DEPARTMENT OF MATHEMATICS & STATISTICS

Faculty
Distinguished Teaching Professor
Edward S. Thomas Jr., Ph.D.
University of California, Riverside
Distinguished Service Professor
Timothy L. Lance, Ph.D.
Princeton University
Distinguished Research Professor
Charles A. Micchelli, Ph.D.
Stanford University
Professors Emeritae/i
Louis Brickman, Ph.D.
University of Pennsylvania
Vincent Cowling, Ph.D.
Rice University
Edward D. Davis, Ph.D.
University of Chicago
Nathaniel A. Friedman, Ph.D.
Brown University
Benton N. Jamison, Ph.D.
University of California, Berkeley
Joe W. Jenkins, Ph.D.
University of Illinois
Melvin L. Katz, Ph.D.
University of California, Berkeley
Violet H. Larney, Ph.D.
University of Wisconsin
Thomas H. MacGregor, Ph.D.
University of Pennsylvania
George E. Martin, Ph.D.
University of Michigan
Hajimu Ogawa, Ph.D.
University of California, Berkeley
Professors
Lindsay N. Childs, Ph.D.
Cornell University
Richard Z. Goldstein, Ph.D.
University of Pennsylvania
Boris Korenblum, Sc.D.
Moscow State University
Timothy L. Lance, Ph.D.
Princeton University
Charles Micchelli, Ph.D.
Stanford University
Richard C. O'Neil, Ph.D.
University of Chicago
R. Michael Range, Ph.D.
University of California, Los Angeles
Michael I. Stessin, Ph.D.
Moscow State University
Howard H. Stratton, Ph.D.
University of California, Riverside
Edward C. Turner, Ph.D.
University of California, Los Angeles
Donald R. Wilken, Ph.D.
Tulane University
Kehe Zhu, Ph.D.
State University of New York at Buffalo
Associate Professors Emeritae/i
Guy D. Allaud, Ph.D.
University of Wisconsin
Herbert I. Brown, Ph.D.
Rutgers University
Lloyd L. Lininger, Ph.D.
University of Iowa
Robert Luippold, M.A.
University of Buffalo
Ricardo Nirenberg, Ph.D.
New York University
Erich Nussbaum, Ph.D.
University of Virginia
John T. Therrien, M.A.
University at Albany
Associate Professors
Hara Charalambous, Ph.D.
University of Illinois, Urbana-Champaign
William F. Hammond, Ph.D.
Johns Hopkins University
Martin Victor Hildebrand, Ph.D.
Harvard University
Steven Plotnick, Ph.D.
University of Michigan
Karin B. Reinhold-Larsson, Ph.D.
Ohio State University
Carlos C. Rodriguez, Ph.D.
Columbia University
Malcolm J. Sherman, Ph.D.
University of California, Berkeley
Anupam Srivastav, Ph.D.
University of Illinois, Urbana-Champaign
Mark Steinberger, Ph.D.
University of Chicago
Assistant Professors
Boris Goldfarb, Ph.D.
Cornell University
Cristian Lenart, Ph.D.
University of Cambridge
Jennifer Taback, Ph.D.
University of Chicago
Alexandre Tchernev, Ph.D.
Purdue University
Rongwei Yang, Ph.D.
SUNY Stony Brook
Adjuncts (estimated): 0
Teaching Assistants (estimated): 30

The department provides a broad offering of courses from which each student can make a selection designed to satisfy any of a large variety of objectives. In addition to including the standard courses in pure and applied mathematics, our course offerings are unusually strong in statistics and actuarial mathematics. The department offers two majors: the major in mathematics and the major in actuarial and mathematical sciences. A third major, the major in computer science and applied mathematics, is offered jointly with the computer science department.

