

**MANAGEMENT 453 (3)—Internship**

*Prerequisites: Junior standing, Williams School major, and permission of the department.* A limited number of off-campus, summer positions open to Williams School majors. Selection is competitive, based on academic performance and personal interviews. Each intern is closely supervised by a member of the management department. Students register for the credits as part of a normal class load for the following fall term, during which they write an in-depth research paper related to their intern experiences. *Pirkle, R. Anderson.*

*Fall*

**MANAGEMENT 493 (3-3)—Honors Thesis**

*Fall-Winter*

**MATHEMATICS**

Society of the Cincinnati Foundation

PROFESSORS EVANS, BOURDON, DYMACEK,  
JOHNSON, VINSON  
ASSISTANT PROFESSORS DRESDEN, McRAE

**MAJOR**

A major in **mathematics** leading to a Bachelor of Arts degree requires the completion of at least 33 credits as follows:

1. Mathematics 221, 222, 311, 312, 321, 322
2. One course selected from Computer Science 211, 313; Economics 395; Mathematics 218, 310, 333, 353; Physics 112
3. 12 additional credits selected from mathematics courses numbered above 300

Additional courses required as prerequisites for completion of the above include Mathematics 101 and 102 or their equivalents; furthermore, the course selected to fulfill requirement 2 above may have prerequisites.

A major in **mathematics** leading to a Bachelor of Science degree requires the completion of at least 51 credits as follows:

1. Mathematics 221, 222, 311, 312, 321, and 322
2. All eight credits from Physics 111-114
3. Either Computer Science 112 or 120
4. 15 additional credits selected from mathematics courses numbered above 300
5. Six additional credits selected from courses in biology, chemistry, computer science, engineering, geology, mathematics (numbered 200 and above), and physics, except courses excluded from degree programs in those subjects

Additional courses required as prerequisites for completion of the above include Mathematics 101 and 102 or their equivalents.

*HONORS: An Honors Program in mathematics is offered for well-qualified majors; see department head for details.*

**★MATHEMATICS 101 (3)—Calculus I**

An introduction to the calculus of functions of one variable including a study of limits, derivatives, extrema, integrals, and the fundamental theorem.

*Fall, Winter*

**★MATHEMATICS 102 (3)—Calculus II**

*Prerequisite: The equivalent of Mathematics 101.* A continuation of Mathematics 101, including techniques of integration, transcendental functions, and infinite series. (A special section of Mathematics 102 is offered in the fall term for well-prepared freshmen. See department head for details.)

*Fall, Winter, Spring*

**★MATHEMATICS 118 (3)—Introduction to Statistics**

*Prerequisite: Mathematics 101.* Elementary probability and counting. Mean and variance of discrete and continuous random variables. Central Limit Theorem. Confidence intervals and hypothesis tests concerning parameters of one of two normal populations.

*Winter, Spring*

**★MATHEMATICS 121 (3)—Discrete Mathematics I**

A study of concepts fundamental to the analysis of finite mathematical structures and processes. These include logic and sets, algorithms, induction, the binomial theorem, and combinatorics.

*Fall, Winter*

**★MATHEMATICS 122 (3)—Discrete Mathematics II**

*Prerequisite: Mathematics 121.* A continuation of Mathematics 121. Applications of 121 include probability theory in finite sample spaces and properties of the binomial distribution. This course also includes relations on finite sets, equivalence classes, partial orderings, and an introduction to graph theory and enumeration.

*Winter*

**MATHEMATICS 195 (3)—Special Topics in Contemporary Mathematics**

*Prerequisite: Mathematics 101 or 121, depending on course topic.* A selected mathematical topic of current widespread interest.

*Spring*

**MATHEMATICS 218 (3)—Applications of Statistics**

*Prerequisite: Mathematics 118 or Mathematics 309 or Economics/Management 201.* Theory and applications of the General Linear Model, including analysis of variance and covariance, multiple regression, and experimental design.

*Spring 2000 and alternate years*

**MATHEMATICS 221 (3)—Multivariable Calculus**

*Prerequisite: The equivalent of Mathematics 102 with C grade or better.* Multivariable calculus, including motion in  $\mathbb{R}^3$ , parametric curves in  $\mathbb{R}^n$ , differential calculus of functions from  $\mathbb{R}^n$  to  $\mathbb{R}^1$  and to  $\mathbb{R}^m$ , multiple integrals.

*Fall, Winter*

**MATHEMATICS 222 (3)—Linear Algebra**

*Prerequisite: The equivalent of Mathematics 102 with C grade or better.* Introductory linear algebra: systems of linear equations, matrices and determinants, vector spaces over the reals, linear transformations, eigenvectors, vector geometry.

*Winter, Spring*

**MATHEMATICS 242 (3)—Vector Analysis**

*Prerequisite: Mathematics 221.* Vector differential operators: gradient, divergence, and curl. Path and surface integrals. Orientation. Calculus of differential forms. Theorems of Green, Gauss, and Stokes. Applications.

*Winter*

**MATHEMATICS 301 (3)—Fundamental Concepts of Mathematics**

*Prerequisite: Six credits of mathematics or a grade of at least B in Mathematics 101.* An introduction to abstract methods in mathematical analysis and algebra.

*Spring*

**MATHEMATICS 303 (3)—Complex Analysis**

*Prerequisite: Mathematics 221 or permission of the instructor.* Algebra of complex numbers, polar form, powers, and roots. Derivatives and geometry of elementary functions. Line integrals, the Cauchy Integral Theorem, the Cauchy Integral formula, Taylor and Laurent Series, residues, and poles. Applications.

*Winter 2001 and alternate years*

**MATHEMATICS 309 (3)—Mathematical Statistics I**

*Prerequisite: The equivalent of Mathematics 221 with C grade or better.* Probability, probability density and distribution functions, mathematical expectation, discrete and continuous random variables, moment generating functions.

