</td>
</tr>
<tr>
<td>(800:140g)</td>
</tr>
<tr>
<td>Advanced Calculus I</td>
</tr>
<tr>
<td>MATH 4421/5421</td>
</tr>
<tr>
<td>(800:141g)</td>
</tr>
<tr>
<td>Advanced Calculus II</td>
</tr>
<tr>
<td>MATH 4500/5500</td>
</tr>
<tr>
<td>(800:160g)</td>
</tr>
<tr>
<td>Modern Algebra I</td>
</tr>
<tr>
<td>MATH 4501/5501</td>
</tr>
<tr>
<td>(800:162g)</td>
</tr>
<tr>
<td>Modern Algebra II</td>
</tr>
<tr>
<td>MATH 4900</td>
</tr>
<tr>
<td>(800:194)</td>
</tr>
<tr>
<td>Senior Mathematics Seminar</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Probability/Statistics: select one of the following. 3-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH/STAT 3751 will not satisfy this requirement if a student has credit for STAT 1772 (800:072).</td>
</tr>
<tr>
<td>MATH/STAT 3751</td>
</tr>
<tr>
<td>Probability and Statistics</td>
</tr>
<tr>
<td>STAT 1772</td>
</tr>
<tr>
<td>(800:072)</td>
</tr>
<tr>
<td>Introduction to Statistical Methods</td>
</tr>
<tr>
<td>and</td>
</tr>
<tr>
<td>MATH/STAT 3752</td>
</tr>
<tr>
<td>Introduction to Probability</td>
</tr>
<tr>
<td>STAT 1772</td>
</tr>
<tr>
<td>(800:072)</td>
</tr>
<tr>
<td>Introduction to Statistical Methods</td>
</tr>
<tr>
<td>&amp; STAT 3771/5771</td>
</tr>
<tr>
<td>(800:121g)</td>
</tr>
<tr>
<td>and Applied Statistical Methods for Research</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electives: Select two of the following. 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3410/5410 (800:142g)</td>
</tr>
<tr>
<td>Dynamical Systems: Chaos Theory and Fractals</td>
</tr>
<tr>
<td>MATH 3425/5425 (800:149g)</td>
</tr>
<tr>
<td>Differential Equations</td>
</tr>
<tr>
<td>Course Code</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>MATH 3440/5440 (800:176g)</td>
</tr>
<tr>
<td>MATH 3530/5530 (800:143g)</td>
</tr>
<tr>
<td>MATH 3600/5600 (800:166g)</td>
</tr>
<tr>
<td>MATH 3610/5610 (800:165g)</td>
</tr>
<tr>
<td>MATH 3630/5630 (800:155g)</td>
</tr>
<tr>
<td>MATH 3640/5640 (800:180g)</td>
</tr>
<tr>
<td>MATH/STAT 3752</td>
</tr>
<tr>
<td>MATH/ACT SCI 3780</td>
</tr>
<tr>
<td>MATH 4460/5460 (800:156g)</td>
</tr>
<tr>
<td>MATH 4510/5510 (800:144g)</td>
</tr>
<tr>
<td>MATH 4641/5641 (800:167g)</td>
</tr>
</tbody>
</table>

Total Hours: 40-43

* These courses have additional prerequisites as follows: MATH 1420 (800:060) has prerequisite of a satisfactory score on a mathematics placement exam, or subsequent remediation. MATH 3440/5440 (800:176g) has prerequisite of CS 1130 (810:030), CS 1160 (810:036), or CS 1510 (810:051).

Mathematics Major-Statistics/Actuarial Science

The Mathematics-Statistics/Actuarial Science major requires a minimum of 120 total hours to graduate. This total includes Liberal Arts Core requirements and the following specified major requirements, plus electives to complete the minimum of 120 hours.

The major is available in two emphases, the Statistics emphasis and the Actuarial Science emphasis. Each emphasis requires completion of the common core, the seminar/research requirement, the core for the chosen emphasis (Statistics or Actuarial Science), and 6 hours of electives that do not duplicate course work chosen to meet the chosen emphasis (Statistics or Actuarial Science) core requirement.

**Required**

**Mathematics:**

<table>
<thead>
<tr>
<th>Common core:</th>
<th>Calculus I *</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1420 (800:060)</td>
<td>Calculus I</td>
<td>15</td>
</tr>
<tr>
<td>MATH 1421 (800:061)</td>
<td>Calculus II</td>
<td>15</td>
</tr>
<tr>
<td>MATH 2422 (800:062)</td>
<td>Calculus III</td>
<td>15</td>
</tr>
<tr>
<td>MATH 2500 (800:076)</td>
<td>Linear Algebra for Applications</td>
<td>15</td>
</tr>
</tbody>
</table>

**Statistics/Actuarial Science core:**

<table>
<thead>
<tr>
<th>STAT 1772 (800:072)</th>
<th>Introduction to Statistical Methods</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH/STAT 3752</td>
<td>Introduction to Probability</td>
<td>9</td>
</tr>
<tr>
<td>MATH/ACT SCI 3780</td>
<td>Mathematics of Finance</td>
<td>9</td>
</tr>
<tr>
<td>MATH 4900 (800:194)</td>
<td>Senior Mathematics Seminar</td>
<td>9</td>
</tr>
<tr>
<td>CS 1130 (810:030)</td>
<td>Visual BASIC Programming</td>
<td>9</td>
</tr>
<tr>
<td>CS 1160 (810:036)</td>
<td>C/C++ Programming</td>
<td>9</td>
</tr>
<tr>
<td>CS 1510 (810:051)</td>
<td>Introduction to Computing</td>
<td>9</td>
</tr>
<tr>
<td>STAT 4772/5772 (800:122g)</td>
<td>Statistical Computing I</td>
<td>9</td>
</tr>
</tbody>
</table>

**Electives:** 6

Select two electives from the following list. The same course cannot be used to satisfy both the emphasis core and elective requirement.

| STAT 3775/5775 (800:174g) | Introduction to Mathematical Statistics | 6 |
| MATH/STAT 3752 | Introduction to Probability | 6 |
| STAT 3771/5771 (800:121g) | Applied Statistical Methods for Research | 6 |
| STAT 3776/5776 (800:175g) | Regression Analysis | 6 |
| STAT 4773/5773 (800:123g) | Design and Analysis of Experiments | 6 |
| STAT 4779/5779 (800:196g) | Applied Multivariate Statistical Analysis | 6 |
| STAT 4788/5788 (800:170g) | Loss Models | 6 |
| ACT SCI 4785/5785 (800:197g) | Introduction to Financial Engineering | 6 |
| ACT SCI 4735/5735 (800:153g) | Actuarial Mathematics | 6 |
| ACT SCI 4739/5739 (800:158g) | Topics in Actuarial Science, Topics in Actuarial Science: Long-Term Actuarial Mathematics | 6 |
| ACT SCI 4788/5788 (800:170g) | Loss Models | 6 |

**Actuarial Science Emphasis Core:**

Select three from the following:

| ACT SCI/MATH 3780 | Mathematics of Finance | 3 |
| ACT SCI 4735/5735 (800:153g) | Actuarial Mathematics | 3 |
| ACT SCI 4739/5739 (800:158g) | Topics in Actuarial Science, Topics in Actuarial Science: Long-Term Actuarial Mathematics | 3 |
| ACT SCI 4788/5788 (800:170g) | Loss Models | 3 |

**Statistics Emphasis Core:**

Select three from the following:

| STAT 3771/5771 (800:121g) | Applied Statistical Methods for Research | 3 |
| STAT 3776/5776 (800:175g) | Regression Analysis | 3 |
| STAT 4773/5773 (800:123g) | Design and Analysis of Experiments | 3 |
| STAT 4779/5779 (800:196g) | Applied Multivariate Statistical Analysis | 3 |
| STAT 4788/5788 (800:170g) | Loss Models | 3 |
| ACT SCI 4785/5785 (800:197g) | Introduction to Financial Engineering | 3 |
### Mathematics Major-Teaching

The Mathematics-Teaching major requires a minimum of 122-123 total hours to graduate.

This total includes Liberal Arts Core requirements, the Professional Education Requirements, and the following specified major requirements to complete the minimum of 122-123 hours.