Careers

The objective of the department is to serve the needs of students aspiring to careers that require mathematical background: physical, biological, social, and management sciences; statistics, actuarial work, computer science, applied mathematics; secondary school teaching; graduate work; college and university teaching; and research in mathematics. In most cases, training beyond the bachelor's degree is desirable and can often be obtained after the graduate has secured employment. The department also welcomes students who wish to study mathematics as part of a traditional liberal arts education.

Placement and Proficiency Credit

The University awards up to 8 credits and advanced placement in its sequences of calculus courses based on performance on the advanced placement calculus examinations administered by the College Board. Details concerning the decisions on credit and placement are available from the Admissions Office.

Admission

Students may not declare a major in either mathematics or actuarial and mathematical science until they have completed at least one of A Mat 113, 119, or 214 with a grade of *A, B, C,* or *S.* Transfer credits and grades may be used to satisfy the requirement.

The Mathematics Major

Students majoring in mathematics may choose to complete the requirements for either the B.A. or B.S. degree. Under any of the four program-degree combinations, a student may apply for admission to the honors program.

Students considering a major in mathematics or actuarial minor are encouraged to visit the department office (ES-110) for advice. Information is also available at the web site http://math.albany.edu.

Degree Requirements for the Major in Mathematics

General Program B.A.: A minimum of 36 credits from the Department of Mathematics and Statistics in courses numbered above 110, including A Mat 214, 220, and a 3-credit course numbered above 300 in each of these four areas: algebra, analysis, geometry/topology, and probability/statistics.

General Program B.S.:

A minimum of 36 credits from the Department of Mathematics and Statistics in courses numbered above 110, including A Mat 214, 220, and two of the following four options: (1) A Mat 326 and 327, (2) either (a) both A Mat 314 and 315 or (b) any two of 312, 412, 413, or 414, (3) any two of A Mat 342, 441, or 442, (4) any two of A Mat 367, 368, 369, 464, 465, 467, 468. With departmental approval, other 400-level or 500-level courses may be substituted for the courses listed above. In addition, each student must complete: 6 credits in computer science from A Csi 101N, 201N, 203, 204, 205, 310; and a minor in atmospheric science, biology, business, chemistry, computer science, economics, electronics, geology, or physics.

NOTE: The Statistics minor is *not* open to students with a major in mathematics.

General Program
Students, with suitable advisement, can design programs that will best meet their particular interests and career goals. Note, however, that those who plan to do graduate work in any mathematical field—pure or applied—should obtain as strong an undergraduate background as possible in the basic areas of mathematics: algebra, analysis, and geometry/topology. In particular, they should make every effort to include A Mat 413 and 414 (Advanced Calculus) in their programs.

To guide students in their planning, a number of options, some of a general nature and others to meet specific career objectives, are presented here.

1. Liberal Arts (B.A.)
Some professional careers and many jobs require a mathematical background characterized more by breadth than by concentration in any particular area of the mathematical sciences. The purpose of the B.A. program is to assure that the student acquires a broad view of mathematics and statistics. Each B.A. major is required to complete a 3-credit course numbered above 300 in each of these areas: algebra, analysis, geometry/topology, and probability/statistics. The following lists those courses that can be taken to fulfill that requirement:

Algebra: A Mat 326, 326Z, 327, 327Z, 424

Analysis: A Mat 311, 312, 312Z, 314, 409, 412, 412Z, 413, 413Z, 414

Geometry/Topology: A Mat 331, 331Z, 342, 342Z, 432, 432Z, 441, 442

Probability/Statistics: A Mat 367, 367Z, 368, 369, 464, 465, 465Z, 467, 468

Students are urged to explore in greater depth, preferably at the 400 level. Since students will have different goals, it is impossible to provide useful sample programs. Students are encouraged to devise their own plans in consultation with their advisers. However, if a student is to graduate on time, the calculus sequence and linear algebra should be completed during the freshmen and sophomore years.

2. Graduate School Preparation
The department offers excellent opportunities for students who plan to go on to graduate work in mathematics and statistics as well as other areas such as computer science, the natural sciences, and the social and behavioral sciences.

