

# DEPARTMENT OF MATHEMATICAL SCIENCES

*Chair: P. Douglas Elosser*

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The Department of Mathematical Sciences offers courses in mathematics and computer science leading to majors in mathematics and computer information systems. Minors may be earned in mathematics and computer science. General education courses and courses designed for students majoring in other disciplines also are provided.

## GENERAL EDUCATION REQUIREMENTS

To earn a degree from UVa-Wise a student must complete six semester hours in mathematics. Entering students who have not completed this requirement are required to take a mathematics placement test administered by the department. Students may begin their study of mathematics with MATH 100, 101, 102, 103, or 204; however, if deficiencies are identified, students are required to satisfactorily complete MATH 090 before registering for a 100-level mathematics course. MATH 090 is a non-degree credit course. The department recommends the appropriate placement determined by the following criteria:

- 1) The student's SAT or ACT scores;
- 2) The student's high school record;
- 3) The student's score on the Mathematics Placement Test.

MATH 301 and 302 do not satisfy general education requirements.

A 100-level course may not be taken for credit after a 200- or higher level course has been completed successfully. MATH 100 and MATH 101 may not be taken for credit after MATH 103 has been completed successfully. MATH 101 may not be taken for credit after MATH 100 has been completed successfully; however, a student who receives a grade of "C-" or lower in MATH 101 may take MATH 100 for credit and the grade in MATH 100 will replace the grade for MATH 101.

The student successfully completing MATH 103 with a grade of "C" or better will also receive credit for MATH 101. The student successfully completing MATH 204 with a grade of "C" or better will also receive credit for MATH 103 and MATH 101. Students who score a 4 or 5 on the

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AB Advanced Placement Examination in Calculus and students who score a 3 on the BC Advanced Placement Examination in Calculus will receive credit for MATH 204 and will be placed in MATH 205. Students who score a 4 or 5 on the BC Advanced Placement Examination in Calculus will receive credit for both MATH 204 and 205.

### MINOR IN COMPUTER SCIENCE

A minor in computer science consists of 18 semester hours of computer science, at least 12 of which must be in 300- or 400-level courses. The program of study must include COSC 190, Fundamentals of Computer Programming; COSC 281, Data Structures; COSC 381, Algorithms, and must be approved by the chair of the department. COSC 320, C and C++ Programming and COSC 350, Computer Systems Analysis and Development, are highly recommended for minors. Other recommended courses are COSC 330, Fundamentals of Computer Science and COSC 360, Operations Research.

### MINOR IN MATHEMATICS

A minor in mathematics consists of 18 semester hours of mathematics, at least 12 of which must be in 300- or 400-level courses. MATH 301 and 302 do not satisfy this requirement. The program of study must include MATH 204 and must be approved by the department chair.

### TEACHER LICENSURE

Licensure to teach mathematics at two different levels, general mathematics and high school mathematics, may be obtained by completing the professional education courses for secondary level teachers as outlined on page 123-124 in addition to the requirements of the chosen major. Students are advised to consult the Director of the Teacher Education Program for specific requirements.

**General Mathematics:** This licensure requires 18 semester hours of credit in mathematics and licenses one to teach general, consumer, basic, career and shop mathematics. MATH 301 and 302 cannot be included in the 18 semester hours.

**High School Mathematics:** Licensure to teach high school mathematics requires 27 semester hours of mathematics, including calculus, modern algebra, geometry, probability and statistics, and a computer programming course. MATH 301 and 302 cannot be included in the 27 semester hours.

**Computer Science:** Teacher licensure with an endorsement in computer science may be obtained by completing the general education

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requirements, the computer science major, the professional studies courses, and the teaching internship. For additional requirements and information relative to the Teacher Education Program, please contact the Director of Teacher Education.

### **BACHELOR OF SCIENCE IN COMPUTER INFORMATION SYSTEMS**

#### **COMPUTER SCIENCE MAJOR**

The degree program in computer information systems is designed to prepare students for entry-level employment in computer applications and to provide the background necessary for graduate work in computer science and other fields which require extensive work in information processing.

It is strongly recommended that students take MATH 205, Calculus II; MATH 306, Calculus III; PHYS 311-312, General College Physics; and PHIL 103, Logic I. Courses in business management, economics and public speaking are also suggested as electives.

The remaining general education courses are to be selected in consultation with the academic advisor.