*Fall 1999 and alternate years*

**MATHEMATICS 310 (3)—Mathematical Statistics II**

*Prerequisite: Mathematics 309.* Sampling distributions, point and interval estimation, testing hypotheses, regression and correlation, analysis of variance.

*Winter 2000 and alternate years*

**MATHEMATICS 311 (3)—Real Analysis I**

*Prerequisite: Mathematics 221 with C grade or better; Mathematics 301 is recommended.* Basic properties of the real numbers, elementary topology of the real line and Euclidean spaces, continuity and differentiability of real-valued functions on euclidean spaces.

*Fall*

**MATHEMATICS 312 (3)—Real Analysis II**

*Prerequisite: Mathematics 311.* Riemann integration, nature and consequences of various types of convergence of sequences and series of functions, some special series, and related topics.

*Winter*

**MATHEMATICS 321 (3)—Abstract Algebra I**

*Prerequisite: Mathematics 222; Mathematics 301 is recommended.* Groups, including normal subgroups, quotient groups, permutation groups. Cauchy's theorem and Sylow's theorems. Rings, including ideals, quotient rings, Euclidean rings, polynomial rings. Fields of quotients of an integral domain.

*Fall*

**MATHEMATICS 322 (3)—Abstract Algebra II**

*Prerequisite: Mathematics 321.* Vector spaces (over arbitrary fields), inner product spaces, modules, linear transformations, matrices, and determinants. Further field theory as time permits.

*Winter*

**MATHEMATICS 332 (3)—Ordinary Differential Equations**

*Prerequisite: Mathematics 221 with C grade or better.* First and second order differential equations, systems of differential equations, and applications. Techniques employed are analytic, qualitative, and numerical.

*Fall*

**MATHEMATICS 333 (3)—Partial Differential Equations**

*Prerequisite: Mathematics 332.* An introduction to the study of boundary value problems and partial differential equations. Topics include modeling heat and wave phenomena, Fourier series, separation of variables, and Bessel functions. Techniques employed are analytic, qualitative, and numerical.

*Winter 2000 and alternate years*

**MATHEMATICS 340 (3)—Classical Geometric**

*Prerequisite: Mathematics 221.* A survey of the world of geometry primarily for prospective high school teachers, featuring exposure to current computer technology in the field, construction of geometric models, and an historical and axiomatic development. Basic concepts are developed through non-Euclidean geometry. *McRae.*

*Offered in the spring term when interest is expressed and departmental resources permit.*

**MATHEMATICS 341 (3)—Geometric Topology**

*Prerequisite: Mathematics 221.* A study of the shape of space focusing on characteristics not detected by geometry alone. Topics are approached pragmatically and include point set topology of Euclidean space, map-coloring problems, knots, the shape of the universe, surfaces, graphs and trees, the fundamental group, the Jordan Curve Theorem, and homology. *McRae.*

*Fall 2000 and alternate years*

**MATHEMATICS 342 (3)—Modern Geometry**

*Prerequisites: Mathematics 221.* A survey of recent developments in geometry, a subject with an array of applications ranging from DNA analysis to creation theories of Nature's fundamental forces. Topics include geodesics, Clairaut's Relation, soap bubbles and minimal surfaces, holonomy, the Gauss-Bonnet Theorem, Foucault's Pendulum, Bjorling's Problem, and the calculus of variations. *McRae.*

*Winter 2001 and alternate years*

**MATHEMATICS 353 (3)—Numerical Analysis**

*Prerequisites: Mathematics 221 and 222 and either Computer Science 110 or permission of the instructor.* Solution of equations, polynomial approximations, interpolation and quadrature, and eigenvalues. Students will be required to write computer programs.

*Spring 2000 and alternate years*

**MATHEMATICS 361 (3)—Graph Theory**

*Prerequisite: Mathematics 122 or 222.* Graphs and digraphs, trees, connectivity, cycles and traversability, and planar graphs. Additional topics selected from colorings, matrices and eigenvalues, and enumeration.

*Spring 2001 and alternate years*

**MATHEMATICS 365 (3)—Number Theory.**

*Prerequisite: Mathematics 301 or permission of the instructor.* Topics include prime numbers, Euclidean algorithm, congruences, Chinese Remainder Theorem, Fermat's Little Theorem, Euler's Theorem, arithmetic functions, Euler's phi function, perfect numbers, quadratic reciprocity law, continued fractions and other topics as time and student interest permit. *Dresden.*

*Winter 2000 and alternate years.*

**Note:** Seminar and research offerings are contingent upon the demonstrated need and aptitude of the student for independent work in mathematics and upon the availability of departmental resources.

**MATHEMATICS 383 (3)—Seminar**

*Prerequisite: Permission of the department.\** Readings and conferences for a student or students on topics agreed upon with the directing staff. May be repeated for degree credit with permission and if the topics are different.

*Fall, Winter, Spring*

**MATHEMATICS 401 (1), 402 (2), 403 (3)—Directed Individual Study**

*Prerequisite: Permission of the department.\** Individual conferences. May be repeated for degree credit with permission and if the topics are different.

**MATHEMATICS 421 (1), 422 (2), 423 (3), 426 (6)—Directed Individual Research**

*Prerequisite: Permission of the department.\** Directed independent work in mathematics, especially for honors candidates. May be repeated for degree credit with permission and if the topics are different.

**MATHEMATICS 493 (3-3)—Honors Thesis**

*Prerequisites: Honors candidacy, senior standing. Fall-Winter*

**MILITARY ENGINEERING**—For qualified students who may request it, a course in fortifications, gunnery, and ballistics will be offered.

\*See department head for permission *prior* to registration.