Students whose goal is to obtain a graduate degree in mathematics should include in their programs as many of the following core courses as possible in each of the designated areas:

Algebra: A Mat 326, 327, 424

Analysis: A Mat 413, 414

Geometry/Topology: A Mat 342

Probability/Statistics: A Mat 467, 468

Those hoping to do graduate work should also consider entering the honors program.

3. Applied Mathematics
Although it is common to classify mathematics as either "pure" or "applied," the division is often arbitrary. Some extremely abstract mathematics in recent years has turned out to be useful in areas outside mathematics. Students preparing for a career in applied mathematics would be well advised to acquire as strong a background as possible in the pure mathematical areas of analysis, algebra, and geometry/topology. On the other hand, students concentrating in pure mathematics should have some understanding of how to apply mathematical methods to other disciplines.

Listed here are the mathematical subjects that are more commonly applied to problems in other fields along with the corresponding courses in which methodology or applications are treated.

Applied algebra: A Mat 326, 372

Applied analysis: A Mat 311, 314, 315, 409, 412, 416

Numerical Methods: A Mat 313, 401

Probability/Statistics: A Mat 367, 368, 369, 464, 465

4. Statistics
Statistics is a widely applied branch of mathematics and the demand for statisticians is high. Preparation for a career or for advanced study in statistics should include one of the following two combinations of courses: (1) probability (A Mat 367 or 367Z, 464) and statistics (A Mat 368 or 368Z, 369 or 369Z, 465 or 465Z), or (2) probability (A Mat 367 or 367Z, 464) and statistics (A Mat 467, 468). Sequence (2) is recommended as the more advanced and thorough treatment. A Mat 424 (advanced linear algebra) is highly recommended. Also useful are A Mat 401, 409, 413 or 413Z, and 414. Because computing is a close adjunct to statistics, students are strongly advised to include A Csi 201N, 205, and 310 as a minimal introduction.

Honors Program

The honors program is designed for the talented and committed student of mathematics. Successful completion of the program is excellent preparation for graduate work in mathematics.

Students entering the University with strong mathematical backgrounds should consider taking Honors Calculus, A Mat 118 and 119, in place of the standard Calculus, A Mat 112 and 113.

A student may be admitted formally to the honors program at any time after the sophomore year, and then will be formally advised by the Director of the Honors Program. However, any student who is interested in the program should see the Director of the Honors Program as early as possible for informal advisement.

To be admitted, the applicant must have an academic average in all University courses of at least 3.30, and an academic average in all mathematics courses of at least 3.40. Specific course requirements are: A Mat 413 or 413Z, 414, 424, and 9 additional credits from among A Mat 327 or 327Z, 416, 420, 425, 432 or 432Z, 441, 442, 464, 467, 468, 510A, 513A, 520A, 520B, 540A, 557A, 557B, and independent study (maximum of 3 credits).

To be recommended for graduation with honors, the candidate must write an acceptable honors thesis and also maintain an academic average of at least 3.30 in all University courses and at least 3.40 in all mathematics courses numbered 400 or above.

The Actuarial Major

The actuarial major is designed to prepare students for employment in the actuarial field and as preparation for the preliminary actuarial examinations. Past experience suggests that students who pass even one actuarial examination while in college are likely to receive multiple employment offers. Many students have secured employment in the actuarial field before taking or passing any actuarial examinations. The B.S. program in actuarial science exposes students to virtually all the material on the Course 1, 2, 3, and 4 actuarial examinations.

The B.S. in actuarial science was revised in 2002 to reflect recent revisions (jointly made by the Society of Actuaries and by the Casualty Actuarial Society) of the actuarial examinations. The new actuarial major reflects the new examinations' greater emphasis on applied probability, stochastic modeling, economics, and finance.