The courses required for the computer science major are as follows:

|  | <i>semester hours</i> |
|--|-----------------------|
| MATH 204 Calculus I                                | 4                     |
| MATH 208 Elementary Probability and Statistics     | 4                     |
| COSC 190 Foundations of Computer Programming       | 4                     |
| COSC 281 Data Structures                           | 3                     |
| COSC 320 C and C++ Programming                     | 3                     |
| COSC 350 Computer Systems Analysis and Development | 3                     |
| COSC 371 Discrete Structures                       | 3                     |
| COSC 381 Introduction to Algorithms                | 3                     |
| COSC 400 Operating Systems                         | 3                     |
| COSC 410 Database Design                           | 3                     |
| COSC 420 Programming Languages                     | 3                     |
| COSC 430 Computer Architecture                     | 3                     |
| COSC 499 Senior Seminar (Capstone Course)          | 1                     |
| Technical Elective                                 | 3                     |
| Elective sequence*                                 | 6                     |
| <b>TOTAL SEMESTER HOURS</b>                        | <b>49</b>             |

\*The elective sequence is a two-course sequence approved by the computer science faculty. Examples are:

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### **Business Computing Track:**

|          |                          |
|----------|--------------------------|
| COSC 270 | COBOL Programming        |
| COSC 411 | Advanced Database Design |

OR

### **Network Programming Track:**

|          |                             |
|----------|-----------------------------|
| COSC 435 | Computer Networks           |
| COSC 490 | Information Characteristics |

The technical elective may be any non-required computer course numbered 300 or above, MATH 205, 306, 313, 325, 338, or 408, or PHYS 311-312. The student must complete a total of 120 semester hours including the required courses and electives approved by the academic advisor and also perform satisfactorily on comprehensive examinations administered by the department. Courses in marketing and business management would be useful to students interested in a software development career. Courses in the psychology or biology of the brain, molecular genetics and DNA mechanisms may be considered in preparing the student for state-of-the-art research areas of computer science.

## **BACHELOR OF ARTS OR BACHELOR OF SCIENCE IN MATHEMATICS**

### **MATHEMATICS MAJOR**

**For all baccalaureate degrees with a major in mathematics, students must complete either a minor in another discipline or a second major.**

All mathematics majors are required to complete the following core courses:

|  | <i>semester hours</i> |
|--|-----------------------|
| MATH 204 Calculus I                      | 4                     |
| MATH 205 Calculus II                     | 4                     |
| MATH 306 Calculus III                    | 4                     |
| MATH 311 Ordinary Differential Equations | 3                     |
| MATH 313 Introduction to Linear Algebra  | 3                     |
| MATH 325 Probability and Statistics      | 3                     |
| MATH 335 Abstract Algebra I              | 3                     |
| MATH 344 Advanced Calculus I             | 3                     |
| MATH 490 Mathematics Seminar             | 1                     |
| <b>TOTAL SEMESTER HOURS</b>              | <b>28</b>             |

At least 12 additional semester hours of advanced work in mathematics or computer science numbered 300 or above are also required. These

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courses are to be selected in consultation with the academic advisor and approved by the chairman of the department. The student should use these courses to develop an area of special interest.

Students whose interests are in applied mathematics or computer science are encouraged to select from the following courses:

|  | <i>semester hours</i> |
|--|-----------------------|
| COSC 330 Fundamentals of Computer Science  | 3                     |
| COSC 360 Operations Research               | 3                     |
| COSC 371 Discrete Structures               | 3                     |
| MATH 338 Introduction to Numerical Methods | 3                     |
| MATH 408 Applied Statistics                | 3                     |

Students whose interests are in pure mathematics are encouraged to select from the following courses:

|  | <i>semester hours</i> |
|--|-----------------------|
| MATH 312 Introduction to Geometry            | 3                     |
| MATH 320 Introduction to Number Theory       | 3                     |
| MATH 331 Introduction to Mathematical Proofs | 3                     |
| MATH 410 Set Theory                          | 3                     |

Students whose interests are in teaching mathematics in the secondary schools must take COSC 190 and are encouraged to take the following courses:

|   | <i>semester hours</i> |
|---|-----------------------|
| COSC 330 Fundamentals of Computer Science | 3                     |
| MATH 312 Introduction to Geometry         | 3                     |

These students are encouraged to select their remaining area electives from the following courses:

|  | <i>semester hours</i> |
|--|-----------------------|
| COSC 360 Operations Research                 | 3                     |
| COSC 371 Discrete Structures                 | 3                     |
| MATH 315 History of Mathematics              | 3                     |
| MATH 320 Introduction to Number Theory       | 3                     |
| MATH 331 Introduction to Mathematical Proofs | 3                     |
| MATH 410 Set Theory                          | 3                     |

All students seeking a major in mathematics must perform satisfactorily on comprehensive examinations administered by the department. The examination will cover the contents of MATH 204, 205, 306, 311, 313, 325, 335, and 344.

