Mathematics

Opportunities for mathematics majors have expanded greatly in recent years. Mathematics majors become actuaries, statisticians, mathematical computer scientists, applied mathematicians, operations research analysts and mathematical researchers. Mathematics is growing and changing and holds fascinating challenges for inquiring minds.

As an undergraduate mathematics major at Southern Illinois University Carbondale, you may work toward a Bachelor of Science degree in the College of Science or the College of Education and Human Services, or a Bachelor of Arts degree in the College of Liberal Arts. The classes in the mathematics major curriculum are small and are taught by senior faculty members. A strong support system of college and departmental advisement is available to you at SIU throughout the year.

A student planning for employment with a bachelor's degree should consider a minor or a second major in some field in which mathematics is applied. Many students earn a double major in mathematics and computer science. All of the bachelor's degree programs in mathematics, including the Bachelor of Science degree in the College of Education and Human Services, have sufficient flexibility to allow you to prepare for alternate career possibilities.

To prepare to major in mathematics at SIU, you should have a solid high school preparation in algebra, geometry in two and three dimensions, and trigonometry, including a substantial study of functions and graphing. Students transferring to SIU after two years at a community college should have completed the calculus sequence, linear algebra and a course in a high-level computer programming language.

As a mathematics major at SIUC, you will meet with a Department of Mathematics advisor at least once each semester for planning and departmental approval of courses appropriate to your goals and interests.

A grade of C or better is required in every mathematics course used to satisfy departmental requirements. A student cannot repeat a course or its equivalent in which a grade of B or better was earned without the consent of the department. A math major is required to obtain the permission of the department for a second repeat (third attempt) of a course that is required or elective for the major.

Double majors in mathematics and related fields

Special provisions are made for students to earn a double major in mathematics and a field in which mathematics is extensively applied. The courses MATH 447, MATH 449, MATH 471, MATH 472, and MATH 475 carry credit in both mathematics and computer science. See Bachelor of Science Degree, College of Science for specific requirements in mathematics for students who also earn a major or minor in computer science.

For students pursuing a double major in math and engineering, physics, or chemistry, the mathematics requirements are MATH 150 or MATH 151, MATH 221, MATH 250, MATH 251, MATH 305 and five additional mathematics courses numbered above 300, including at least three courses above 400, and including two of the three areas of algebra, analysis, probability and statistics. A mathematics department advisor must approve the courses.

Students majoring in business may obtain a second major in mathematics. The requirements are MATH 150 or MATH 151, MATH 221, MATH 250, MATH 251, and five approved mathematics courses at the 300-400 level, of which at least four are at the 400-level. Recommended courses for this program include MATH 471, MATH 472, MATH 475, MATH 483, MATH 484.
Option in Statistics

A student majoring in mathematics in the College of Science may choose to concentrate in statistics. For this option, the 300- and 400-level course requirements include: MATH 302; either MATH 417 or MATH 421; either MATH 305 or MATH 472; one of MATH 352, MATH 450, or MATH 455; MATH 480; MATH 483; at least two of MATH 473, MATH 481, MATH 484, MATH 485 and one additional approved upper division mathematics course.

Bachelor of Science Degree in Mathematics Requirements

<table>
<thead>
<tr>
<th>Degree Requirements</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>University Core Curriculum Requirements</td>
<td>39</td>
</tr>
<tr>
<td>College of Science Academic Requirements</td>
<td>12</td>
</tr>
<tr>
<td>Biological Sciences: six hours (not University Core Curriculum courses) (Three hours included in the UCC Life Science hours)</td>
<td>3</td>
</tr>
<tr>
<td>Mathematics: completed with the major Physical Sciences: six hours (not University Core Curriculum courses) (Three hours included in the UCC Life Science hours)</td>
<td>3</td>
</tr>
<tr>
<td>Supportive Skills: a two-semester sequence in a foreign language, or three years of one foreign language in high school with no grade lower than C</td>
<td>6</td>
</tr>
<tr>
<td>Requirements for Major in Mathematics</td>
<td>42</td>
</tr>
<tr>
<td>MATH 150 or MATH 151, MATH 221, MATH 250, MATH 251 (Three hours included in UCC mathematics hours)</td>
<td>11</td>
</tr>
<tr>
<td>CS 202 or approved substitute</td>
<td>4</td>
</tr>
<tr>
<td>MATH 302</td>
<td>3</td>
</tr>
<tr>
<td>At least one course from each of the following groups</td>
<td>12</td>
</tr>
<tr>
<td>(One group may be waived for students with a minor in CS) Group A: Algebra/Discrete Math/Linear Algebra: MATH 319, MATH 349, MATH 419, MATH 421 Group B: Analysis: MATH 352, MATH 450, MATH 455 At least two, from different groups, of the following: Group C: Applied Math/Numerical Analysis: MATH 305, MATH 471, MATH 472, MATH 475 Group D: Probability/Statistics: MATH 380, MATH 480, MATH 483 Group E: GEO 335, GEO 433</td>
<td></td>
</tr>
<tr>
<td>Four additional courses in mathematics numbered above MATH 299 (excluding MATH 300I, MATH 311A, MATH 311B, MATH 321, MATH 322, MATH 388, MATH 389, MATH 411, MATH 412)</td>
<td>12</td>
</tr>
</tbody>
</table>
### Degree Requirements

<table>
<thead>
<tr>
<th>Credit Hours</th>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>A minimum of five 400-level math courses must be taken. Each student’s program must be approved by a mathematics department advisor. Courses taken Pass/Fail will not count toward the major.</td>
<td></td>
</tr>
<tr>
<td>Electives</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td></td>
</tr>
</tbody>
</table>

The student must work with the Advisement Office to ensure that SIUC’S 42 Senior-Hours requirement is met by appropriate choices of core, college, major and elective coursework.

### Bachelor of Arts Degree in Mathematics Requirements

<table>
<thead>
<tr>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>University Core Curriculum Requirements</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>College of Liberal Arts Academic Requirements</td>
<td>12-15</td>
</tr>
<tr>
<td></td>
<td>English Composition (one of ENGL 290, ENGL 291, ENGL 390, ENGL 391, ENGL 392)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Foreign Language</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>International Coursework: 2 courses from the Global Studies Minor, Section A. Three hours MAY possibly be used for both International and UCC requirements</td>
<td>3-6</td>
</tr>
<tr>
<td>Requirements for a Major in Mathematics ¹</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>MATH 150 or MATH 151, MATH 221, MATH 250, MATH 251</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>(Three hours are accounted for in UCC) CS 202 or approved substitute</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>MATH 302</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>At least one course from each of the following groups:</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

(One group may be waived for students who have a minor in Computer Science) Group A: Algebra/Discrete Math/Linear Algebra: MATH 319, MATH 349, MATH 421 Group B: Analysis: MATH 352, MATH 450, MATH 455 Group C: Applied Math/ Numerical Analysis: MATH 305, MATH 471, MATH...
Degree Requirements

<table>
<thead>
<tr>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>472, MATH 475 Group D: Probability/Statistics: MATH 380, MATH 480, MATH 483</td>
</tr>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

Four additional courses in mathematics numbered above MATH 299 (excluding MATH 300I, MATH 311A-B, MATH 321, MATH 322, MATH 388, MATH 389, MATH 411, MATH 412) 12

Secondary Concentration Requirements ² 6-9

6-9 hours approved by the Mathematics Department in one of the following areas: engineering, computer science, physics, economics, business & administration. A minor in any department of the College of Liberal Arts or College of Science may be substituted for this requirement.

Electives to make a total of 120 hours 15-20

Total 120

Each student’s program must include at least 5 mathematics courses at the 400 level. Courses taken Pass/Fail will not count toward the major. Mathematics majors are required to meet with a departmental advisor for approval of their courses prior to registering each semester.

1 Three hours of mathematics course work are accounted for in the 39-hour Core Curriculum requirement.

2 Secondary Concentration Requirement (Choose one of the following options) i) PHYSICS: six hrs from PHYS 205A, PHYS 205B, or 300-level courses with math prerequisites. ii) ENGINEERING: six hrs of ENGR courses with math prerequisites numbered above 222. iii) COMPUTER SCIENCE: CS 215, CS 220, and one of CS 306 or CS 311. iv) ECONOMICS: six hrs from the following, including 3 hours above the 200 level: ECON 240, ECON 241, ECON 340, ECON 341, ECON 440, ECON 441, ECON 465. v) BUSINESS: ACCT 220 & ACCT 230 plus one additional course chosen from ECON 240, ECON 241, MATH 139. vi) CHEMISTRY: CHEM 200 and CHEM 210, plus one advanced CHEM with a math prerequisite. vii) ANY MINOR in the College of Science or the College of Liberal Arts.