**Required**

**Mathematics:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1420 (800:060)</td>
<td>Calculus I *</td>
<td>4</td>
</tr>
<tr>
<td>MATH 1421 (800:061)</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 2422 (800:062)</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>MATH 2500 (800:076)</td>
<td>Linear Algebra for Applications</td>
<td>3</td>
</tr>
</tbody>
</table>

**Teaching core:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1310 (800:096)</td>
<td>Technology for Secondary Mathematics Teachers</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2303</td>
<td>Introduction to Teaching Secondary Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2900</td>
<td>Discrete and Argumentative Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3302</td>
<td>Field Experience in Teaching Secondary Mathematics</td>
<td>1</td>
</tr>
</tbody>
</table>

**Mathematics 122-123 hours: 43-46**

* MATH 1420 (800:060) has a prerequisite of satisfactory score on mathematics placement exam or subsequent remediation.

** MATH SCI 3731 (800:146) may be repeated for credit for preparation for different exams, however only 3 hours will count toward the Statistics/Actuarial Science major.

### Notes:

For departmental approval to student teach, a student in the program must satisfy the University requirements to student teach and the following specific departmental requirements:

1) Must earn a C– or better in: MATH 1420 (800:060), MATH 1421 (800:061), MATH 2500 (800:076), MATH 2900, MATH 3302, MATH 3600/5600 (800:166g), MATH 4500/5500 (800:160g), and courses taken to satisfy the Probability and Statistics and Computer Science requirements.
Department of Mathematics

Science requirements. MATH 3302 is offered credit/no credit only effective Fall 2019 and beyond, and student must pass this course.

2) Must earn a grade of C or higher in: MATH 2303 and MATH 3304 (800:190).

3) Must complete all of the courses in the major with a major grade point average of 2.50 or higher.

Minors

Data Science Minor

The Data Science minor is an interdisciplinary program that integrates computer programming, machine learning, statistics, predictive modeling and visualization to provide students with broad based skills for extracting gainful information from data that originate from a variety of sources. A final project (ideally with corporate or non-profit partnerships) will ensure that students employ their skills to solve a real-world problem.

Statistics:
- STAT 1772 (800:072) Introduction to Statistical Methods 3
- STAT 4784/5784 Introduction to Machine Learning 3

Computer Science:
- CS 1510 (810:051) Introduction to Computing 4
- CS 2150 Computing for Data Science 3-6
  or
  - CS 1520 (810:052) & CS 1800 (810:080) Data Structures and Discrete Structures

Physics:
- PHYSICS 4160/5160 Data Visualization, Modeling and Simulation 3

Required Data Science Project
- CS 4800 (810:180) Undergraduate Research in Computer Science 2-3
  or
  - MATH 4990 (800:195) Undergraduate Research in Mathematics
  or
  - PHYSICS 3000 Undergraduate Research in Physics (880:180)

Total Hours 21-25

Mathematics Minor

Required
Mathematics:
- MATH 1420 (800:060) Calculus I * 11
- MATH 1421 (800:061) Calculus II
- MATH 2500 (800:076) Linear Algebra for Applications

Electives
Mathematics:

ACT SCI 4739/5739 Topics in Actuarial Science, Topics in Actuarial Science: Long-Term Actuarial Mathematics (800:158g)
- MATH 2422 (800:062) Calculus III
- MATH 2900 Discrete and Argumentative Mathematics
- MATH 3410/5410 (800:142g) Dynamical Systems: Chaos Theory and Fractals
- MATH 3425/5425 (800:149g) Differential Equations
- MATH 3430/5430 (800:150g) Partial Differential Equations
- MATH 3440/5440 Numerical Analysis (800:176g)
- MATH 3530/5530 (800:143g) Combinatorics
- MATH 3600/5600 (800:166g) Euclidean Geometry
- MATH 3610/5610 (800:165g) Modern Geometries
- MATH 3630/5630 (800:155g) Differential Geometry
- MATH 3640/5640 (800:180g) History of Mathematics
- MATH 3751 (800:173) Probability and Statistics
- MATH/STAT 3752 Introduction to Probability
- MATH 4420/5420 (800:140g) Advanced Calculus I
- MATH 4421/5421 (800:141g) Advanced Calculus II
- MATH 4460/5460 (800:156g) Introduction to Complex Analysis
- MATH 4500/5500 (800:160g) Modern Algebra I
- MATH 4501/5501 (800:162g) Modern Algebra II
- MATH 4510/5510 (800:144g) Elementary Number Theory
- MATH 4615/5615 (800:189g) Geometric Transformations
- MATH 4641/5641 (800:167g) Topology I
- STAT 3775/5775 (800:174g) Introduction to Mathematical Statistics
- STAT 3776/5776 (800:175g) Regression Analysis
- STAT 4777/5777 (800:157g) Statistical Quality Assurance Methods
- STAT 4779/5779 (800:196g) Applied Multivariate Statistical Analysis

Total Hours 23
Mathematics Minor (K-8)-Teaching

Required

Mathematics:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1204</td>
<td>Mathematical Reasoning for Elementary Teachers I</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2204</td>
<td>Mathematical Reasoning for Elementary Teachers II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3204</td>
<td>Mathematical Reasoning for Elementary Teachers III</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3211</td>
<td>Introduction to Algebraic Thinking for Elementary Teachers</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3212/5212</td>
<td>Introduction to Geometry and Measurement for Elementary Teachers</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3213/5213</td>
<td>Topics in Mathematics for Grades K-8</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3214/5214</td>
<td>Problem Solving in Mathematics for Elementary Teachers</td>
<td>3</td>
</tr>
</tbody>
</table>

Computer Science:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS ED 1310</td>
<td>Programming Environments for Elementary Education</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours | 24 |

Statistics and Actuarial Science Minor

Complete one of the following emphases

Actuarial Science emphasis: 14

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1420 (800:060)</td>
<td>Calculus I *</td>
<td>4</td>
</tr>
<tr>
<td>MATH 1421 (800:061)</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>ACT SCI/MATH 3780</td>
<td>Mathematics of Finance</td>
<td>3</td>
</tr>
<tr>
<td>MATH/STAT 3752</td>
<td>Introduction to Probability</td>
<td>3</td>
</tr>
</tbody>
</table>

Statistics emphasis 12

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 1772 (800:072)</td>
<td>Introduction to Statistical Methods</td>
<td>3</td>
</tr>
<tr>
<td>STAT 1774 (800:064)</td>
<td>Introductory Statistics for Life Sciences</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3751 (800:173)</td>
<td>Probability and Statistics</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2303</td>
<td>Introduction to Teaching Secondary Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2500 (800:076)</td>
<td>Linear Algebra for Applications</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2900</td>
<td>Discrete and Argumentative Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3600/5600 (800:166g)</td>
<td>Euclidean Geometry</td>
<td>3</td>
</tr>
<tr>
<td>MATH 4500/5500 (800:160g)</td>
<td>Modern Algebra I</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3302</td>
<td>Field Experience in Teaching Secondary Mathematics</td>
<td>1</td>
</tr>
<tr>
<td>MATH 3304 (800:190)</td>
<td>The Teaching of Secondary Mathematics</td>
<td>3</td>
</tr>
</tbody>
</table>

Computer Science:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 1120 (810:056)</td>
<td>Media Computation</td>
<td>3</td>
</tr>
<tr>
<td>CS 1130 (810:030)</td>
<td>Visual BASIC Programming</td>
<td>3</td>
</tr>
<tr>
<td>CS 1160 (810:036)</td>
<td>C/C++ Programming</td>
<td>3</td>
</tr>
<tr>
<td>CS ED 1320</td>
<td>Fundamentals of Programming</td>
<td>3</td>
</tr>
<tr>
<td>CS 1510 (810:051)</td>
<td>Introduction to Computing</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours | 33-34 |

Electives 9

Select three courses from the following or from the emphasis not chosen:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT SCI 3731</td>
<td>Actuarial Examination (800:146)</td>
<td>3</td>
</tr>
<tr>
<td>ACT SCI 4785/5785</td>
<td>Introduction to Financial Engineering (800:197g)</td>
<td>3</td>
</tr>
<tr>
<td>ACT SCI 4735/5735</td>
<td>Actuarial Mathematics (800:153g)</td>
<td>3</td>
</tr>
<tr>
<td>ACT SCI 4788/5788</td>
<td>Loss Models (800:170g)</td>
<td>3</td>
</tr>
<tr>
<td>MATH 2422 (800:062)</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>MATH 2500 (800:076)</td>
<td>Linear Algebra for Applications</td>
<td>3</td>
</tr>
</tbody>
</table>

* MATH 1420 (800:060) has prerequisite of satisfactory score on mathematics placement exam or subsequent remediation.