Courses may be applied toward two majors where appropriate; however, the course of study submitted for a major may not contain any courses used for the minor.

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For the Bachelor of Arts degree in mathematics, students may elect a minor offered in the following areas:

- History and Philosophy
- International Studies
- Language and Literature
- Visual and Performing Arts
- Women's Studies.

For the Bachelor of Science degree in mathematics, students may elect a minor offered by the following departments:

- Business and Economics
- Education
- Mathematical Sciences
- Natural Science
- Social and Behavioral Sciences.

## COURSES IN COMPUTER SCIENCE

### **COSC 101: Object Oriented Programming (3)**

Programming in C++ as an introduction to computer programming for non-science majors. Variables, declarations, branching, looping, and arrays. Computer information science majors and minors cannot get credit for this course.

### **COSC 110: Computer Literacy (3)**

Basic concepts of computer hardware and software, word processing, spreadsheets, database use, Internet use, graphic presentations, introduction to object oriented programming. Students may not receive credit for both COSC 110 and BUAD 111.

### **COSC 135: Computer Network Assembly (1)**

Assembly and testing of local area networks for offices and schools. Selection of components, software for networks and labs.

### **COSC 190: Foundations of Computer Programming (4)**

Beginning computer programming. Ada program language syntax, structured and object based techniques, data types and program constructs, functions and procedures, basic programming practices, arrays, records, pointers, packages, input/output techniques.

### **COSC 270: Programming in COBOL (4)**

Introduction to a major computer language used in the business environment. Flowcharting; coding; testing and debugging programs

typical to business applications. Examples using single and multi-level tables, sequential files, indexed files, COBOL sort/merge, report writing, libraries, and subprograms. Two hours lecture and two hours laboratory.

**COSC 281: Data Structures (3)**

*Prerequisite: COSC 190*

Data and abstract data types; programming principles, lists, dynamic memory allocation, stacks, queues, trees, graphs, recursion.

**COSC 320: C/C++ Programming (3)**

*Prerequisite: COSC 190 or permission of instructor*

Syntax and programming techniques for object oriented C and C++ programming; data types; flow of control; functions; arrays; pointers; strings; bit-wise operations; structures; unions; list processing.

**COSC 325: Unix Systems (3)**

*Co- or Prerequisite: COSC 320*

Detailed study of the UNIX operating system; UNIX commands; File system; software development tools; system call interface and standard C library; Process control and inter-process communication; graphical user interfaces, Shell scripts and scripting languages; networking; variations of the UNIX system.

**COSC 330: Fundamentals of Computer Science (3)**

*Prerequisite: COSC 190 or permission of instructor*

Overview of how computer systems process information. Topics include fundamentals of high order languages, machine languages, assembly languages, operating systems, computer architecture, and computer networks. Programming exercises in a high level language and an assembly language; searching and sorting algorithms, recursion. Intended for computer science, mathematics, and science majors who want an overall view of computer science.

**COSC 350: Computer Systems Analysis and Development (3)**

*Prerequisite: One computer language course*

Development of a total system concept is emphasized. Project planning, requirements analysis, system design, program design, program implementation, program testing, system testing, system delivery, maintenance, documentation, and examining the development process.

**COSC 360: Operations Research (3)**

*Prerequisite: One year of college-level mathematics*

An introduction to the theory and techniques of operations research.

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Topics include mathematical modeling and simulation, linear programming and queuing. Practical examples are emphasized throughout the course.

### **COSC 371: Discrete Structures (3)**

*Prerequisite: MATH 204 or permission of instructor*

Topics include: algebra of sets, equivalence relations, counting techniques, induction, algebraic structures, flowcharts, algorithms, syntax and semantics, graphs, monoids and machines and logic.

### **COSC 381: Introduction to Algorithms (3)**

*Prerequisite: COSC 281*

Sorting and searching; recursion; analysis of complexity; algorithm paradigms; NP complete problems; complexity metrics.