Specialization in Actuarial Mathematics

Students pursuing the Bachelor of Arts degree with a major in mathematics in the College of Liberal Arts may choose to specialize in Actuarial Mathematics. Actuaries put a price on risk, and Actuaries are often ranked as a top ten job with high pay. The Actuarial program at Southern Illinois University Carbondale provides course work in Mathematics to prepare students for work as Actuaries. Students become Actuaries by taking three Validation by Educational Experience (VEE) course sequences and by passing professional examinations given by the Society of Actuaries (SOA, see www.soa.org) and Casualty Actuarial Society (CAS, see www.casact.org). The professional exams cover probability, financial mathematics for investments including interest theory and financial derivatives, life contingencies: mathematics for life insurance, and loss models. More information about Actuaries and the professional exams can be found at (www.beanactuary.com).

Freshmen admitted to the program should have at least a 24 Math ACT score. Students can also enroll as Math majors and transfer to the Actuarial program after receiving a C or higher in MATH 250. The program offers preparation for four Actuarial exams and for the three VEE course sequences. Students
are required to complete three VEE course sequences and are encouraged to pass Exam P/1, FM/2 and either MLC/3L or C/4.

### Specialization in Actuarial Mathematics Requirements

<table>
<thead>
<tr>
<th>Degree Requirements</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>University Core Curriculum Requirements</td>
<td>39</td>
</tr>
<tr>
<td>To include MATH 150 or MATH 151, ECON 240, MATH 300I and FL.</td>
<td></td>
</tr>
<tr>
<td>College of Liberal Arts Academic Requirements</td>
<td>12-15</td>
</tr>
<tr>
<td>English Composition (one of ENGL 290, ENGL 291, ENGL 390, ENGL 391, ENGL 392)</td>
<td>3</td>
</tr>
<tr>
<td>One approved writing intensive course (MATH 302) (accounted for in the major)</td>
<td></td>
</tr>
<tr>
<td>Foreign Language</td>
<td>6</td>
</tr>
<tr>
<td>International Coursework: 2 courses from the Global Studies Minor, Section A.</td>
<td></td>
</tr>
<tr>
<td>Three hours MAY possibly be used for both International and UCC requirements.</td>
<td>3-6</td>
</tr>
<tr>
<td>Requirements for Actuarial Specialization</td>
<td>47</td>
</tr>
<tr>
<td>(MATH 150), MATH 221, MATH 250, MATH 251 (Three hours included in UCC mathematics hours)</td>
<td>11</td>
</tr>
<tr>
<td>CS 202</td>
<td>4</td>
</tr>
<tr>
<td>MATH 302 and MATH 483</td>
<td>7</td>
</tr>
<tr>
<td>At least one course from each of the following groups</td>
<td>9</td>
</tr>
<tr>
<td>Group A: Algebra/Discrete Math/Linear Algebra: MATH 319, MATH 349, MATH 421</td>
<td></td>
</tr>
<tr>
<td>Group B: Analysis: MATH 352, MATH 450, MATH 455</td>
<td></td>
</tr>
<tr>
<td>Group C: Applied Math/Numerical Analysis: MATH 305, MATH 471, MATH 472, MATH 475</td>
<td></td>
</tr>
<tr>
<td>MATH 400, MATH 474, and MATH 484</td>
<td>10</td>
</tr>
<tr>
<td>Either MATH 401 and MATH 402 or MATH 403 and MATH 404</td>
<td>6</td>
</tr>
</tbody>
</table>
Bachelor of Science Degree in Mathematics Education

<table>
<thead>
<tr>
<th>Degree Requirements</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>University Core Curriculum Requirements to include ENGL 101 &amp; ENGL 102, PSYC 102, MATH 300I, EDUC 311, EDUC 314</td>
<td>39</td>
</tr>
<tr>
<td>Requirements for major in Mathematics</td>
<td>46</td>
</tr>
<tr>
<td>Content Courses</td>
<td>40</td>
</tr>
<tr>
<td>MATH 150 or MATH 151, MATH 221, MATH 250, and MATH 251 or MATH 305 (Three hours included in UCC mathematics hours)</td>
<td>11</td>
</tr>
<tr>
<td>CS 202 or approved substitute</td>
<td>4</td>
</tr>
<tr>
<td>MATH 302, MATH 319, MATH 335, MATH 349, MATH 352, MATH 433, MATH 483</td>
<td>19</td>
</tr>
<tr>
<td>At least two additional approved 400-level mathematics courses excluding MATH 411, MATH 412</td>
<td>6</td>
</tr>
<tr>
<td>Methods Course, MATH 311A, MATH 311B</td>
<td>6</td>
</tr>
<tr>
<td>Professional Education and Licensure Requirements</td>
<td>24</td>
</tr>
<tr>
<td>EDUC 301, EDUC 302, EDUC 303, EDUC 308, EDUC 313, EDUC 319, EDUC 401A Other requirements for licensure CI 360</td>
<td>3</td>
</tr>
<tr>
<td>Electives to make 120 hours</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
</tr>
</tbody>
</table>
Admission into the Teacher Education Program requires a 2.5 average in MATH 150 or MATH 151, MATH 221, MATH 250; and MATH 251 or MATH 305 in addition to College of Education and Human Services requirements for admission to the TEP.

Retention in the Teacher Education Program and approval for student teaching requires a 2.75 average in the major and departmental approval.

Mathematics majors are required to meet with a departmental advisor for approval of their courses prior to registering each semester.

**Concentration in Mathematics for Elementary Education**

Consult with College of Education and Human Services and with Mathematics advisors about the latest requirements.

**Mathematics Minor**

A non-teaching minor consists of MATH 150 or MATH 151 and 12 hours of mathematics courses at the 200 level or above, including at least three hours at the 400 level (excluding MATH 220, MATH 257, MATH 282, MATH 300I, MATH 311A, MATH 311B, MATH 321, MATH 322, MATH 388, MATH 389, MATH 411, MATH 412). All courses used for the minor must be completed with a grade of C or better. The 400-level mathematics courses must be taken at SIU Carbondale.

The departmental advisor must approve the student's minor program.

**Additional Educator Endorsements in Mathematics**

Students pursuing a teaching license in another discipline and interested in adding an endorsement in mathematics should see a mathematics department advisor to obtain a list of specific requirements.

**Honors**

MATH 395 and MATH 495 are used for individual honors work for upper level undergraduates in mathematics. Concurrent participation in the University Honors Program is encouraged.

**Placement**

In addition to having taken the prerequisite mathematics courses, students are required to present a satisfactory placement score as a condition for registration in mathematics courses. Contact the Department of Mathematics for current information regarding placement.

**Mathematics Courses**

**MATH101 - Intro to Contemporary Math** 101-3 Introduction to Contemporary Mathematics. (University Core Curriculum Course) [IAI Course: M1 904] Elementary mathematical principles as they relate to a variety of applications in contemporary society. Exponential growth, probability, geometric ideas and other topics. This course does not count towards the major in mathematics. Prerequisite: MATH 107 with a grade of C or better or high school Geometry and Algebra 2 with a grade of C or better, and satisfactory placement score. $96 fee will cover student access to mylabsplus. Platform is used for assessment and online access to learning aids and e-textbook.

**MATH105 - College Algebra for Teachers** 105-3 College Algebra and Mathematical Modeling for Teachers. A course in college algebra designed for the pedagogical and content needs of K-8 teachers. Equations and inequalities involving linear, polynomial, rational, absolute value, exponential and logarithmic functions, and systems of linear equations; the algebra of functions (polynomials, rational,
exponential, logarithmic, graphing functions; domain and range. Conic sections. Modeling and solving real-world problems and situations. Use of technology as appropriate to interpret data and create mathematical models. Core Standards Mathematical Practices will be infused throughout. No credit may be earned for MATH 105 if there is prior credit in MATH 106, 108 or 111. Prerequisite: Satisfactory placement score OR MATH 220 with a grade of C or better. Digital Course Materials Fee: $93.

**MATH106 - College Algebra Enhanced** 106-3 College Algebra Enhanced. (University Core Curriculum) The course leads students through an intensive review of foundational algebra concepts followed by a careful study of functions (polynomial, rational, exponential, logarithmic), graphing, solving equations including systems. Two lecture and three lab hours per week. Credit is given for only one of MATH 106, 108, 111. Prerequisite: Three years of college preparatory mathematics including Algebra I, Geometry and Algebra II AND satisfactory placement score. Digital Course Materials and CAI (Computer Aided Instruction) Fee: $183.

**MATH107 - Intermediate Algebra** 107-3 Intermediate Algebra. Properties & operations of real numbers. Polynomials, factoring, algebraic fractions, exponents, roots, and radicals. First and second-degree equations and inequalities. Functions, graphing, systems of equations and inequalities. Exponential and logarithmic functions. Does not satisfy the University Core Curriculum mathematics requirement and does not count toward the hours required for graduation. Prerequisite: satisfactory placement score. $96 fee will cover student access to mylabsplus. Platform is used for assessment and online access to learning aids and e-textbook.