Notes: For departmental approval to student teach, a student in the program must satisfy the University requirements to student teach and the following specific departmental requirements:

1) Must earn a C– or better in MATH 1420, MATH 1421, MATH 2500, MATH 2900, MATH 3302, MATH 3600, MATH 4500, and STAT 1772 or STAT 1774 or MATH 3751. MATH 3302 is offered credit/no credit only effective Fall 2019 and beyond, and student must pass this course.

2) Must earn a grade of C or higher in MATH 2303 and MATH 3304.

3) Must complete all of the courses in the minor with a minor grade point average of 2.50 or higher.
The major in Mathematics is available in three emphases: Mathematics, Secondary Teaching, and Community College Teaching.

Only graduate courses (course numbers 5000 or above) will apply to a graduate degree, even if the undergraduate course number (4999 or less) is listed. No exceptions will be made.

The Mathematics emphasis is available on the thesis and non-thesis options. A minimum of 36 hours is required for the thesis option, including 6 hours of MATH 6299 (800:299) and a minimum of 15 additional hours of 200/6000-level course work. A minimum of 33 hours is required for the non-thesis option, including a minimum of 3 hours of MATH 6299 (800:299) and a minimum of 15 additional hours of 200/6000-level course work.

The Secondary Teaching emphasis is offered on a non-thesis option only; a minimum of 30 hours, including a minimum of 18 hours of 200/6000-level course work is required.

The Community College Teaching emphasis is offered on a non-thesis option only; a minimum of 30 hours, including a minimum of 15 hours of 200/6000-level course work is required.

Students interested in this program must submit a completed Application for Admission to Graduate Study and should refer to their MyUNIverse Student Center To-Do list or contact the Department of Mathematics for other application requirements. Graduate information and application for graduate admission can be found at www.grad.uni.edu/admission.

The Graduate Record Examination (General Test) is not required for admission to the program.

Courses taken to satisfy B.A. requirements may not be repeated to count toward the graduate program.

Successful completion of a final written comprehensive examination is required for the non-thesis option on the Mathematics emphasis only.
### Secondary Teaching Emphasis

The Secondary Teaching emphasis is designed for secondary school mathematics teachers interested in developing a deeper background in mathematics and pedagogy to enhance teaching and increase student learning.

**Required**

**Mathematics Education:**
- MATH 6201 (800:220) Foundations of Mathematics Education 3
- MATH 6381 (800:281) Current Research in Mathematics Education 3
- MATH 6209 Mathematics Curriculum and Assessment 3
- MATH 6225 Teaching and Learning Mathematics 3
- MATH 6236 Equity and Mathematics Education 3

**Mathematics:**
- MATH 6371 (800:271) Probability and Statistical Inference 3
- MATH 6370 (800:270) Applied Linear Statistical Methods 3
- MATH 6410 Foundations of Calculus 3
- MATH 6670 (800:267) Non-Euclidean Geometry 3

**Total Hours** 30

### Community College Teaching Emphasis

The Community College Teaching emphasis is designed to serve those seeking to prepare for a career in community college teaching or working professionals in the field who are seeking career advancement.

**Required:**

**Mathematics Education:**
- MATH 6201 (800:220) Foundations of Mathematics Education 3
- MATH 6381 (800:281) Current Research in Mathematics Education 3
- MATH 6225 Teaching and Learning Mathematics 3
- MATH 6236 Equity and Mathematics Education 3
- MATH 6209 Mathematics Curriculum and Assessment 3

**Mathematics:**
- MATH 6504 Advanced Linear Algebra 3
- MATH 6370 (800:270) Applied Linear Statistical Methods 3
- MATH 6371 (800:271) Probability and Statistical Inference 3
- MATH 6410 Foundations of Calculus 3
- MATH 6670 (800:267) Non-Euclidean Geometry 3

**Total Hours** 30

### Major in Mathematics for the Elementary and Middle Grades (K-8)

This major is intended for teachers interested in mathematics for the elementary and middle grades (K-8) and for mathematics specialists and supervisors. Teacher licensure is a prerequisite for completing the program approval process for this major. Normally, candidates will have at least 2 years teaching experience.

Students interested in this program must submit a completed Application for Admission to Graduate Study and should refer to their MyUNIverse Student Center To-Do list or contact the Department of Mathematics for other application requirements. Graduate information and application for graduate admission can be found at [www.grad.uni.edu/admission](http://www.grad.uni.edu/admission).

The Graduate Record Examination (General Test) is **not** required for admission to the program.

**Only graduate courses (course numbers 5000 or above) will apply to a graduate degree, even if the undergraduate course number (4999 or less) is listed. No exceptions will be made.**

This major is available on the **non-thesis** option only; a **minimum of 30 hours** is required. A **minimum of 15 hours of 200/600-level course work is required.**

**Required**

**Mathematics Education:**
- MATH 6201 (800:220) Foundations of Mathematics Education 3
- MATH 6205 (800:215) Teaching Rational Numbers and Proportionality 3
- MATH 6212 (800:211) Foundations of Algebraic Reasoning 3

**Mathematics:**
- MATH 6215 Foundations of Geometric Reasoning 3
- MATH 6670 (800:267) Non-Euclidean Geometry 3
- MATH 6410 Foundations of Calculus 3
- MATH 6205 (800:215) Teaching Rational Numbers and Proportionality 3

**Total Hours** 30
**Professional Science Master’s Degree Program**

**Major in Industrial Mathematics**

The Professional Science Master’s Degree in Industrial Mathematics is designed to prepare students for a career in industry. The curriculum combines a business and experiential component with advanced course work.

Students interested in this program must submit a completed Application for Admission to Graduate Study and should refer to their MyUNIverse Student Center To-Do list or contact the Department of Mathematics for any other application requirements. Graduate information and application for graduate admission can be found at www.grad.uni.edu/admission.

The Graduate Record Examination (General Test) is not required for admission to the program.

Only graduate courses (course numbers 5000 or above) will apply to a graduate degree, even if the undergraduate course number (4999 or less) is listed. No exceptions will be made.

This major is a non-thesis program. A minimum of 30 hours is required. A minimum of 12 hours of 6000-level course work is required.

No comprehensive examination is required for this non-thesis option.

Requirements for admission to the program include the completion of a bachelor’s degree with a GPA of 3.00 or higher and successful completion of the following university-level courses:

<table>
<thead>
<tr>
<th>Prerequisite Courses:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1420 (800:060)</td>
<td>Calculus I</td>
</tr>
<tr>
<td>MATH 1421 (800:061)</td>
<td>Calculus II</td>
</tr>
<tr>
<td>MATH 2422 (800:062)</td>
<td>Calculus III</td>
</tr>
<tr>
<td>MATH 2500 (800:076)</td>
<td>Linear Algebra for Applications</td>
</tr>
<tr>
<td>STAT 1772 (800:072)</td>
<td>Introduction to Statistical Methods</td>
</tr>
</tbody>
</table>

One course in computer programming (or equivalent):

| CS 1130 (810:030) | Visual BASIC Programming | 3 |

<table>
<thead>
<tr>
<th>Electives from the following:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketing:</td>
<td>21</td>
</tr>
<tr>
<td>MKTG 4170/5170 (130:191g)</td>
<td>Marketing Strategy</td>
</tr>
<tr>
<td>or MKTG 6170 (130:263)</td>
<td>Marketing Management</td>
</tr>
<tr>
<td>MGMT 6250 (150:250)</td>
<td>Strategic Planning and Organization Analysis</td>
</tr>
<tr>
<td>MGMT 6262 (150:272)</td>
<td>Cross-Functional Operations</td>
</tr>
<tr>
<td>FIN 3130/5130 (160:151g)</td>
<td>Corporate Finance</td>
</tr>
<tr>
<td>FIN 3160/5160 (160:152g)</td>
<td>Principles of Investments</td>
</tr>
<tr>
<td>FIN 6266 (160:266)</td>
<td>Financial Management and Markets</td>
</tr>
<tr>
<td>TECH 3024/5024 (330:122g)</td>
<td>Advanced CAD and Modeling</td>
</tr>
<tr>
<td>TECH 3147 (330:147)</td>
<td>Computer Aided Manufacturing</td>
</tr>
<tr>
<td>MATH 3425/5425 (800:149g)</td>
<td>Differential Equations</td>
</tr>
<tr>
<td>MATH 3430/5430 (800:150g)</td>
<td>Partial Differential Equations</td>
</tr>
<tr>
<td>MATH 3440/5440 (800:160g)</td>
<td>Numerical Analysis</td>
</tr>
<tr>
<td>MATH 3530/5530 (800:143g)</td>
<td>Combinatorics</td>
</tr>
<tr>
<td>ACT SCI/MATH 3780</td>
<td>Mathematics of Finance</td>
</tr>
<tr>
<td>ACT SCI 4735/5735 (800:153g)</td>
<td>Actuarial Mathematics</td>
</tr>
<tr>
<td>ACT SCI 4739/5739 (800:158g)</td>
<td>Topics in Actuarial Science, Topics in Actuarial Science: Long-Term Actuarial Mathematics</td>
</tr>
<tr>
<td>ACT SCI 4785/5785 (800:170g)</td>
<td>Loss Models</td>
</tr>
</tbody>
</table>

This major requires completion of 9 hours of the PSM Industrial Mathematics core, and 21 hours of electives.
Program Certificates

The University of Northern Iowa makes available, in addition to traditional programs, the opportunity for students to earn program certificates. Program certificates provide an alternative to programs leading to a degree, a major, or a minor; they certify that an individual has completed a program approved by the university. For information on the following certificates, contact the Department of Mathematics or the Office of the Registrar, which serves as the centralized registry.