### **COSC 387, 388: Cooperative Education Project I (1-6, 1-6)**

Students can obtain information from the Department Chair.

### **COSC 395, 396: Special Topics (1-3, 1-3)**

*Prerequisite: Permission of instructor*

### **COSC 400: Operating Systems: Theory and Practice (3)**

*Prerequisite: COSC 281*

The concepts behind the design and working of the operating system on a computer are introduced. A system programming course emphasizing topics such as resource management, processes, process management, file design and allocation, system calls, and shell design.

### **COSC 410: Database Design and Applications (3)**

*Prerequisite: COSC 281*

Evolution of data models, relational, network, hierarchical, and ER model concepts. DDL and DML concepts, relational algebra, relational calculus, SQL, Network and Hierarchical DMLs. Design, implementation, and manipulation of a relational database using current database technology..

### **COSC 411: Advanced Database Systems (3)**

*Prerequisite: COSC 410*

Advanced database design concepts, multivalued dependencies, functional dependencies, normalization. Concurrency control and recovery techniques, serializability, deadlocks, distributed databases, object-oriented databases, and current trends in database systems. Relational database implementation and manipulation using SQL embedded in various programming languages.

**COSC 415: Introduction to Robotics and Artificial Intelligence (3)**

*Prerequisite: COSC 281 or permission of instructor*

Human or interface design, social and ethical and professional issues, introduction to robotics and controls interfaces, artificial intelligence interfaces. Numerical and symbolic computation interface design, representation graphics.

**COSC 420: Programming Languages (3)**

*Prerequisite: COSC 281 and senior standing*

Survey of contemporary languages, compiler construction techniques, parsing, formal grammars, virtual machines.

**COSC 430: Computer Architecture (3)**

*Prerequisite: COSC 281*

A detailed study of the design and functional organization of a modern digital computer. Instruction sets I/O handling, interrupts, addressing schemes, microprogramming and memory management are investigated.

**COSC 435: Computer Networks (3)**

*Prerequisite: COSC 320 or permission of instructor*

Network structure, architectures, network standardization, TCP/IP reference model and different network layers, Local Area Network protocols, routing algorithms, internetworking.

**COSC 440: Computer Graphics (3)**

*Prerequisite: COSC 190*

Concepts of representation, manipulation, and rendering of graphical objects, concept of developing graphical user interface (GUI), devices for graphical input, graphics software, graphics standards; simple algorithms for line, circle, box, polygon drawing; attributes of lines and other geometrical shapes, attributes of text; 2D rerepresentation, scaling, rotating, etc.; 3D graphics; hidden line removal; rendering objects.

**COSC 445: Introduction to Compilers (3)**

*Prerequisite: COSC 281*

Concepts behind programming languages, their structure, and grammar. Use of these concepts to design and implement a simple translator. Sets and strings, grammars and their classification, context-free grammar and parsing; programming language design, design philosophies; top-down parsing, LL(1) grammars; bottom-up parsing, polish notation, simple precedence grammars, LR grammars.

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### **COSC 450: Modeling and Simulation (3)**

*Prerequisites:* COSC 190, COSC 360, MATH 205 and MATH 208 or 325

An introduction to model building and simulation techniques. Experimental design and statistical analysis of business, social and physical science systems.

### **COSC 487, 488: Cooperative Education Project II (1-6, 1-6)**

Students can obtain information from the Department Chair.

### **COSC 490: Information Characteristics (1-3)**

*Prerequisite:* COSC 281

State machines, information measurement, software metrics, reliability, binary codes, encryption, data compression, pattern recognition, and information recovery.

### **COSC 494: Special Studies in Computer Science (1-3)**

*Prerequisite:* Two programming languages and permission of instructor

Students select appropriate topics from within their field of interest. Problem analysis and selection of an appropriate solution is emphasized.

### **COSC 495, 496: Special Topics (1-3, 1-3)**

*Prerequisite:* Permission of instructor

### **COSC 497: Independent Study (1-3)**

### **COSC 499: Computer Science Seminar (Capstone Course) (1)**

*Prerequisite:* Permission of instructor

Students select and present appropriate topics from within their field of interest.