**MATH108 - College Algebra** 108-3 College Algebra. (Advanced University Core Curriculum Course) The algebra of functions (polynomials, rational, exponential, logarithmic), graphing, conic sections, solving equations including systems. Not open to students with prior credit in MATH 106 or MATH 111. Prerequisite: Three years of college preparatory mathematics including Algebra I, Geometry and Algebra II AND satisfactory placement score. $156 course fee will cover student access to Mylabsplus. Platform is used for assessment and online access to learning aids and e-textbook.

**MATH109 - Trig & Analytic Geometry** 109-3 Trigonometry and Analytic Geometry. (Advanced University Core Curriculum Course) Trigonometric and inverse trigonometric functions, complex numbers, conic sections, polar coordinates. Credit is not given for both MATH 109 and 111. Prerequisites: MATH 108 or MATH 106 or equivalent, with C or better. New students must present satisfactory placement scores.

**MATH110 - Non-Technical Calculus** 110-3 Non-Technical Calculus. (University Core Curriculum) The elements of differentiation and integration. The emphasis is on the concepts and the power of the calculus rather than on technique. It is intended to provide an introduction to calculus for non-technical students. Does not count towards the major in mathematics. No credit hours may be applied to fulfillment of any degree requirements if there is prior credit in Mathematics 140, 141, 150, or 151. Prerequisite: 3 years of college preparatory mathematics including algebra I, algebra II and geometry with C or better. Students must present satisfactory placement scores or obtain the permission of the Department of Mathematics.

**MATH111 - Precalculus** 111-4 Precalculus. (Advanced University Core Curriculum Course) Intensive review of college algebra and trigonometry necessary for Calculus I. Algebra of rational and transcendental functions, graphing, trigonometric identities, laws of sines and cosines, conics, complex numbers, polar coordinates. Not open to students with credit in 106, 108 or 109. Prerequisites: High school advanced algebra and trigonometry with at least C and satisfactory placement score. Course Materials included Fee: $96.

**MATH120 - Math for Elem School I** 120-3 Mathematics Content and Methods for Elementary School I. (Same as CI 120) Modern approaches to mathematics instruction for the elementary grades. Mathematics content includes problem solving, intuitive set theory, development of whole numbers, integers and rational numbers and the fundamental arithmetic operations. Place value. Prime numbers and divisibility properties. Computation includes students’ informal mathematics, mental computation and estimation, algorithms and the appropriate use of calculators. Emphasis is placed throughout on reasoning, multiple representations of mathematical concepts, making connections and communication. Three hours lecture/laboratory per week. Prerequisite: Three years of college preparatory mathematics including Algebra I, Algebra II and Geometry and satisfactory placement score.
MATH125 - Tech Math with Applications
125-4 Technical Mathematics with Applications. (Advanced University Core Curriculum course) Emphasizes the applications of algebra and trigonometry in technical fields. Topics in algebra include functions and graphs, systems of linear equations, quadratic equations, higher degree equations and variation. Topics in trigonometry include the trigonometric functions, laws of sines and cosines, complex numbers, exponential and logarithmic functions. Meets University Core Curriculum requirement in mathematics for Applied Sciences and Arts students. Prerequisite: Mathematics 107 or two years of high school algebra or equivalent, with a grade of C or better. Enrollment restricted to students in the College of Applied Sciences and Arts or permission of department. Course Materials included Fee: $96.

MATH139 - Finite Mathematics
139-3 Finite Mathematics. (Advanced University Core Curriculum Course) Set concepts and operations, combinations, permutations, elementary probability theory including Bayes Formula, linear systems of equations, matrix algebra, row reduction, introduction to linear programming and simplex method. This course does not count toward the major in mathematics. Prerequisite: MATH 108 with grade of C or better or satisfactory placement score. Satisfies UCC Mathematics in lieu of 110 or 101.

MATH140 - Short Course in Calculus
140-4 Short Course in Calculus. (Advanced University Core Curriculum Course) Techniques of differentiation, increasing and decreasing functions, curve sketching, max-min problems in business and social science; partial derivatives; LaGrange multipliers; elementary integration techniques. Not open to students with prior credit in 141, 150, or 151. Does not count toward the major in mathematics. Prerequisite: MATH 108 with grade of C or better or satisfactory placement score. Satisfies University Core Curriculum Mathematics requirement in lieu of 110 or 101. $92 fee will cover student access to mylabsplus. Platform is used for assessment and online access to learning aids and e-textbook.

MATH141 - Calculus for Biological Sci
141-4 Short Course in Calculus for Biological Sciences. (Advanced University Core Curriculum Course) Techniques of differentiation and integration. Applications to population and organism growth and other biological science problems. Not open to students with prior credit in 150, 151 or 140. Does not count toward the major in mathematics. Prerequisite: High school advanced algebra and trig or MATH 111 or 108 plus 109 with C or better, AND satisfactory placement score. Satisfies University Core Curriculum Mathematics requirement in lieu of 110 or 101.

MATH150 - Calculus I
150-4 Calculus I. (Advanced University Core Curriculum course) [IAI Course: MTH 901] [IAI Course: M1 900-1] Major concepts and techniques of single variable calculus with careful statements but few proofs. Differential and integral calculus of the elementary functions; analytic geometry. Only 2 hours credit toward graduation if there is prior credit in 140 or 141. Prerequisite: High school advanced algebra and trig or MATH 111 or 108 plus 109 with C or better, AND satisfactory placement score. Satisfies University Core Curriculum Mathematics requirements in lieu of 110 or 101.

MATH151 - Calculus I Enhanced
151-4 Calculus I Enhanced. (Advanced University Core Curriculum course) [IAI Course: MTH 901] This course leads students through an intensive review of foundational algebra and trigonometry concepts followed by a careful study of major concepts and techniques of single variable calculus with careful statements but few proofs. Differential and integral calculus of the elementary functions; analytic geometry. Only 2 hours credit toward graduation if there is prior credit in 140 or 141. Credit is given for only one of MATH 150, 151. Prerequisite: High school advanced algebra and trigonometry with at least C, AND satisfactory placement score. Additional Instruction Lab fee: $90.

MATH220 - Math for Elem School II
MATH221 - Intro to Linear Algebra 221-3 Introduction to Linear Algebra. Vector spaces, linear functions, systems of equations, dimensions, determinants, eigenvalues, quadratic forms. Prerequisite: MATH 150 or MATH 151 with a grade of C or better.

MATH250 - Calculus II 250-4 Calculus II. (Advanced University Core Curriculum Course) [IAI Course: MTH 902] [IAI Course: M1 900-2] Develops the techniques of single-variable calculus begun in Calculus I and extends the concepts of function, limit, derivative and integral to functions of more than one variable. The treatment is intuitive, as in Calculus I. Techniques of integration, introduction to multivariate calculus, elements of infinite series. Prerequisite: MATH 150 or MATH 151 with C or better. Satisfies University Core Curriculum Mathematics requirement in lieu of 110 or 101.

MATH251 - Calculus III 251-3 Calculus III. (Advanced University Core Curriculum Course) [IAI Course: M1 900-3] [IAI Course: MTH 903] Further topics in calculus. Definite integrals over solid regions, applications of partial derivatives, vectors and vector operations, derivatives of vector functions, line integrals, Green's Theorem. Prerequisite: MATH 250 with C or better. Satisfies University Core Curriculum Mathematics requirements in lieu of 110 or 101.

MATH257 - Concurrent Work Experience 257-1 to 12 Concurrent Work Experience. As an instructional aide, the student will do tutoring under the direction of an established teacher and under the supervision of a representative of the Department of Mathematics. Special approval needed from the department. Mandatory Pass/Fail.

MATH282 - Intro to Statistics 282-3 Introduction to Statistics. (Advanced University Core Curriculum Course) Designed to introduce beginning students to basic concepts, techniques, and applications of statistics. Topics include the following: organization and display of data, measures of location and dispersion, elementary probability, statistical estimation, and parametric and nonparametric tests of hypotheses. Prerequisite: MATH 108 with C or better. Satisfies University Core Curriculum Mathematics requirement in lieu of 110 or 101.

MATH300I - History of Mathematics 300I-3 History of Mathematics. (University Core Curriculum) This course examines how diverse cultures and history from the ancient past to the present have shaped the development of mathematical thought and how developing mathematical ideas have influenced history and society. Particular attention will be given to the evolution of the concepts of number and space; the emergence and applications of calculus, probability theory, non-Euclidean geometries and technology; and to the changes in the concept of mathematical rigor. Does not count towards the mathematics requirements of the mathematics major. Open to all students. Prerequisite: MATH 150 or MATH 151.