Statistical Computing Certificate

Required:

- STAT 3771/5771 (800:121g) Applied Statistical Methods for Research
- STAT 4772/5772 (800:122g) Statistical Computing I
- STAT 4775/5775 (800:174g) Introduction to Mathematical Statistics
- STAT 4777/5777 (800:157g) Statistical Quality Assurance Methods
- STAT 4779/5779 (800:196g) Applied Multivariate Statistical Analysis

Electives: 6 hours from the following

- STAT 3776/5776 (800:175g) Regression Analysis
- STAT 3778/5778 (800:171g) Spatial Data Analysis
- STAT 4773/5773 (800:123g) Design and Analysis of Experiments
- STAT 4779/5779 (800:196g) Applied Multivariate Statistical Analysis

Any other courses with the consent of the mathematics department

Total Hours 15

Actuarial Science Courses

ACT SCI 3731 (800:146). Actuarial Examination Preparation — 3 hrs.
Strengthening student skills solving computational problems similar to those included on actuarial examinations. Analyzing and practicing appropriate choice of problem solving techniques and strategies. May be repeated for credit for preparation for different examinations. (Fall and Spring)

ACT SCI 3780/5780 (800:145g). Mathematics of Finance — 3 hrs.
Measurement of interest, annuities, yield rates, amortization and sinking funds, bonds, term structure of interest rates, interest rate sensitivity, stocks and derivatives, elements of risk management. Prerequisite(s): MATH 1420 (800:060); junior standing. (Same as MATH 3780/5780 (800:145g)) (Spring)

ACT SCI 3790. Introduction to Actuarial Science — 1 hr.
Fundamental concepts of actuarial science; actuarial areas of practice; connections between coursework and actuarial practice; key competencies for actuaries, development of computing and communications skills in the context of actuarial science. Prerequisite(s): ACT SCI 3780/5780 (800:145g)/MATH 3780/5780 (800:145g). (Variable)

Survival distributions and life tables, life insurance, life annuities, benefit premiums. Prerequisite(s): MATH 1420 (800:060); junior standing. (Even Falls)

ACT SCI 4739/5739 (800:158g). Topics in Actuarial Science — 3 hrs.
Topics from mathematics of life contingencies, risk theory, survival analysis, construction of actuarial tables, demography, graduation. May be repeated on different topic with consent of instructor. Prerequisite(s): MATH 3752/5752 (800:152g); junior standing. (Even Falls)

ACT SCI 4785/5785 (800:197g). Introduction to Financial Engineering — 3 hrs.
Financial derivatives, option pricing, Binomial model, Black-Scholes formula, Greeks and hedging, introduction to stochastic calculus, financial model simulation, Monte-Carlo valuation. Prerequisite(s): MATH 3752/5752 (800:152g); junior standing. (Spring)

ACT SCI 4788/5788 (800:170g). Loss Models — 3 hrs.
Applied probability methods used in modeling loss. Loss distributions, aggregate loss models, credibility theory and long term models. Prerequisite(s): MATH 3752/5752 (800:152g); STAT 3775/5775 (800:174g); junior standing. (Odd Falls)
Mathematics Courses

MATH 100. Intermediate Algebra — 3 hrs.
Fundamental mathematical concepts; functions and graphs; solutions of equations; systems of equations and inequalities; matrices and determinants. Successful completion will satisfy the university’s high school mathematics requirement. Does not count toward minimum hours required for baccalaureate degree. (Fall)

MATH 1100 (800:023). Mathematics in Decision Making — 3 hrs.
Selection of mathematical topics and their applications with an emphasis on mathematical reasoning. Topics include probability and statistics. (Fall, Spring, Summer)

MATH 1110 (800:043). Analysis for Business Students — 3 hrs.
Analysis and interpretation of data using numerical, graphical, and functional viewpoints; linear and exponential functions; modeling data using functions. No credit for students with credit in MATH 1140 (800:046) or MATH 1120 (800:056). Prerequisite(s): Satisfactory score on ALEKS exam. (Fall and Spring)

MATH 1120 (800:056). Mathematics for Biological Sciences — 3 hrs.
Proportional reasoning, linear functions and linear regression, exponential functions, and logarithmic functions with scientific applications. No credit for students with credit in MATH 1110 (800:043) or MATH 1140 (800:046). Prerequisite(s): Satisfactory score on ALEKS exam. (Fall and Spring)

MATH 1130 (800:044). Trigonometry — 2 hrs.
Trigonometric functions, solution of triangles and applications of simple harmonic motion, polar coordinates, and vectors. No credit for students with credit in MATH 1140 (800:046). Prerequisite(s): Satisfactory score on ALEKS exam. (Fall and Spring)

MATH 1140 (800:046). Precalculus — 4 hrs.
Pre-calculus mathematics; equations and inequalities; logarithms, exponential and circular functions; analytic trigonometry, analytic geometry, mathematical induction; applications. Credit reduced to 1 hour for students with credit in MATH 1110 (800:043) or MATH 1120 (800:056), and to 2 hours for students with credit in MATH 1130 (800:044). Prerequisite(s): Satisfactory score on ALEKS exam. (Fall and Spring)

MATH 1150 (800:048). Calculus for Technology — 4 hrs.
Survey of analytic geometry and elementary calculus with emphasis on applications. May not be applied to Mathematics major or minor. Prerequisite(s): Satisfactory score on ALEKS exam. (Spring)

MATH 1204. Mathematical Reasoning for Elementary Teachers I — 3 hrs.
Mathematics as problem solving, communication, connections, and reasoning. Includes whole numbers, rational numbers, percent, and operations. Activities investigating these topics connect to elementary school mathematics. Primarily for education majors. (Fall and Spring)

Introduction to technologies (calculators, spreadsheets, and dynamic geometric and statistical programs) used in mathematics classrooms (5-12). Activities to develop facility with the technologies while addressing mathematics and pedagogical implications. Prerequisite(s) or corequisite(s): MATH 1420 (800:060). (Fall)

MATH 1420 (800:060). Calculus I — 4 hrs.
Limits, differentiation, introduction to integration including the fundamental theorem of calculus. Prerequisite(s): Satisfactory score on ALEKS exam. (Fall and Spring)

MATH 1421 (800:061). Calculus II — 4 hrs.
Integration techniques, sequences and series, applications. Prerequisite(s): C- or better in MATH 1420 (800:060). (Fall and Spring)

MATH 1900 (800:090). Mathematical Problem Solving — 1 hr.
Basic techniques used to solve challenging mathematics problems. Problems considered will come from a broad range of courses. Prepares students to take the William Lowell Putnam Examination and the Iowa Collegiate Mathematics Competition. May be repeated. (Fall and Spring)

MATH 2204. Mathematical Reasoning for Elementary Teachers II — 3 hrs.
Mathematics as problem solving, communication, connections, and reasoning. Includes data analysis, probability, and algebraic reasoning. Activities connected to elementary school mathematics. Designed for elementary education majors. Prerequisite(s): MATH 1204. (Fall and Spring)

MATH 2303. Introduction to Teaching Secondary Mathematics — 3 hrs.
Students will be introduced to National Council of Teachers of Mathematics Principles and Standards and research-based methods of teaching secondary mathematics while learning ways to teach proportional reasoning and rational numbers. A grade of C or better is required for MATH 3304 (800:190). Prerequisite(s): admitted to Teacher Education. (Spring)