## COURSES IN MATHEMATICS

### **MATH 090: Mathematics (3)**

Fundamental arithmetic operations; basic algebraic processes; linear equations in one and two unknowns; polynomials; factoring trinomials; solutions of quadratic equations. (A remedial course designed for students who are not prepared to take college-level mathematics courses. Offered for credit/no credit only.)

### **MATH 100: Introduction to Algebra and Trigonometry (4)**

*Prerequisite:* Departmental placement or successful completion of MATH 090

Review of basic algebraic processes; relations and functions; linear equations and inequalities; graphing of linear and quadratic function; ratio and proportion; complex numbers; quadratic equations; exponential

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and logarithmic functions; trigonometric functions; and solutions of triangles. (A course meeting five days a week designed for students who are not prepared to take MATH 101. A student may not receive credit for both MATH 100 and MATH 101.)

### **MATH 101: Algebra and Trigonometry (3)**

*Prerequisite: Satisfactory performance on placement test or successful completion of MATH 090*

Relations and functions; linear equations and inequalities; graphing of linear and quadratic functions; ratio and proportion; complex numbers; quadratic equations; exponential and logarithmic functions; trigonometric functions; solutions of triangles. (No credit is given for this course if a student has satisfactorily completed MATH 100, MATH 103 or above.)

### **MATH 102: Finite Mathematics (3)**

*Prerequisite: Satisfactory performance on placement test or successful completion of MATH 090*

Algebra of sets; permutations and combinations; probability; elementary statistics; systems of linear equations and linear inequalities; matrix algebra; linear programming, and mathematics of finance. Emphasis is given to learning practical applications. (A course of interest to business and social science majors.)

### **MATH 103: Pre-calculus (3)**

*Prerequisite: Satisfactory performance on placement test or successful completion of Math 100 or Math 101*

Functions; algebraic, trigonometric, exponential and logarithmic functions; elementary properties of lines, circles, parabolas.

### **MATH 194, 195: Special Topics (1-3, 1-3)**

*Prerequisite: Permission of instructor*

### **MATH 204: Calculus I (4)**

*Prerequisite: MATH 103 or permission of instructor*

Limits and continuity; differentiation of algebraic functions; derivative as a rate of change; maxima and minima; integration of algebraic functions; definite integrals and applications.

### **MATH 205: Calculus II (4)**

*Prerequisite: MATH 204 or permission of instructor*

Differentiation and integration of exponential, logarithmic and trigonometric functions; polar coordinates; parametric equations; arc

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length; area of surface of revolution; volume by the disk, washer and shell methods; indeterminate forms and improper integrals.

### **MATH 208: Elementary Probability and Statistics (4)**

*Prerequisite: MATH 101/103 or permission of instructor*

Rules of probability; random sampling; binomial and normal distributions; Chi-Square, T- and F-distributions; hypotheses testing; linear regression and correlation.

### **MATH 301: Euclidean Geometry (3)**

*Prerequisite: MATH 102 or MATH 103 or MATH 208.*

An application-oriented study of Euclidean geometry for students whose interests are in teaching K-8. Topics that will be emphasized include: foundations of geometry; introduction to proofs; triangles; parallel lines and polygons; ratio, proportion and similarity; right triangles and the pythagorean theorem; circles; and solid geometry. (*MATH 301 does not satisfy the general education requirement or count toward a major or minor in mathematics.*)

### **MATH 302: Problem Solving (3)**

*Prerequisite: MATH 102 or MATH 103 or MATH 208.*

A study of topics from the foundations of mathematics, with emphasis on problem solving. Topics will include: steps in problem solving in mathematics; elementary set theory; elementary logic and mathematical proofs; elementary number theory; properties of integers and properties of rational numbers; lines and linear functions; combinatorics and probability; elementary statistics; sequences; and systems of linear equations. (*MATH 302 does not satisfy the general education requirement or count toward a major or minor in mathematics.*)

### **MATH 306: Calculus III (4)**

*Prerequisite: MATH 205 or permission of instructor*

Infinite series; lines and planes in space; vector-valued functions; functions of several variables; partial derivatives; gradients; maxima and minima; multiple integration.

### **MATH 311: Ordinary Differential Equations (3)**

*Prerequisite: MATH 205*

A study of differential equations of the first order, linear differential equations and their applications, and other selected topics.

### **MATH 312: Introduction to Geometry (3)**

*Prerequisite: MATH 331 or permission of instructor*

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The history and development of Euclidean and non-Euclidean geometries. The axiomatic method and techniques of proof are emphasized.