MATH302 - Transition to Higher Math 302-3 Mathematical Communication and the Transition to Higher Mathematics. A course in communicating mathematical ideas with a special emphasis on reading, writing, and critiquing mathematical proofs. Topics covered include logic, proofs, set theory, relations, functions. Additional illustratory topics will be drawn from linear algebra, number theory, complex variables, and geometry. Prerequisite: MATH 221 and MATH 250 with a grade of C or better.

MATH305 - Intro Differential Equations 305-3 Introduction to Differential Equations. [IAI Course: MTH 912] First-order equations (including initial value problems, basic numerical methods, existence and uniqueness of solutions, separable equations, linear equations, exact equations, substitution methods and applications). Higher-order equations (including the general solution to homogeneous linear equations, linear independence, method of undetermined coefficients, the general solution to linear non-homogeneous equations, variation of parameters, and applications). Power series solutions. Partial differential equations and Fourier series. Prerequisite: MATH 250 with a grade of C or better.

MATH311A - Teaching Secondary Math I 311A-3 Teaching of Secondary Mathematics I. The nature and objectives of the standards-based secondary mathematics curriculum, particularly the means of introducing new ideas into the high school program. An important focus will be state and national teaching and learning standards and the use of technology. Heavy emphasis will be placed on development of formative and summative assessment measures and the use of such assessments in planning future instruction and remediation. For students preparing to be secondary mathematics teachers. Does not count toward a mathematics major in the Colleges of Liberal Arts or Science. Prerequisites: EDUC 313, EDUC 301 and MATH 349, MATH 335 or MATH 433, and MATH 352 with grades of C or better. Concurrent enrollment in MATH 335 or MATH 433 and MATH 352 is permissible.
MATH311B - Teaching Secondary Math II 311B-3 Teaching of Secondary Mathematics II. The nature and objectives of the standards-based secondary mathematics curriculum, particularly the means of introducing new ideas into the high school program. An important focus will be state and national teaching and learning standards and the use of technology. Emphasis in part II will be on the development of a complete curriculum, understanding the secondary curriculum as a dynamic system and the use of standardized testing to adjust curriculum and remediate students. Must be taken in A-B sequence. For students preparing to be secondary mathematics teachers. Does not count toward a mathematics major in the Colleges of Liberal Arts or Science. Prerequisite: MATH 311A with a grade of C or better and MATH 319. Concurrent enrollment in MATH 319 permissible.

MATH318 - Intro to Math Software 318-2 An Introduction to Mathematics Software. This course is an introduction to the use of Maple, a modern computer algebra system, as a computational and experimental tool in mathematics. The preparation of reports using text, graphics and mathematics is emphasized. Topics will include: solving equations, plotting techniques, special packages, programming with Maple V. Prerequisite: MATH 150 or MATH 151 with B or better or MATH 250 with C or better.

MATH319 - Intro Abstract Algebra I 319-3 Introduction to Abstract Algebra I. Basic properties of groups and rings: Binary operations, groups, subgroups, permutations, cyclic groups, isomorphisms. Cayley’s theorem, direct products, cosets, normal subgroups, factor groups, homomorphisms, rings, integral domains. Prerequisite: MATH 302 with C or better.


MATH322 - Math for Elem School IV 322-3 Mathematics Content and Methods for the Elementary School IV. (Same as CI 322) Modern approaches to mathematics instruction for the elementary grades. Mathematics content focuses on: algebra and algebraic thinking, geometry, relations and functions and their applications to real-life problems. Emphasis is placed throughout on reasoning, multiple representations of mathematical concepts, making connections and communication. Prerequisite: MATH 321 or Curriculum and Instruction 321 with a grade of C or better.

MATH335 - Concepts of Geometry 335-3 Concepts of Geometry. Introduction to the foundations of Euclidean and non-Euclidean geometries. Topics include synthetic approach (Euclidean geometry, axiomatic systems, constructions, proofs), symmetries (similarly, congruence and various transformations and their invariants), metric approach (distance), vector space approach (transformations and matrices, inner product), inversive geometry, projective geometry (art and math) and non-Euclidean geometries. Some applications in modern science, such as Relativity Theory, may also be covered. Historical background and connections with other parts of mathematics, science and culture are important components of this course. Prerequisite: MATH 250 with C or better, or MATH 302 with C or better or concurrent enrollment in MATH 302.

MATH349 - Intro to Discrete Math 349-3 Introduction to Discrete Mathematics. Numbers, sets, relations and functions; elementary enumeration; introduction to graph theory; logic, partially ordered sets and Boolean algebra; mathematical induction; recurrence relations. Prerequisite: MATH 221 and MATH 250 with C or better; Co-requisite: MATH 302 or prior completion of MATH 302.

MATH352 - Theory of Calculus 352-3 Theory of Calculus. An introduction to understanding and writing proofs in mathematical analysis, through a careful study of limits, continuity, the derivative, and the integral. Prerequisite: MATH 302 with C or better.

MATH388 - Int Math Content & Methods P-4 388-3 Integrated Math Content and Methods for Teachers (PreK-4th Grade). (Same as CI 388) This course is designed for early childhood and elementary school teachers, focusing on Pre-K through 4th grade mathematics content and methods. Math content covers the developmental progression of concepts and skills in counting and cardinality, numbers and operations in base-ten system, algebraic thinking, fractional reasoning, measurement and data, and geometry. Methods of math teaching are integrated with the delivery of math content. The course showcases standards-based mathematical practices including problem solving, mathematical modeling, communication and justification, use of tools and technology, assessment and interventions, diverse learner support, supportive math environments, lesson planning, and interdisciplinary connections. Prerequisite: C or better in CI/MATH 220 or equivalent.

MATH389 - Int Math Content/Methods 4-8 389-3 Integrated Math Content and Methods for Teachers (4th-8th Grade). (Same as CI 389) This course is designed for elementary school and middle school teachers, focusing on 4th-8th grade mathematics content and methods. Math content covers the developmental sequence of grade-appropriate mathematical concepts and skills in number systems, operations and algebraic thinking, ratios and proportional relationships, expressions and equations, functions and applications, measurement and data analysis, statistics and probability, and geometry. Methods of math teaching are integrated with the delivery of math content. The course showcases standards-based mathematical practices including problem solving, mathematical modeling, communication and justification, use of tools and technology, informative assessment, meeting the needs of diverse learners, building supportive math environments, lesson planning, and making interdisciplinary connections. Prerequisite: CI/MATH 388 with a minimum grade of C. Co-requisites: EDUC 319 and EDUC 302.

MATH390 - Topics in Contemporary Math 390-3 to 6 Topics in Contemporary Mathematics. Content will vary according to the instructor. The seminar will introduce students to new and developing areas of mathematics, such as Chaos, Fractals, Algorithms, Fourier Analysis, Difference Equations, etc. Prerequisite: intended for students who have completed Mathematics 150 or 151, 221, 250 and either 251 or 305.

MATH395 - Readings in Mathematics 395-1 to 6 Readings in Mathematics. Supervised reading in selected subjects. Prerequisite: 3.00 grade point average in mathematics. Special approval needed from the chair.

MATH400 - Interest Thry Fin Derivatives 400-4 Interest Theory and Financial Derivatives. This course examines financial mathematics and actuarial models for investments including interest, annuities, stocks, bonds, and mutual funds. There is an introduction to financial derivatives, options, and futures. Preparation for Exam FM/2. Prerequisite: MATH 250 (Calculus II) with C or better.

MATH401 - Life Contingencies I 401-3 Life Contingencies I. This course examines actuarial models for life insurance. Life contingency models include life insurance liability calculations, annuities, and credit risk. Basic properties of survival models and Poisson processes are covered. This course and MATH 402 prepare students for Exam MLC/3L. Prerequisite: MATH 483 with C or better.

MATH402 - Life Contingencies II 402-3 Life Contingencies II. This is a second course in actuarial models for life insurance including multiple contingencies, multiple survivals and claim frequency models. Basic properties of Markov Chains are covered. This course and MATH 401 prepare students for Exam MLC/3L. Prerequisites: MATH 221 and MATH 401 with C or better.

MATH403 - Loss Models I 403-3 Loss Models I. This course examines loss models including severity models, ruin models, and estimating and fitting the models. This course and MATH 404 prepare students for Exam C/4. Prerequisite: MATH 483 with C or better.

MATH404 - Loss Models II 404-3 Loss Models II. This is a second course in loss models including estimation and fitting of severity and ruin models, and credibility theory. This course and MATH 403 prepare students for Exam C/4. Prerequisite: MATH 403 with C or better.
MATH405 - Intermediate Diff Equations 405-3 Intermediate Differential Equations. This course features the study of several sets of differential equations with the aid of computers. The equations are actual applications in biology, chemistry, economics, engineering, finance, medicine and physics. Where possible, problems will be chosen to match student's interests. Students from these areas are particularly welcome. Basic theory of differential equations is cited as needed. Prerequisite: MATH 305 with C or better.