MATH 2422 (800:061). Calculus III — 4 hrs.
The derivatives and integrals of multi-variable functions and their applications; Gauss', Green's, and Stokes' theorems. Prerequisite(s): for Mathematics majors and minors: C- or better in MATH 1421 (800:061) and MATH 2500 (800:076). Prerequisites for non-Mathematics majors and minors: C- or better in MATH 1421 (800:061); MATH 2500 (800:076) or consent of department. (Fall and Spring)

MATH 2500 (800:076). Linear Algebra for Applications — 3 hrs.
Gaussian elimination; matrix algebra; vector spaces, kernels, and other subspaces; orthogonal projection; eigenvalues and eigenvectors. Prerequisite(s): MATH 1420 (800:060). (Fall and Spring)

MATH 2900. Discrete and Argumentative Mathematics — 3 hrs.
Logical argument techniques. The writing process in a mathematical context. Theory of sets, functions, and relations. Elements of graph theory. Prerequisite(s): MATH 1420 (800:060). (Fall)

MATH 3203 (800:134). Teaching Mathematics in the Elementary School — 3 hrs.
Effective instructional models and strategies for teaching elementary school mathematics; involves selecting and designing mathematical tasks, creating an environment, and orchestrating discourse. Using and supplementing mathematics materials within a sound psychological framework for making instructional decisions. Prerequisite(s): MATH 3204; UNI and cumulative GPA of 2.50 or better; full admission to teacher education is required. (Fall, Spring, Summer)

Mathematics as problem solving, communication, connections, and reasoning. Includes geometry, measurement, and proportionality. Activities connected to elementary school mathematics. Designed for elementary education majors. Prerequisite(s): MATH 2204; UNI and cumulative GPA of 2.50 or better; junior standing or consent of department. (Fall and Spring)
MATH 3211 (800:111g). Introduction to Algebraic Thinking for Elementary Teachers — 3 hrs.
Investigation of problems involving patterns, variables, relations, functions, and their graphs. Exploration and representation of these problems using physical models and technology. Prerequisite(s): MATH 2204. (Fall and Spring)

MATH 3212/5212 (800:112g). Introduction to Geometry and Measurement for Elementary Teachers — 3 hrs.
Van Hiele levels of thinking. Investigation of two- and three-dimensional concepts, rigid transformations, symmetry, and spatial sense. Prerequisite(s): MATH 3204; junior standing. (Fall and Spring)

MATH 3213/5213 (800:113g). Topics in Mathematics for Grades K-8 — 3 hrs.
Investigation of number theory, extending ratio, proportion and probability with connections to rational numbers, algebra and geometry. Reasoning about topics in the context of the K-8 mathematics curriculum. Prerequisite(s): MATH 1420; or equivalent; junior standing. (Fall and Spring)

MATH 3214/5214 (800:114g). Problem Solving in Mathematics for Elementary Teachers — 3 hrs.
Strategies for constructing and communicating a mathematics problem-solving process. Analysis of resources and strategies to generate mathematics tasks and to create an effective problem-solving environment. Problem solving as a means of constructing mathematics knowledge. Prerequisite(s): MATH 3203 (800:134); at least one of MATH 3211 (800:111g), MATH 3212/5212 (800:112g), MATH 3213/5213 (800:113g); junior standing. (Fall and Spring)

MATH 3215 (800:192). Mathematics for Elementary Students with Special Needs — 1 hr.
Assessing, designing, and providing appropriate mathematical tasks for students with special needs. Prerequisite(s): MATH 3203 (800:134) or MATH 3304 (800:190); junior standing. Prerequisite(s) or corequisite(s): MATH 3214/5214 (800:114g). (Variable)

MATH 3302. Field Experience in Teaching Secondary Mathematics — 1 hr.
Field experience in which students are actively involved in preparing and teaching lessons in 6-12 mathematics classrooms. Teacher candidates will spend a minimum of 30 hours in math classrooms. In preparing, teaching and reflecting on their lessons, teacher candidates will be expected to draw on theory and research related to teaching and learning processes, motivation, and classroom management and to discuss these theory/practice connections in required written assignments. Offered on credit/no credit basis only. Prerequisite(s): TEACHING 3128; EDPSYCH 3148 (200:148); MEASRES 3150 (250:150); MATH 3600/5600 (800:166g); MATH 4500/5500 (800:160g). Corequisite(s): MATH 3304 (800:190). (Fall)

MATH 3304 (800:190). The Teaching of Secondary Mathematics — 3 hrs.
Mathematics teaching strategies for grades 5-12; roles of content and methods; addressing the needs of diverse learners in secondary mathematics classes; assessing teaching and learning of secondary mathematics. A grade of C or better is required to be eligible for student teaching. Prerequisite(s): TEACHING 3128; EDPSYCH 3148 (200:148); MEASRES 3150 (250:150); MATH 4500/5500 (800:160g); MATH 3610/5610 (800:165g) or MATH 3600/5600 (800:166g); a grade of C or better in MATH 2303. (Fall)

Connections between the undergraduate mathematics major and the secondary mathematics curriculum. Consideration of modern algebra, modern geometry, probability and statistics, calculus and number theory in the context of the secondary mathematics curriculum. Prerequisite(s): 6 hours of 100/3000/4000-level courses in mathematics. Corequisite(s): EDPSYCH 3148 (200:148); MEASRES 3150 (250:150). Prerequisite(s) or corequisite(s): EDPSYCH 2030 (200:030); TEACHING 2017; TEACHING 3128; MATH 2303. (Spring)

MATH 3313. Topics in Secondary Mathematics — 3 hrs.
Investigation of selected topics from algebra, geometry and data analysis. Reasoning about topics in the context of the secondary mathematics curriculum. Prerequisite(s): TEACHING 2017; EDPSYCH 2030 (200:030). (Spring)

MATH 3410/5410 (800:142g). Dynamical Systems: Chaos Theory and Fractals — 3 hrs.
Historical background, including examples of dynamical systems; orbits, fixed points, and periodic points; one-dimensional and two-dimensional chaos; fractals: Julia sets, the Mandelbrot set, and fractal dimension; computer programs and dynamical systems. Prerequisite(s): MATH 1421 (800:061); MATH 2500 (800:076); junior standing. (Even Springs)

MATH 3425/5425 (800:149g). Differential Equations — 3 hrs.
Elementary theory and applications of first order differential equations; introduction to numerical techniques of solving differential equations; solutions of nth order linear differential equations with constant coefficients. Prerequisite(s): MATH 2422 (800:062); MATH 2500 (800:076); junior standing. (Odd Springs)

MATH 3430/5430 (800:150g). Partial Differential Equations — 3 hrs.
Study of applied partial differential equations using heat, wave, and potential equations as basis; Fourier series and integrals; Laplace transformations. Prerequisite(s): MATH 3425/5425 (800:149g); junior standing. (Even Springs)

MATH 3440/5440 (800:176g). Numerical Analysis — 3 hrs.
Theory and application of standard numerical techniques dealing with nonlinear equations, systems of linear equations, interpolation and approximation, numerical differentiation and integration. Prerequisite(s): MATH 1421 (800:061); MATH 2500 (800:076); CS 1130 (810:030) or CS 1160 (810:036) or CS 1510 (810:051) or equivalent; junior standing. (Odd Falls)

MATH 3530/5530 (800:143g). Combinatorics — 3 hrs.
Various ways to enumerate elements of a set and graph theory. Appropriate for mathematics, mathematics education, computer science, and actuarial science students. Prerequisite(s): MATH 1420 (800:060) or CS 1800 (810:080); junior standing. (Fall and Spring)

MATH 3600/5600 (800:166g). Euclidean Geometry — 3 hrs.
Topics of plane geometry beyond a first course; compass and straightedge constructions, the nine-point circle, Ceva's and Menelaus' theorems, triangle centers, conics, and tessellations. Prerequisite(s): MATH 1420 (800:060) or equivalent; junior standing. (Fall)

MATH 3610/5610 (800:165g). Modern Geometries — 3 hrs.
Euclid's postulates serve as a model for studying various axiomatic systems defining incidence geometries. Geometries include finite geometries, plane geometry, neutral geometry, taxicab geometry, spherical geometry, and hyperbolic geometry. Prerequisite(s):
MATH 2900 or MATH 3600/5600 (800:166g); junior standing. (Even Springs)

MATH 3630/5630 (800:155g). Differential Geometry — 3 hrs.
Analytic study of curves and surfaces in three-dimensional Euclidean space. Prerequisite(s): MATH 2422 (800:062); MATH 2500 (800:076); junior standing. (Odd Springs)