### **MATH 313: Introduction to Linear Algebra (3)**

*Prerequisite: One year of college-level mathematics*

Vector spaces; subspaces; linearly dependent and independent subsets; linear transformations; matrices; determinants; eigenvalues and eigenvectors.

### **MATH 315: History of Mathematics (3)**

*Prerequisite: MATH 204 or permission of instructor*

Emphasis is given to mathematicians and their contributions; various trends of mathematics of different eras. (A course of interest and benefit to teachers and prospective teachers of mathematics. MATH 315 does not satisfy the general education requirement.)

### **MATH 320: Introduction to Number Theory (3)**

*Prerequisite: MATH 331 or permission of instructor*

Unique factorization theorem; linear Diophantine equations; linear congruences; Fermat's and Wilson's theorems; divisors of an integer; perfect numbers; Euler's theorem; numbers of other bases; quadratic congruences and reciprocity. (A course of interest and benefit to prospective teachers of mathematics.)

### **MATH 325: Probability and Statistics I (3)**

*Prerequisite: MATH 205*

Probability in finite, discrete and general spaces; discrete and continuous random variables; conditional and independent joint distributions; confidence intervals; testing hypotheses; regression and correlation; sampling methods.

### **MATH 331: Introduction to Mathematical Proofs (3)**

*Prerequisite: MATH 205 or permission of instructor*

Writing mathematical proofs. Exercises in set theory, number theory. Includes set operations, equivalence relations, induction, completeness property, Archimedean property and the Fundamental Theorem of Arithmetic.

### **MATH 335: Abstract Algebra I (3)**

*Prerequisite: MATH 331 or permission of instructor*

Groups; cyclic groups; normal subgroups; Lagrange's theorem; permutation groups; group homomorphisms; Cayley's theorem; elementary theory of rings and fields.

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### **MATH 338: Introduction to Numerical Methods (3)**

*Prerequisites: MATH 205 or permission of instructor*

The theory and techniques of numerical computation involving interpolation methods; solution of systems of equations and methods of solving ordinary differential equations. Practice in the use of modern computers and programming.

### **MATH 344: Advanced Calculus I (3)**

*Prerequisite: MATH 331 or permission of instructor*

The real number system; differential and integral calculus of one variable; uniform continuity; Taylor's theorem; infinite sequences and series; uniform convergence; real-valued functions of several variables.

### **MATH 387, 388: Cooperative Education Project I (1-6, 1-6)**

Students can obtain information from the Department Chair.

### **MATH 394, 395, 396: Special Topics (1-3)**

*Prerequisite: MATH 205 and permission of instructor*

Advanced undergraduate mathematics topics.

### **MATH 408: Applied Statistics (3)**

*Prerequisite: MATH 208/325 or permission of instructor*

Design of experiments; hypothesis testing; multivariate statistical analysis; analysis of variance and covariance; regression analysis; nonparametric statistics. Problems in the student's field of interest are solved using SPSS on the digital computer.

### **MATH 410: Set Theory (3)**

*Prerequisite: MATH 205 or permission of instructor*

Axiomatic development of sets that includes operations on sets; relations; order; the axiom of choice; Zorn's lemma; Schroeder-Bernstein theorem.

### **MATH 426: Probability and Statistics II (3)**

*Prerequisite: MATH 325*

A continuation of MATH 325.

### **MATH 436: Abstract Algebra II (3)**

*Prerequisite: MATH 335*

Structure of finite groups; ideal theory of commutative rings; Galois fields.

### **MATH 445: Advanced Calculus II (3)**

*Prerequisite: MATH 344*

A continuation of MATH 344.

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### **MATH 487, 488: Cooperative Education Project II (1-6, 1-6)**

Students can obtain information from the Department Chair.

### **MATH 490: Mathematics Seminar (Capstone Course) (1)**

*Prerequisites: MATH 306, Junior or Senior Status, declared major and approval of Department Chair.*

This course should be taken concurrently with (or following) an approved advanced mathematics course. Study of a topic related to the material in advanced course will be required along with completion of project in consultation with the instructor. The student will be required to present a summary of the project, both orally and in writing, demonstrating critical thinking and problem-solving ability.

### **MATH 495, 496: Special Topics (1-3)**

*Prerequisite: MATH 306 and permission of instructor*

Advanced undergraduate mathematics topics.

### **MATH 497: Independent Study (1-3)**