MATH406 - Linear Analysis 406-3 Linear Analysis. Introduction to function spaces and operators used in quantum mechanics, partial differential equations, etc. Topics include: discrete and continuous models for the vibrating string, separation of variables, eigenfunction analysis, inner product spaces; operators on inner produce spaces; the spectral theorem for Hermitian operators on finite dimensional spaces, the Courant-Fisher characterization. Prerequisite: MATH 221 and MATH 305 with C or better.

MATH407 - Partial Differential Equations 407-3 Partial Differential Equations. Solution methods for linear partial differential equations arising in engineering and science. Topics include: the heat equation, the wave equation, Laplace's equation, separation of variables, boundary and initial value problems, uniqueness via the energy methods, the maximum principle and characteristics. Solutions to the vibrating string and dissipation of heat in a bar will be discussed. Prerequisite: MATH 251 and MATH 305 with C or better.

MATH409 - Fourier Analysis 409-3 Fourier Analysis. Introduction to the theory, techniques and applications of Fourier analysis. Topics include: Fourier synthesis and analysis equations for periodic and aperiodic functions; convolution; the calculus of Fourier transforms, Fourier series of DFT's; operators and Fourier transforms; FFT and related algorithms; generalized functions such as Dirac's delta and others; selected applications. Prerequisite: MATH 221 and MATH 305 with C or better.

MATH411 - Math Topics for Teachers 411-1 to 6 Mathematical Topics for Teachers. Variety of short courses in mathematical ideas useful in curriculum enrichment in elementary and secondary mathematics. May be repeated as topics vary. Does not count toward a mathematics major.

MATH412 - Prob Solving Approach 412-3 Problem Solving Approaches to Basic Mathematical Skills. Content of basic skills at all levels of education and the development of these skills from elementary school through college; emphasis on problem solving and problem solving techniques; determination of student skills and proficiency level. Credit may not be applied toward degree requirements in mathematics. Prerequisite: MATH 321 or CI 321.

MATH417 - Applied Matrix Theory 417-3 Applied Matrix Theory. Selected applications of matrices to physics, chemistry and economics. This material is also useful for engineering and computer science. Topics include matrix representation of symmetry groups, non-negative matrices and the subsidy problem, location of eigenvalues. Prerequisite: MATH 221 with C or better.

MATH418 - Computer Algebra Systems 418-3 Computer Algebra Systems. This course presents modern computer algebra systems (CAS) as a research tool in mathematics. The use of a CAS in the preparation of reports, theses and dissertations will also be covered. Topics will include: solving differential equations with a CAS; plotting techniques with a CAS; symbolic packages for such areas as abstract algebra, number theory; and combinatorics; programming with a CAS; exporting results to TeX or word processing software; The AMS-LaTeX package. Restricted to graduate standing. Special approval needed from the instructor.

MATH419 - Intro Abstract Algebra II 419-3 Introduction to Abstract Algebra II. A detailed study of polynomial equations in one variable. Solvable groups and the Galois theory of field extensions are developed and applied to extensions of the quadratic formula, proving the impossibility of trisecting an angle with only a straight-edge and compass, and to the basic facts about finite fields as needed in coding theory and computer science. Prerequisite: MATH 319 with C or better.

MATH421 - Linear Algebra 421-3 Linear Algebra. The extension of basic linear algebra to arbitrary scalars. The theory and computation of Jordan forms of matrices (as needed e.g., for certain diffusion equations). Inner products, quadratic forms and Sylvester's Law of Inertia. Prerequisite: MATH 221 with C or better.
MATH425 - Intro to Number Theory 425-3 Introduction to Number Theory. Properties of integers, primes, divisibility, congruences, quadratic forms, diophantine equations, and other topics in number theory. Prerequisite: MATH 319 with C or better.

MATH430 - Intro to Topology 430-3 Introduction to Topology. Study of the real line and the plane, metric spaces, topological spaces, compactness, connectedness, continuity, products, quotients and fixed point theorems. This course will be particularly useful to students who intend to study analysis or applied mathematics. Prerequisite: MATH 352 with C or better.

MATH433 - Classical & Modern Geometry 433-3 Classical and Modern Geometry. Introduction to the foundations of Euclidean and non-Euclidean geometries. Topics include synthetic approach (Euclidean geometry, axiomatic systems, constructions, proofs), symmetries (similarity, congruence and various transformations and their invariants), metric approach (distance), vector space approach (transformations and matrices, inner product), inversive geometry, projective geometry (art and math) and non-Euclidean geometries. Some applications in modern science, like Relativity Theory, may also be covered. Historical background and connections with other parts of mathematics, science and culture are important components of this course. Prerequisite: MATH 250 and MATH 302 with grades of C or better.

MATH435 - Elem Differential Geometry 435-3 Elementary Differential Geometry. Introduction to modern differential geometry through the study of curves in R3. Local curve theory with emphasis on the Serret-Frenet formulas; global curve theory including Fenchel's theorem; local surface theory motivated by curve theory; global surface theory including the Gauss-Bonnet theorem. Prerequisite: MATH 221 and MATH 251 with C or better.

MATH447 - Intro to Graph Theory 447-3 Introduction to Graph Theory. (Same as CS 447) Graph theory is an area of mathematics which is fundamental to future problems such as computer security, parallel processing, the structure of the World Wide Web, traffic flow and scheduling problems. It also plays an increasingly important role within computer science. Topics include: trees, coverings, planarity, colorability, digraphs, depth-first and breadth-first searches. Prerequisite: MATH 349 with C or better.

MATH449 - Intro to Combinatorics 449-3 Introduction to Combinatorics. (Same as CS 449) This course will introduce the student to various basic topics in combinatorics that are widely used throughout applicable mathematics. Possible topics include: elementary counting techniques, pigeonhole principle, multinomial principle, inclusion and exclusion, recurrence relations, generating functions, partitions, designs, graphs, finite geometry, codes and cryptography. Prerequisite: MATH 349 with C or better.

MATH450 - Methods of Advanced Calculus 450-3 Methods of Advanced Calculus. Multivariable calculus fundamental to continuum mechanics, differential geometry, electromagnetism, relativity, thermodynamics, etc. Includes: parametric curves and surfaces, inverse and implicit function theorems, contraction mapping and fixed point theorems, differentials, convergence of multivariate integrals, coordinate systems in space, Jacobians, surfaces, volumes and Green's, Gauss', and Stokes' theorems. Prerequisite: MATH 251 with C or better.

MATH452 - Introduction to Analysis 452-3 Introduction to Analysis. A rigorous development of one-variable calculus providing the tools necessary for understanding all other advanced courses in analysis. Topics include: sets, axioms for the real numbers, continuity, limits, differentiation, the Riemann integral, infinite sequences and series of functions. Additional topics may include areas such as Riemann-Stieltjes integration or the analysis of multivariable functions. Prerequisite: MATH 252 with C or better.

MATH455 - Complex Analysis 455-3 Complex Analysis with Applications. Analysis of differentiable functions of a single complex variable. Introduces mathematical techniques used to analyze problems in the sciences and engineering that are inherently two dimensional. Topics include: the complex plane, analytic functions, the Cauchy-Riemann equations, line integrals, the Cauchy integral formula, Taylor and Laurent series, the residue theorem, conformal mappings, applications. Prerequisite: MATH 251 with C or better.

MATH460 - Transformation Geometry 460-3 Transformation Geometry. Geometry viewed as the study of properties invariant under the action of a group. Topics include: collineations, isometries, Frieze groups, Leonardo's Theorem, the classification of isometries of Euclidean and hyperbolic geometries.
Recommended elective for secondary education majors in mathematics. Prerequisite: MATH 319 with C or better.

**MATH471 - Optimization Techniques** 471-3 Optimization Techniques. (Same as CS 471) Introduction to algorithms for finding extreme values of nonlinear multivariable functions with or without constraints. Topics include: convex sets and functions; the arithmetic-geometric mean inequality; Taylor's theorem for multivariable functions; positive definite, negative definite, and indefinite matrices; iterative methods for unconstrained optimization. Prerequisite: MATH 221 and MATH 250 with C or better.

**MATH472 - Linear Programming** 472-3 Linear Programming. (Same as CS 472) Introduction to finding extreme values of linear functionals subject to linear constraints. Topics include: recognition, formulation, and solution of real problems via the simplex algorithm; development of the simplex algorithm; artificial variables; the dual problem and duality theorem; complementary slackness; sensitivity analysis; and selected applications of linear programming. Prerequisite: MATH 221 with C or better.