MATH 3640/5640 (800:180g). History of Mathematics — 3 hrs.
Survey of mathematical activities of humankind in numeration and number systems, algebra, number theory, and calculus from pre-history through the present day. Motives, influences, and methods affecting development of these mathematical topics in Mesopotamian, Egyptian, Greek, Islamic, Indian, Chinese, Native American, and Western civilizations. Ethnomathematics as related to these topics. Prerequisite(s): junior standing. (Variable)

Descriptive statistics and graphical representations, basic concepts of probability and distributions, random variables, expectations, sampling theory, tests of statistical significance. Calculus is employed in developing and applying these ideas. Specific attention devoted to the use of technology in motivating and explaining concepts and techniques. No credit with credit in STAT 3770, credit reduced to 1 hour for students with credit in STAT 1772 (800:072). Prerequisite(s): MATH 1421 (800:061). (Same as STAT 3751) (Variable)

MATH 3752/5752 (800:152g). Introduction to Probability — 3 hrs.
Axioms of probability, sample spaces having equally likely outcomes, conditional probability and independence, random variables, expectation, moment generating functions, jointly distributed random variables, weak law of large numbers, central limit theorem. Prerequisite(s): MATH 1421 (800:061); junior standing. (Same as STAT 3752/5752 (800:152g)) (Fall and Spring)

MATH 3780/5780 (800:145g). Mathematics of Finance — 3 hrs.
Measurement of interest, annuities, yield rates, amortization and sinking funds, bonds, term structure of interest rates, interest rate sensitivity, stocks and derivatives, elements of risk management. Prerequisite(s): MATH 1420 (800:060); junior standing. (Same as ACT SCI 3780/5780 (800:145g)) (Spring)

MATH 4198 (800:198). Independent Study.
(Variable)

MATH 4420/5420 (800:140g). Advanced Calculus I — 3 hrs.
Algebraic and topological structure of the reals; limits and continuity; theory of differentiability of functions of a single real variable. Prerequisite(s): MATH 2422 (800:062); MATH 2500 (800:076); MATH 2900 or consent of the instructor; junior standing. (Fall)

MATH 4421/5421 (800:141g). Advanced Calculus II — 3 hrs.
Riemann integration; sequences and series of functions; introduction to Lebesgue integration. Prerequisite(s): MATH 4420/5420 (800:140g); junior standing. (Spring)

MATH 4460/5460 (800:156g). Introduction to Complex Analysis — 3 hrs.
Algebraic and geometric structure of of complex number system; elementary functions and mappings; differentiation and integration of functions of a single complex variable; analytic and harmonic functions. Prerequisite(s): MATH 2422 (800:062); junior standing. (Odd Springs)

MATH 4500/5500 (800:160g). Modern Algebra I — 3 hrs.
Basic properties of rings, integral domains, and fields. Polynomials over fields. Ideals and quotient rings. Introduction to groups. Prerequisite(s): MATH 2500 (800:076); MATH 2900; junior standing. (Fall)

MATH 4501/5501 (800:162g). Modern Algebra II — 3 hrs.
Groups, homomorphisms, and quotient groups. Field extensions, straightedge and compass constructions. Additional topics from group theory and field theory. Prerequisite(s): MATH 4500/5500 (800:160g); junior standing. (Spring)

MATH 4510/5510 (800:144g). Elementary Number Theory — 3 hrs.
Topics from properties of integers, prime numbers, congruences, cryptography, Pythagorean triples, Diophantine equations, Fermat’s last theorem, Fibonacci numbers, and the golden rectangle. Also, number theoretic connections to abstract algebra. Prerequisite(s): MATH 2900; junior standing. (Falls and Even Springs)

MATH 4615/5615 (800:189g). Geometric Transformations — 3 hrs.
Isometries of the plane in context of Klein's definition of a geometry as a group acting on a set of points. Rotations, reflections, and translations are used to study congruence, similarity, and symmetry and to solve problems that would otherwise be difficult using analytic geometry and calculus. Prerequisite(s): MATH 2500 (800:076); MATH 3610/5610 (800:165g) or MATH 3600/5600 (800:166g); junior standing. (Fall)

MATH 4641/5641 (800:167g). Topology I — 3 hrs.
Introductory study of metric spaces, completeness, topological spaces, continuous functions, compactness, connectedness, separability, product, and quotient spaces. Prerequisite(s): MATH 2422 (800:062); MATH 2500 (800:076); junior standing. (Odd Springs)

MATH 4900 (800:194). Senior Mathematics Seminar — 1 hr.
Researching and writing a paper exploring specific theme, topic, or problem in mathematics, culminating with oral presentation to the class. Prerequisite(s): senior mathematics major. (Fall and Spring)

MATH 4990 (800:195). Undergraduate Research in Mathematics — 3 hrs.
Research on selected topic in mathematics with faculty supervision. Presentation of written paper at departmental seminar. Prerequisite(s): completion of the major core with minimum GPA of 3.00. (Fall and Spring)

MATH 6201 (800:222). Contemporary Assessment in Mathematics Education — 3 hrs.
Introduces current recommendations and policies regarding mathematics goals, content, frameworks, instructional strategies, and curricula. Investigates topics and documents with a focus on application and impact to classrooms. (Variable)

MATH 6203 (800:222). Contemporary Assessment in Mathematics Education I — 2 hrs.
Study of strategies and practices for assessing students' thinking and performance. Multiple forms of quality assessment with an emphasis on formative assessment, aligning assessment to instruction, and interpreting evidence. Prerequisite(s): MATH 6201 (800:220) or consent of department. (Variable)

MATH 6204 (800:191g). Contemporary Mathematics Curricula — 2 hrs.
Study and evaluation of innovative curriculum materials. Focus on application to classroom practice and planning for change for a selected topic. Prerequisite(s): MATH 6201 (800:220) or consent of department. (Variable)
Examination of literature, problems, and issues related to teaching fractions, decimals, ratios, proportion, and percent. Exploration of innovative strategies for developing concepts, skills, and proportional reasoning. Prerequisite(s): MATH 6201 (800:220) or consent of department. (Variable)

MATH 6207 (800:221). Mathematics Literacy in an Information Age — 2 hrs.
Examination of applications and contributions of mathematics to other disciplines, the workplace, personal lives, and society. Investigation of shifting conceptions of mathematics and mathematics literacy in today’s world. Diverse uses of mathematics illustrated. Prerequisite(s): MATH 6201 (800:220); MATH 6224 (800:236); MATH 6226 (800:238). (Variable)

MATH 6208. Contemporary Assessment in Mathematics Education II — 1 hr.
Focus on assessment design for classroom use and development of an assessment scheme. Prerequisite(s): MATH 6201 (800:220) or consent of department. (Variable)

MATH 6209. Mathematics Curriculum and Assessment — 3 hrs.
In this course, students will explore various curricula and strategies and practices for assessing students' thinking and performance. Multiple curricula and forms of quality assessment will be considered, with an emphasis on formative assessment, aligning assessment to instruction, and interpreting evidence. (Even Falls)

MATH 6210 (800:237). Technology in Middle Grades Mathematics — 1 hr.
Uses of technology in teaching and learning mathematics. Examination of research related to incorporating technology in the teaching of mathematics. Prerequisite(s): MATH 6201 (800:220) or consent of department. (Variable)

MATH 6212 (800:211). Foundations of Algebraic Reasoning — 3 hrs.
Examination of algebraic standards, content, instructional strategies and curricula. Focus on application and impact on classroom practice, planning, and assessment in algebra. Focus on change in one’s teaching and curriculum. (Summer)

Examine geometric standards, content, methods and curricula. Analyze student thinking, examine van Hiele levels and expand conceptions of proof. Focus on impact on one's own practice, planning and assessment. (Variable)

MATH 6216. Number and Operations — 3 hrs.
Examination of literature, problems, and issues related to the teaching of number and operations, with emphasis on whole numbers, decimals, and fractions. Reasoning about topics in the context and pedagogy of the K-8 mathematics curriculum and exploration of innovative problem solving strategies. (Even Summers)

MATH 6224 (800:236). Mathematics for the Middle Grades Teachers I — 3 hrs.
Integrated, historical, and cultural study of development and structure of quantity, data, and chance. Focus on mathematical ways of knowing and verification. (Variable)

MATH 6225. Teaching and Learning Mathematics — 3 hrs.
Exploration of instructional strategies to support mathematical learning of K-16 students with focus on your own practice. This includes establishing mathematical goals for learning, selecting appropriate tasks, facilitating classroom discourse, building conceptual understanding from procedural fluency, and using technology to enhance instruction. (Even Springs)

MATH 6226 (800:238). Mathematics for the Middle Grades Teacher II — 3 hrs.
Integrated, historical, and cultural study of development and structure of patterns, functions, relationships, and shapes. Focus on ways of knowing and verification. Prerequisite(s): MATH 6224 (800:236). (Variable)

MATH 6227. Data Analysis, Probability, and Discrete Mathematical Reasoning — 3 hrs.
In this course, students will explore data collection, display, and interpretation methods including measures of central tendency; theoretical and empirical probability of single- and multi-stage events; and apportionment, fair division, and counting. Concepts will be explored through and connected to best mathematical teaching practices. (Odd Falls)

MATH 6230. Reflective Teaching-Cognitive Demand of Mathematical Tasks — 1 hr.
Students will critically reflect on classroom practice with the focus on cognitive demand of mathematical tasks. Prerequisite(s): MATH 6201 (800:220) or consent of department. (Variable)

MATH 6231. Reflective Teaching-Classroom Discourse — 1 hr.
Students will critically reflect on classroom practice with the focus on classroom discourse. Prerequisite(s): MATH 6201 (800:220) or consent of department. (Variable)

MATH 6232. Reflective Teaching: Meaningful Distributed Instruction — 1 hr.
Students will critically reflect on classroom practice with the focus on meaningful distributed instruction. Prerequisite(s): MATH 6201 (800:220) or consent of department. (Variable)

MATH 6233. Reflective Teaching: Leadership — 1 hr.
Students will critically reflect on classroom practice with the focus on leadership in mathematics education. Prerequisite(s): MATH 6201 (800:220) or consent of department. (Variable)

MATH 6234. Reflective Teaching: Investigation of Classroom Practice — 1 hr.
Students will critically reflect on classroom practice with the focus on instruction. Prerequisite(s): MATH 6201 (800:220) or consent of department. (Variable)

MATH 6235. Reflective Teaching: Equity and Mathematics Education — 3 hrs.
Examines theories of race, gender, social class, and sexuality and how these theories play out in K-16 mathematics classrooms. Exploration of historical, political, and pedagogical issues within mathematics education. Includes history of treatment of minorities in mathematics education, teaching mathematics for social justice, culturally relevant mathematics pedagogy, and other pedagogies and theories related to teaching socioculturally diverse students. (Odd Springs)

MATH 6299 (800:299). Research.
Prerequisite(s): consent of department. (Variable)

Elements of experimental design. Statistical inferential processes, confidence intervals and hypothesis tests, for comparing means, medians and proportions from multiple groups. Prerequisite(s): STAT 1772 (800:072), MATH 3751 (800:173) or consent of instructor. (Fall and Spring)
Discrete and continuous random variables, central limit theorem, regression, correlation, analysis of covariance and categorical data analysis. Multiple regression, ANOVA and categorical data analysis will provide students with tools to analyze real data sets. Prerequisite(s): STAT 1772 (800:072) or MATH 3751 (800:173) or consent of instructor. (Variable)

MATH 6380 (800:280). Mathematics at the Secondary Level — 1-3 hrs.
History of secondary mathematics in the U.S. Overview of the most recent reform movement in mathematics education; its effect on the teaching and learning of high school mathematics. May be repeated on different topics for up to 3 hours of credit. Prerequisite(s): graduate standing in mathematics. (Variable)

MATH 6381 (800:281). Current Research in Mathematics Education — 3 hrs.
Understand purposes and methods of research in mathematics education with a focus on action research. Review mathematics education research and its implications for instruction. Conduct a classroom-based action research project. Prerequisite(s): MATH 6201 (800:220) or consent of department. (Variable)

MATH 6410. Foundations of Calculus — 3 hrs.
Fundamentals of Calculus from the viewpoint of exploring reasons for the details that support Differential and Integral Calculus. Emphasizes on examples and proving justifications for a variety of mathematical statements. (Variable)

MATH 6420 (800:201). Mathematical Analysis I — 3 hrs.
Set theory; the real number system; Lebesque measure; Lebesque integral. Prerequisite(s): MATH 4420/5420 (800:140g). Corequisite(s): MATH 4421/5421 (800:141g) or consent of instructor. (Odd Springs)

MATH 6421 (800:202). Mathematical Analysis II — 3 hrs.
Differentiation and integration; classical Banach spaces; metric spaces; general measure and integration theory. Prerequisite(s): MATH 6420 (800:201). (Spring)

MATH 6460 (800:203). Complex Analysis I — 3 hrs.
Analyticity; differentiation and integration of functions of one complex variable; power series, Laurent series; calculus of residues. Prerequisite(s): MATH 4420/5420 (800:140g); MATH 4460/5460 (800:156g); or consent of instructor. (Spring)

MATH 6461 (800:204). Complex Analysis II — 3 hrs.
Analytic continuation; harmonic functions; entire functions; conformal mapping; selected applications. Prerequisite(s): MATH 6460 (800:203). (Variable)

Groups: quotient groups, isomorphism theorems, products of groups, group actions, Sylow theorems, solvable and nilpotent groups. Rings and fields: quotient rings, rings of polynomials, integral domains, fields of fractions. Prerequisite(s): MATH 4500/5500 (800:160g). Corequisite(s): MATH 4501/5501 (800:162g) or consent of instructor. (Fall)

Rings: arithmetic properties, prime and maximal ideals, Noetherian rings. Modules and vector spaces: linear transformations, free modules, finitely generated modules over PIDs, canonical forms. Fields: field extensions, Galois theory, solvability by radicals. Prerequisite(s): MATH 6500 (800:240). (Spring)

MATH 6504. Advanced Linear Algebra — 3 hrs.
Vector spaces, linear transformations, matrices, eigenvalues and eigenvectors, canonical forms, bilinear and quadratic forms. Prerequisite(s): MATH 2500 (800:076) or consent of instructor. (Odd Summers)

MATH 6510 (800:210). Theory of Numbers — 3 hrs.
Mathematical study of integers: induction, divisibility, prime numbers, congruences, quadratic reciprocity, multiplicative functions. (Variable)

MATH 6530 (800:243). Topics in Discrete Mathematics — 3 hrs.
Topics from combinatorics, graph theory, analysis and application of algorithms, recurrence relations, difference equations, linear programming, and mathematical induction. Applications of these topics in the secondary curriculum. Prerequisite(s): MATH 3530/5530 (800:143g) or MATH 4500/5500 (800:160g). (Variable)

MATH 6640 (800:246). Topics in the History of Mathematics — 3 hrs.
Topics from history of algebra, analysis, arithmetic, geometry, number theory, probability, and topology as they appear in the development of Mesopotamian, Greek, Islamic, Indian, Chinese, and Western civilizations. May be repeated on different topic with consent of instructor. Prerequisite(s): MATH 3640/5640 (800:180g). (Variable)

MATH 6650 (800:263). Topics in Mathematical Logic and Set Theory — 3 hrs.
Topics from the predicate calculus and first-order mathematical theories; the Godel completeness and incompleteness theorems; algebraic and many-valued logic; Boolean algebras, lattices, representation theorems, and models in set theory and mathematical logic; independence of the axioms of set theory (including the axiom of choice and the continuum hypothesis). May be repeated on different topic with consent of instructor. (Variable)

MATH 6670 (800:267). Non-Euclidean Geometry — 3 hrs.
Historical development of geometry models that do not assume Euclid's fifth postulate. Emphasis on Poincare's disc and upper half-plane models, distance and area in the hyperbolic plane, and Mobius transformations. Prerequisite(s): MATH 2500 (800:076); MATH 4500/5500 (800:160g); MATH 3610/5610 (800:165g) or MATH 3600/5600 (800:166g). (Variable)

Overview of optimization models, mathematical programming (linear, integer, goal), optimization software LINGO, transportation and assignment problems, network models (shortest-path, maximum-flow), multi-period planning problems. Prerequisite(s): MATH 2422 (800:062); MATH 2500 (800:076). (Fall and Spring)

Decision making under uncertainty, Markov chains, deterministic and probabilistic dynamic programming, inventory control, production scheduling, supply chain management, portfolio optimizations. Prerequisite(s): MATH 2422 (800:062); MATH 2500 (800:076), MATH 3752/5752 (800:152g). (Same as STAT 6746) (Fall and Spring)