**MATH473 - Reliability & Survival Models** 473-3 Reliability and Survival Models. Introduction to statistical analysis of data on lifetime, including hazard functions and failure distributions; estimation and hypothesis testing in life testing experiments with complete as well as censored data. Prerequisite: MATH 480 or MATH 483 with C or better.

**MATH474 - Time Series** 474-3 Time Series. An introduction to time series: AR, MA and ARIMA models; estimation, time series models. Prerequisite: MATH 480 or MATH 483 with C or better.

**MATH475 - Numerical Analysis I** 475-3 Numerical Analysis I. (Same as CS 475) Introduction to theory & techniques for computation with digital computers. Topics include: solution of nonlinear equations; interpolation & approximation; solution of systems of linear equations; numerical integration. Students will use MATLAB to study the numerical performance of the algorithms introduced in the course. Prerequisites: MATH 221 and MATH 250 with C or better.

**MATH476 - Numerical Analysis II** 476-3 Numerical Analysis II. (Same as CS 476) Continuation of MATH 475. Topics include: solution of ordinary differential equations; computation of eigenvalues and eigenvectors; and solution of partial differential equations. Students will use MATLAB to study the numerical performance of the algorithms introduced in the course. Prerequisites: MATH 305 and MATH 475 with a C or better.

**MATH480 - Prob Stoch Processes I** 480-3 Probability, Stochastic Processes and Applications I. Introduction to the central topics of modern probability including elementary stochastic processes; random variables and their properties; sum of independent random variables and the Central Limit Theorem; random walks; discrete time finite state Markov chains; applications to random number generators and image and signal processing. Also generating functions, conditional probability, expectation, moments. Prerequisite: MATH 251 with C or better.

**MATH481 - Prob Stoch Processes II** 481-3 Probability, Stochastic Processes and Applications II. Continuation of MATH 480. Thorough introduction to Markov processes and Martingales, including the laws of large numbers, classification of states, recurrence, convergence to the stationary distribution in Markov chains, birth processes, Poisson processes, stopping times, and the Martingale convergence theorem. Important and current applications will be included. Prerequisite: MATH 480 with C or better.

**MATH483 - Math Stats in Engr & Sci** 483-4 Mathematical Statistics in Engineering and the Sciences. Develops the basic statistical techniques used in applied fields like engineering, and the physical and natural sciences. Principal topics include probability; random variables; expectations; moment generating functions; transformations of random variables; point and interval estimation; tests of hypotheses. Applications include one-way classification data and chi-square tests for cross classified data. Prerequisite: MATH 250 with C or better.

**MATH484 - Applied Regression Analysis** 484-3 Applied Regression Analysis and Experimental Design. Introduction to linear models and experimental design widely used in applied statistical work. Topics include linear models; analysis of variance; analysis of residuals; regression diagnostics; randomized blocks; Latin squares; factorial designs. Applications include response surface methodology and model...
MATH 485 - Applied Statistical Methods 485-3 Applied Statistical Methods. Introduction to sampling methods and categorical data analysis widely used in applied areas such as a social and biomedical sciences and business. Sampling methods topics include: simple random and stratified sampling; ratio and regression estimators. Categorical data analysis topics include: contingency tables; loglinear models; logistic regression; model selection; use of a computer package. Prerequisite: MATH 221 and MATH 483 with C or better.

MATH 486 - Statistical Computing 486-3 Statistical Computing. This course covers Statistical Computing Software packages such as R and SAS, Helps prepare students for SAS certification. Topics include obtaining and analyzing output for regression, experimental design, and generalized linear models. Prerequisites: MATH 484 and CS 202 both with C or better.

MATH 490 - Topics in Mathematics 490-3 Topics in Mathematics. Selected topics in mathematics chosen from such areas as: (a) Financial Mathematics, Mathematical Biology or Actuarial Mathematics; (b) Probability, Statistics or Stochastic Processes; (c) Mathematical topics not including Statistics, such as Operations Research, Cryptography and High Dimensional computing in Numerical Analysis, etc. May be repeated up to 3 times as topics vary. Special approval needed from the instructor.

MATH 495 - Special Topics in Mathematics 495-1 to 6 Special Topics in Mathematics. Individual study or small group discussions in special areas of interest under the direction of a member of the faculty. Special approval needed from the chair and instructor.

MATH 501 - Measure and Integration 501-3 Measure and Integration. This course is an introduction to measure theory and the Lebesgue integral. Its purpose is to develop many of the advanced mathematical tools that are necessary for the understanding of all other advanced courses in analysis. Topics will include: measures and measurable functions, Egoroff's theorem, the Lebesgue integral, Fatou's lemma, the monotone and dominated convergence theorems, functions of bounded variation and absolutely continuous functions, Lp-spaces, the Radon-Nikodym theorem, product measures, and Tonelli's and Fubini's theorems. Prerequisite: MATH 452.

MATH 502 - Functional Analysis 502-3 Functional and Linear Analysis. This course is an introduction to infinite-dimensional spaces and their analysis. Topics include Hilbert and Banach spaces, separable and reflexive spaces, operators and their adjoints, and major theorems such as the Banach-Steinhaus, Open-Mapping, Closed Graph, Hahn-Banach, Riesz and matrix representation, Lax-Milgram, Arzela-Ascoli, Kato's theorems. Spectral theory and applications to such areas as differential equations, Block iterations, quantum probability, fixed point theory or other areas are covered as time permits. Prerequisite: MATH 501 with a grade of B or better.

MATH 505 - Ordinary Differential Equations 505-3 Ordinary Differential Equations. Existence and uniqueness theorems; general properties of solutions; linear systems; geometric theory of nonlinear equations; stability; self-adjoint boundary value problems; oscillation theorems. Theory will be illustrated with computer simulation of several real-world problems. Prerequisite: MATH 452 and MATH 421 or consent of instructor.

MATH 506 - Advanced Topics in Ordinary Differential Equations 506-1 to 12 Advanced Topics in Ordinary Differential Equations. Selected advanced topics in ordinary differential equations chosen from such areas as: stability, oscillations, functional differential equations, perturbations, boundary value problems. Special approval needed from the instructor.

MATH 507 - Partial Differential Equations 507-3 Partial Differential Equations. This course introduces the student to the mathematical techniques that are used to analyze qualitative properties of solutions to partial differential equations that arise in engineering and the sciences. Topics studied will include: function spaces including Sobolev spaces; weak derivatives; the Sobolev and Poincare inequalities; existence, uniqueness, and continuous dependence for model equations. Prerequisite: MATH 407 and MATH 501.

MATH 511 - Advanced Topics in Teaching of Mathematics 511-3 Advanced Topics in the Teaching of Mathematics. (Same as CI 529) Selected advanced topics in the teaching of mathematics chosen from such areas as: pedagogical theories; instructional strategies; applications of mathematics; problem solving. This course
is counted by the Mathematics department only as part of an approved minor. Special approval needed from the instructor.

**MATH512A - Elem: Abstract Algebra** 512A-1 to 3 Topics in Mathematics for Teachers of Elementary, Middle School and Junior High Mathematics-Abstract Algebra. This course is counted by the Mathematics department only as part of an approved minor.

**MATH512B - Elem: Geometry** 512B-1 to 3 Topics in Mathematics for Teachers of Elementary, Middle School and Junior High Mathematics-Geometry. This course is counted by the Mathematics department only as part of an approved minor.

**MATH512C - Elem: Probability & Stats** 512C-1 to 3 Topics in Mathematics for Teachers of Elementary, Middle School and Junior High Mathematics-Probability and Statistics. This course is counted by the Mathematics department only as part of an approved minor.

**MATH512D - Elem: Sets, Logic, Number Sys** 512D-1 to 3 Topics in Mathematics for Teachers of Elementary, Middle School and Junior High Mathematics-Sets, Logic and Number Systems. This course is counted by the Mathematics department only as part of an approved minor.

**MATH512E - Elem:Applications of Math** 512E-1 to 3 Topics in Mathematics for Teachers of Elementary, Middle School and Junior High Mathematics-Applications of Mathematics. This course is counted by the Mathematics department only as part of an approved minor.

**MATH512F - Elem: Algebra** 512F-1 to 3 Topics in Mathematics for Teachers of Elementary, Middle School and Junior High Mathematics-Algebra. This course is counted by the Mathematics department only as part of an approved minor.

**MATH512G - Elem: History of Math** 512G-1 to 3 Topics in Mathematics for Teachers of Elementary, Middle School and Junior High Mathematics-History of Mathematics. This course is counted by the Mathematics department only as part of an approved minor.

**MATH513A - Secndy Math: Abstract Algebra** 513A-1 to 3 Topics in Mathematics for Teachers of Secondary Mathematics- Abstract Algebra. This course is counted by the Mathematics department only as part of an approved minor.