MATH 6747 (800:252). Discrete-Event System Simulation — 3 hrs.
Discrete-event systems simulation theory including input analysis, output analysis; applications of simulation software ARENA to studying performances of systems such as bank services, call centers, material-handling systems, and computer networks. Prerequisite(s):
MATH 2422 (800:062); STAT 1772 (800:072). (Same as STAT 6747) (Fall and Spring)

Queueing networks, applications to modeling and evaluating industrial systems such as flexible manufacturing systems, pull-type production systems, polling systems in computer networks, handoff schemes in cellular mobile networks; computational package MATLAB. Prerequisite(s): MATH 2422 (800:062); MATH 2500 (800:076); MATH 3752/5752 (800:152g). (Same as STAT 6748) (Fall and Spring)

Topics from correlation and regression analysis, analysis of variance and co-variance, non-parametric methods, order statistics. May be repeated on different topic with consent of instructor. Prerequisite(s): consent of instructor. (Same as STAT 6779) (Variable)

MATH 6795 (800:275). Industrial Internship/Project — 6 hrs.
Mathematical analysis of industrial problems. Features work on a project of interest to a cooperating company. Oral and written reports required on the project. Prerequisite(s): approval of graduate coordinator and admittance to the P.S.M. program. (Variable)

MATH 6796. PSM Capstone Project — 3 hrs.
Mathematical/statistical modeling and analysis of a problem arising in industrial applications. Oral and written reports required on the project. Prerequisite(s): Approval of PSM-Industrial Mathematics coordinator and admittance to the PSM program in Industrial Mathematics. Completion of at least 9 hours in the PSM-Industrial Mathematics program. (Variable)

Statistics Courses

STAT 1772 (800:072). Introduction to Statistical Methods — 3 hrs.
Descriptive statistics including correlation and curve fitting. Intuitive treatment of probability and inferential statistics including estimation and hypothesis testing. No credit for students with credit in STAT 1774 (800:064). Students with credit in STAT 3770 should not enroll in STAT 1772 (800:072). Prerequisite(s): Satisfactory score on ALEKS exam. (Fall, Spring, Summer)

Descriptive statistics, basic probability concepts, confidence intervals, hypothesis testing, correlation and regression, elementary concepts of survival analysis. No credit for students with credit in STAT 1772 (800:072). Prerequisite(s): Satisfactory score on ALEKS exam. (Variable)

Descriptive statistics and graphical representations, basic concepts of probability and distributions, random variables, expectations, sampling theory, tests of statistical significance. Calculus is employed in developing and applying these ideas. Specific attention devoted to the use of technology in motivating and explaining concepts and techniques. No credit with credit in STAT 3770; credit reduced to 1 hour for students with credit in STAT 1772 (800:072). Prerequisite(s): MATH 1421 (800:061). (Same as MATH 3751 (800:173)) (Variable)

STAT 3752/5752 (800:152g). Introduction to Probability — 3 hrs.
Axioms of probability, sample spaces having equally likely outcomes, conditional probability and independence, random variables, expectation, moment generating functions, jointly distributed random variables, weak law of large numbers, central limit theorem. Prerequisite(s): MATH 1421 (800:061); junior standing. (Same as MATH 3752/5752 (800:152g)) (Fall and Spring)

Inference about two or more population variances, multiple comparisons, categorical data analysis, linear and logistic regression, design of experiments, analysis of variance and covariance, repeated measures and random effects. Prerequisite(s): STAT 1774 (800:064) or STAT 1772 (800:072); junior standing. (Fall)

Sampling distribution theory, point and interval estimation, Bayesian estimation, statistical hypotheses including likelihood ratio tests and chi-square tests, selected nonparametric methods. Prerequisite(s): MATH 3752/5752 (800:152g); junior standing. Prerequisite(s) or corequisite(s): MATH 2422 (800:062). (Spring)

STAT 3776/5776 (800:175g). Regression Analysis — 3 hrs.
Regression analysis, analysis of variance, time series methods. Prerequisite(s): STAT 3775/5775 (800:174g); junior standing. (Fall)

STAT 3778/5778 (800:171g). Spatial Data Analysis — 3 hrs.
Analysis and interpretation of spatial point processes, area, geostatistical and spatial interaction data. Applications to geographic data in real estate, biology, environmental, and agricultural sciences using S-Plus software. Prerequisite(s): STAT 1774 (800:064) or STAT 1772 (800:072) or SOC 2020 (980:080); junior standing. (Same as GEOG 4340/5340 (970:160g)) (Odd Springs)

STAT 4772/5772 (800:122g). Statistical Computing I — 3 hrs.
Statistical computing using S-Plus software. Prerequisite(s): STAT 3772/5772 (800:122g); junior standing. Prerequisite(s) or consent of instructor; junior standing. (Fall)

STAT 4773/5773 (800:123g). Design and Analysis of Experiments — 3 hrs.
Planning and organizing experiments, one-factor experiments, randomized blocks, Latin squares and related designs, factorial designs and fractional factorial designs, response surface methodology, nested and split-plot designs. Prerequisite(s): STAT 3771/5771 (800:121g) or consent of instructor; junior standing. (Spring)

STAT 4777/5777 (800:123g). Design and Analysis of Experiments — 3 hrs.
Planning and organizing experiments, one-factor experiments, randomized blocks, Latin squares and related designs, factorial designs and fractional factorial designs, response surface methodology, nested and split-plot designs. Prerequisite(s): STAT 3771/5771 (800:121g) or consent of instructor; junior standing. (Spring)

Exploratory data analysis, Shewhart control charts and their variations, process capability analysis, CUSUM charts, EWMA charts, sampling inspection by attributes and by variables, continuous sampling plans, application of design of experiments in quality engineering. Prerequisite(s): MATH 3752/5752 (800:152g) or consent of instructor; junior standing. (Variable)

Multivariate normal distribution, tests of significance with multivariate components, canonical correlations, use of statistical computer packages. Prerequisite(s): STAT 3772/5772 (800:152g); junior standing. (Variable)

Computationally-intensive methods in statistics including Regression analysis, analysis of variance, time series methods.
such as SAS, SPSS, S-Plus, and R. Prerequisite(s): STAT 4772/5772 (800:122g); Junior Standing. (Variable)

**STAT 4784/5784. Introduction to Machine Learning — 3 hrs.**
Models and Algorithms for Classification: k-NN, Decision Trees, Neural Networks, Logistic Regression, Naïve Bayes and Bayesian Networks, Support Vector Machines; Clustering: Hierarchical and k-Means, Kohonen Networks, Association Rules and Segmentation, Model Evaluation Techniques; Ensemble Methods: Bagging and Boosting. Prerequisite(s): CS 1510 (810:051) or STAT 4772/5772 (800:122g); STAT 1772 (800:072); junior standing; consent of instructor. (Fall)

**STAT 6746. Probabilistic Operations Research — 3 hrs.**
Decision making under uncertainty, Markov chains, deterministic and probabilistic dynamic programming, inventory control, production scheduling, supply chain management, portfolio optimizations. Prerequisite(s): MATH 2422 (800:062); MATH 2500 (800:076); MATH 3752/5752 (800:152g). (Same as MATH 6746 (800:251)) (Fall and Spring)

**STAT 6747. Discrete-Event System Simulation — 3 hrs.**
Discrete-event systems simulation theory including input analysis, output analysis; applications of simulation software ARENA to studying performances of systems such as bank services, call centers, material-handling systems, and computer networks. Prerequisite(s): MATH 2422 (800:062); STAT 1772 (800:072). (Same as MATH 6747 (800:252)) (Fall and Spring)

**STAT 6748. Modeling Industrial Systems Using Queueing Networks — 3 hrs.**
Queueing networks, applications to modeling and evaluating industrial systems such as flexible manufacturing systems, pull-type production systems, polling systems in computer networks, handoff schemes in cellular mobile networks; computational package MATLAB. Prerequisite(s): MATH 2422 (800:062); MATH 2500 (800:076); MATH 3752/5752 (800:152g). (Same as MATH 6748 (800:253)) (Fall and Spring)

**STAT 6772 (800:272). Advanced Statistical Methods — 3 hrs.**
Categorical data analysis, logistic and Poisson regression, forecasting, repeated measures, classification and discriminant analysis, cluster analysis, data mining. Prerequisite(s): STAT 4773/5773 (800:123g). (Variable)

**STAT 6779. Topics in Probability and Statistics — 3 hrs.**
Topics from correlation and regression analysis, analysis of variance and co-variance, non-parametric methods, order statistics. May be repeated on different topic with consent of instructor. Prerequisite(s): consent of instructor. (Same as MATH 6779 (800:273)) (Variable)