**MATH513B - Secondary Math: Geometry** 513B-1 to 27 Topics in Mathematics for Teachers of Secondary Mathematics- Geometry. This course is counted by the Mathematics department only as part of an approved minor.

**MATH513C - Secndy Math:Probability & Stat** 513C-1 to 3 Topics in Mathematics for Teachers of Secondary Mathematics-Probability and Statistics. This course is counted by the Mathematics department only as part of an approved minor.

**MATH513D - Secndry Mth:Sets,Logic,Numbers** 513D-1 to 3 Topics in Mathematics for Teachers of Secondary Mathematics-Sets, Logic and Number Systems. This course is counted by the Mathematics department only as part of an approved minor.

**MATH513E - Secndy Mth:Applications Math** 513E-1 to 3 Topics in Mathematics for Teachers of Secondary Mathematics-Applications of Mathematics. This course is counted by the Mathematics department only as part of an approved minor.

**MATH513F - Secondary Math: Topics** 513F-1 to 3 Topics in Mathematics for Teachers of Secondary Mathematics-Analysis. This course is counted by the Mathematics department only as part of an approved minor.

**MATH513G - Secondary:Discrete Math** 513G-1 to 3 Topics in Mathematics for Teachers of Secondary Mathematics- Discrete Mathematics. This course is counted by the Mathematics department only as part of an approved minor.
MATH513H - Secondary: Topology 513H-1 to 3 Topics in Mathematics for Teachers of Secondary Mathematics-Topology. This course is counted by the Mathematics department only as part of an approved minor.

MATH513I - Secndry:Computer Simulation 513I-1 to 3 Topics in Mathematics for Teachers of Secondary Mathematics-Computer Simulation. This course is counted by the Mathematics department only as part of an approved minor.

MATH516A - Stat Analy in Soc Sci I 516A-4 Statistical Analysis in the Social Sciences. Descriptive statistics; graphic display of data; concepts of probability; statistical estimation, and hypothesis testing. Applications to social science data. This course does not give credit toward a mathematics major. Prerequisite: one year of high school algebra or equivalent.

MATH516B - Stat Analy in Soc Sci II 516B-4 Statistical Analysis in the Social Sciences. Matrix algebra; general linear model; multivariate statistics, ordinal and nominal measures of associations and causal modeling. Applications to social science data. This course does not give credit toward a mathematics major. Prerequisite: one year of high school algebra or equivalent.

MATH519 - Algebraic Structures I 519-3 Algebraic Structures I. Introduction to the basic techniques in the classification of finite groups, including homomorphism theorems, classification of finitely generated abelian groups, Sylow's theorems and classification of small groups, divisibility theory in rings, especially polynomial rings. Prerequisite: MATH 419 or consent of instructor.

MATH520 - Algebraic Structures II 520-3 Algebraic Structures II. Free modules, torsion modules, tensor products of modules, finitely generated modules over principal ideal domains, application of abelian groups, algebraic geometry, homological algebra and group cohomology. Prerequisite: MATH 519.

MATH522 - Adv Topics-Alg & Num Theory 522-1 to 12 Advanced Topics in Algebra and Number Theory. Selected topics in modern algebra and number theory chosen from such areas as: group theory, commutative algebra, non-commutative algebra, field theory, representation theory, analytical number theory, algebraic number theory, additive number theory. Diophantine approximations, Dirichlet series and automorphic form. Special approval needed from the instructor.

MATH525 - Analytic Number Theory 525-3 Analytic Number Theory. Introduction to modern analytic techniques used in the study of quadratic forms, the distribution of prime numbers, Diophantine approximations and other topics of classical number theory. Prerequisites: MATH 425 and MATH 419 with grades of C or better.

MATH526 - Algebraic Number Theory 526-3 Algebraic Number Theory. Introduction to the modern algebraic techniques used in the study of number theory. Advanced Galois Theory, algebraic integers, prime factorization of ideals, Dirichlet unit theorem, ramification theory, local fields, and other topics. Prerequisites: MATH 425 and MATH 455 with grades of C or better.

MATH530 - Topology 530-3 Topology. This course covers the basics of point-set topology, Urysohn's lemma, Tychonoff's theorem, the Baric category theorem, manifolds and the fundamental group. Prerequisite: MATH 430 or MATH 452 with a C or better.

MATH531 - Algebraic Topology 531-3 Algebraic Topology. This course covers homotopy and homology groups, exact sequences, CW complexes, axioms of homology, and beginnings of cohomology. Prerequisite: MATH 530 with a C or better.

MATH532 - Topics in Geom & Topology 532-1 to 12 Topics in Geometry and Topology. Topics may include dynamical systems, topological groups, knot theory, complexity theory, uniform spaces and frames, differential and Riemannian geometry, voting theory and mathematical physics. Special approval needed from the instructor.

MATH535 - Differential Geometry 535-3 Differential Geometry. This course covers differential forms, curvature, connections, integration on manifolds and may include Riemannian geometry or Lie groups. Prerequisite: MATH 530 with a C or better.

MATH540 - Convex Analysis 540-3 Convex Analysis. The course develops the basic results on convex sets and functions which are extensively used in several areas of applied mathematics and in
business and engineering. Both finite and infinite dimensional spaces will be discussed. Topics covered include separation theorems, extreme points and the Krein-Milman Theorem. For infinite dimensional spaces elementary aspects of locally convex spaces will be included. Applications include inequalities, constrained optimization and minimax theory. Prerequisite: MATH 452 or consent of instructor.

**MATH549 - Combinatorial Theory** 549-3 Combinatorial Theory. This course will introduce the student to various advanced topics in Combinatorial theory that are basic to modern methods in applicable mathematics. Possible topics include: Enumeration, Polya-Burnside theory, DeBruijn sequences, Graph theory, Cayley's Theorem, Ramsey's Theorem, Hall's Theorem, Design Theory, Distinct representatives, Latin squares and Finite geometries. Prerequisite: MATH 449 or consent of instructor.

**MATH553 - Adv Topics Analy & Func Anlys** 553-1 to 12 Advanced Topics in Analysis and Functional Analysis. Advanced topics in analysis and functional analysis from such areas as: harmonic analysis, approximation theory, integration theory, advanced complex variables, topological vector spaces, operator theory, Banach algebras, distribution theory. Special approval needed from the instructor.

**MATH555 - Complex Analysis** 555-3 Complex Analysis. We review the field of complex numbers, differentiability, series convergence and the Cauchy integral formula for functions of a single complex variable. We go on to study the properties analytic, entire, meromorphic, and harmonic functions. We develop rigorous proofs of the Maximum modulus theorem, the Riemann mapping theorem, the residue theorem, and the Weierstrass factorization theorem and related results. If time permits the gamma and Riemann zeta functions are presented. Prerequisite: MATH 455.

**MATH559 - Adv Topics in Combinatorics** 559-1 to 12 Advanced Topics in Combinatorics. Selected advanced topics in combinatorics chosen from such areas as: graph theory; combinatorial designs; enumeration; random graphs; finite geometry; coding theory; cryptography; combinational algorithms. Special approval needed from the instructor.

**MATH566 - Continuum Mechanics** 566-3 Continuum Mechanics. This course will provide a rigorous development of the mechanics of solids and fluids. Topics will include: elements of tensor analysis; kinematics; balance of mass, linear momentum and angular momentum; the concept of stress; constitutive equations for fluid and solid bodies; and invariance of constitutive equations under a change in observer. Applications of continuum mechanics to the solution of problems in materials science will be included as time permits. Prerequisite: MATH 450 or MATH 452.

**MATH569 - Adv Topics in Applied Math** 569-1 to 12 Advanced Topics in Applied Mathematics. Selected advanced topics in applied mathematics chosen from such areas as: continuum mechanics; electromagnetic theory; control theory; mathematical physics. Special approval needed from the instructor.

**MATH570 - Adv Topics: Optimization** 570-1 to 12 Advanced Topics in Optimization. Selected advanced topics in optimization and operations research chosen from such areas as: calculus of variations, optimal control theory, nonlinear programming, convex analysis, non-smooth analysis, new flows, advanced computer simulation, large scale linear programming. Special approval needed from the instructor.

**MATH572 - Adv Topics in Numerical Anlys** 572-1 to 12 Advanced Topics in Numerical Analysis. (Same as CS 572) Selected advanced topics in numerical analysis chosen from such areas as: approximation theory, spline theory; special functions; wavelets; numerical solution of initial value problems; numerical solution of boundary value problems; numerical linear algebra; numerical methods of optimization; and functional analytic methods. Special approval needed from the instructor.

**MATH574 - Approximation Theory** 574-3 Approximation Theory. A study of techniques for approximating functions by polynomials, trigonometric polynomials, polynomial splines, wavelets, etc. Topics include: existence, uniqueness and characterization of best approximations in normed linear spaces; projection methods for good approximation; the Weierstrass, Muntz-Szasz, and Stone-Weierstrass theorems; degree of approximation and the Jackson theorems; construction of optimal min-max and least squares approximation using rational functions, splines, wavelets. Students will use MATLAB to study the quality of various approximations developed in the course. Prerequisite: MATH 452, MATH 475, and one of MATH 406, MATH 421.
MATH575 - Matrix Computations 575-3 Matrix Computations. A practical introduction to modern numerical linear algebra. Topics include: vector and matrix norms; Householder, Givens and Gauss transforms; factorization methods for solving systems of linear equations with roundoff error analysis; QR and SVD methods for solving linear least squares problems; the QR algorithm for computing the eigenvalues of a matrix. Students will use MATLAB to study the algorithms developed in the course. Prerequisite: MATH 475 and one of MATH 406, MATH 421.

MATH580 - Statistical Theory 580-3 Statistical Theory. The course gives a rigorous introduction to statistical inference. Topics covered include statistical models; sufficiency and completeness; Cramer-Rao bound; Rao-Blackwell theorem; best estimators; most powerful tests; likelihood ratio tests; elements of Bayes and minimax procedures. Prerequisite: MATH 483 or MATH 480.

MATH581 - Probability 581-3 Probability. A rigorous, measure-theoretic introduction to probability theory. Principal topics include general probability spaces, product spaces and product measures, random variables as measurable functions, distribution functions, conditional expectation, types of convergence, characteristic functions and the Central Limit theorem, tail events and 0-1 laws, the Borel-Cantelli lemma, and the weak and strong law of large numbers. Concurrent course in real variables, MATH 501.

MATH582 - Adv Topics in Probability 582-1 to 6 Advanced Topics in Probability. Selected advanced topics in probability chosen from such areas as: martingales, Markov processes, Brownian motion, infinitely divisible laws. Special approval needed from the instructor.

MATH583 - Advanced Topics in Stats 583-1 to 12 Advanced Topics in Statistics. Selected advanced topics in statistics chosen from such areas as: advanced linear models, advanced experimental design, multivariate statistical analysis, decision theory, advanced nonparametric theory. Special approval needed from the instructor.

MATH584 - Linear Models 584-3 Linear Models. This course examines the theory of linear models with applications to the analysis of variance and regression and to the design of experiments. Least squares estimation, and testing for full rank and less than full rank models are covered. Prerequisites: MATH 221 and MATH 484 with grades of C or better.

MATH585 - Multivariate Analysis 585-3 Multivariate Analysis. This course examines the multivariate normal and elliptically contoured distributions, estimators of multivariate location and dispersion, Hotelling's T^2 test, MANOVA, multivariate regression, principal component analysis, factor analysis, canonical correlation analysis, discriminant analysis, and clustering. Prerequisites: MATH 221 and MATH 483 and MATH 221 with grades of C or better.

MATH586 - Statistical Learning 586-3 Statistical Computing and Learning. This course covers Statistical Computing and Learning, including supervised and unsupervised learning, statistical computations in software packages such as R and SAS, loops, approximation of distribution functions, computation of maximum likelihood estimations, random number generation, bootstrap, Monte Carlo, permutation tests, and Bayesian techniques. Prerequisites: MATH 483 and MATH 221 with grades of C or better.

MATH590 - Contemporary Math Research 590-1 to 6 Contemporary Mathematics Research. Lectures on various mathematical topics of current research interest by members of the department and by distinguished visitors. Special approval needed from the graduate adviser.

MATH595 - Individual Study 595-1 to 12 Individual Study. Individual study supervised by a member of the continuing faculty. Graded S/U only. Special approval needed from the instructor.

MATH598 - Research Paper 598-1 to 6 Master's Research Paper. Minimum of three hours to be counted toward the Master of Arts or Science in Mathematics degree. Graded S/U only. Special approval needed from the instructor.

MATH599 - Thesis 599-1 to 6 Master's Thesis. Minimum of three hours to be counted toward the Master of Arts or Science in Mathematics degree. Graded S/U only. Special approval needed from the instructor.
MATH600 - Dissertation 600-1 to 30 (1 to 16 per semester) PhD Dissertation. Minimum of 24 hours to be earned for the Doctor of Philosophy degree in Mathematics. Special approval needed from the instructor.

MATH601 - Continuing Enrollment 601-1 per semester Continuing Enrollment. For those graduate students who have not finished their degree programs and who are in the process of working on their dissertation, thesis, or research paper. The student must have completed a minimum of 24 hours of dissertation research, or the minimum thesis, or research hours before being eligible to register for this course. Concurrent enrollment in any other course is not permitted. Graded S/U or DEF only.

MATH699 - Postdoctoral Research 699-1 Postdoctoral Research. Must be a Postdoctoral Fellow. Concurrent enrollment in any other course is not permitted.

Mathematics Faculty

Ban, Dubravka, Professor, Dr. Sci., University of Zagreb, 1998.
Beckemeyer, Imogene C., Assistant Professor, Emerita, M.A., Southern Illinois University, 1952.
Bhattacharya, Bhaskar, Professor and Chair, Ph.D., University of Iowa, 1993.
Calvert, Wesley, Associate Professor, Ph.D., University of Notre Dame, 2005.
Choiy, Kwangho, Assistant Professor, Ph.D., Purdue University, 2012.
Clark, Lane, Professor, Emeritus, Ph.D., University of New Mexico, 1980.
Crenshaw, James, Associate Professor, Emeritus, Ph.D., University of Illinois, 1967.
Danhof, Kenneth, Professor, Emeritus, Ph.D., Purdue University, 1969.
Dharmadhikari, Sudhakar, Professor, Emeritus, Ph.D., University of California at Berkeley, 1962.
Earnest, Andrew, Professor, Emeritus, Ph.D., Ohio State University, 1975.
Elston, George, Assistant Professor, Emeritus, M.S., University of Wisconsin, 1949.
Feinsilver, Philip, Professor, Emeritus, Ph.D., New York University (Courant), 1975.
Fitzgerald, Robert W., Professor, Emeritus, Ph.D., University of California at Los Angeles, 1980.
Foland, Neal E., Professor, Emeritus, Ph.D., University of Missouri, 1961.
Grimmer, Ronald C., Professor, Emeritus, Ph.D., University of Iowa, 1967.
Hooker, John W., Professor, Emeritus, Ph.D., University of Oklahoma, 1967.
Hughes, Harry R., Associate Professor, Emeritus, Ph.D., Northwestern University, 1988.
Hunsaker, Worthen N., Professor, Emeritus, Ph.D., Washington State University, 1966.
Jayaratnam, Sakhthivel, Professor, Emeritus, Ph.D., Colorado State University, 1978.
Kammler, David, Professor, Emeritus, Ph.D., University of Michigan, 1971.
Kirk, Ronald B., Professor, Emeritus, Ph.D., California Institute of Technology, 1968.
Koch, Charles, Assistant Professor, Emeritus, Ph.D., University of Illinois, 1961.
Kocik, Jerzy, Associate Professor, Ph.D., Southern Illinois University Carbondale, 1989.
Langenhop, Carl E., Professor, Emeritus, Ph.D., Iowa State University, 1948.
Mark, Abraham M., Professor, Emeritus, Ph.D., Cornell University, 1947.
McSorley, John, Professor, Ph.D., Oxford University, 1988.
Moore, Robert A., Associate Professor, Emeritus, Ph.D., Indiana University, 1961.
Neuman, Edward G., Professor, Emeritus, Ph.D., University of Wroclaw (Poland), 1972.
Olive, David, Professor, Ph.D., University of Minnesota, 1998.
Paine, Thomas B., Assistant Professor, Emeritus, Ph.D., University of Oregon at Eugene, 1966.
Pedersen, Franklin D., Associate Professor, Emeritus, Ph.D., Tulane University, 1967.
Pericak-Spector, Kathleen, Professor, Emerita, Ph.D., Carnegie-Mellon University, 1980.
Redmond, Donald, Associate Professor, Ph.D., University of Illinois, 1976.
Samadi, Yaser, Assistant Professor, Ph.D., University of Georgia, 2014.
Schurz, Henri, Professor, Ph.D., Humboldt University, Berlin, 1997.
Sullivan, Michael, Professor, Ph.D., University of Texas at Austin, 1992.
Wallis, Walter, Professor, Emeritus, Ph.D., University of Sydney, 1968.
Wright, Mary H., Professor, Emerita, Ph.D., McGill University (Montreal), 1977.
Xiao, Mingqing, Professor, Ph.D., University of Illinois, 1997.
Xu, Dashun, Professor, Ph.D., Memorial University of Newfoundland, 2004.