Actuarial majors who first enrolled at the University at Albany prior to September 2002 may choose to fulfill the requirements of the catalogue in effect at the time of their first enrollment. Or they may decide to fulfill the requirements of the new program. A third option is to modify the old program by making course substitutions – with the written approval of their adviser.

The actuarial exams are interdisciplinary, testing material from several courses. Some of the courses listed below as preparation for an exam are relevant to only a few questions on that exam. Students may reasonably decide to take an exam before taking all the courses listed as relevant.

Course 1 Exam: Mathematical Foundations of Actuarial Science.

Students need A Mat 112, 113, 214, 367, and 368 (continuous probability) before attempting this exam. A Mat 467 and A Eco 110M will also be useful, but only for a few questions.

Course 2 Exam: Interest Theory, Economics, and Finance.

Topics: Interest Theory (A Mat 301/A Eco 351); Microeconomics (A Eco 110M); Macroeconomics (A Eco 111M); Finance (A Eco 466); Interest Theory/Finance (A Mat 301, A Eco 466); Finance/Economics (A Mat 301, A Eco 466).

B Fin 300 may also be useful for the last two topics.

Course 3 Exam: Actuarial models.

Requires A Mat 301, 403A, 464, and 465 (which in turn requires 368).

Course 4 Exam: Actuarial Modeling.

Requires A Mat 464, 465, plus some self-study on topics not normally covered in these course.

Students are encouraged to adhere to the following schedule for required mathematics course.

Year	Fall	Spring
Fresh.	A 112 or 118	113 or 119
Soph.	214	220 & 367(Z)
Junior	301 & 368(Z)	464
Senior	465 & 467	403A and 469 (optional)

Notes: (1) A 469 is an optional one-credit course that drills students on problems from the Course 1 actuarial exam. (2) Actuarial students are encouraged (but not required) to take the honors versions, A Mat 118 and 119 of A Mat 112 and 113.

Students are advised to take A Eco 110M and 111M as freshmen, and in any event, no later than their sophomore year. By doing so, students will not need to take more than one upper division economics course during any single semester.

Most actuarial students will take A Mat 367Z or 368Z (instead of A Mat 367 or 368) in order to meet the University's upper division writing requirement.

Degree Requirements for the Major in Actuarial and Mathematical Sciences

General Program B.S. A combined major and minor sequence consisting of 63 credits as follows:

36 credits in mathematics: A Mat 112 (or 118), 113 (or 119), 214, 220, 301 (or A Eco 351), 367 (or 367Z), 368 (or 368Z), 403A, 464, 465, and 467.

6 credits: chosen from A Csi 201N, 203, 204, 205, and 310.

6 credits: B Acc 211, B Fin 300.

15 credits in economics: A Eco 110M, 111M, 300, 301, and 466. Note: Actuarial majors automatically fulfill the requirement for a minor in economics (since A Mat 301 is equivalent to A Eco 351).

The requirements for graduation with honors for actuarial majors are included under the heading Honors Program.

Combined B.A./M.A. and B.S./M.A. Programs

The combined B.A./M.A. and B.S./M.A. programs in mathematics provide an opportunity for students of recognized academic ability and educational maturity to fulfill integrated requirements of undergraduate and master's degree programs from the beginning of their junior year. A carefully designed program can permit a student to earn the B.A or B.S. and the M.A. degrees within nine semesters.

The combined programs require a minimum of 138 credits, of which at least 30 must be graduate credits. In qualifying for the B.A. or B.S., students must meet all University and college requirements, including the requirements of the undergraduate major described previously, the minimum 90- or 60-credit liberal arts and sciences requirement, general education requirements, and residence requirements. In qualifying for the M.A., students must meet all University and college requirements as outlined in the Graduate Bulletin, including completion of a minimum of 30 graduate credits and any other conditions such as a research seminar, thesis, comprehensive examination, professional experience, and residence requirements. Up to 12 graduate credits may be applied simultaneously to both the B.A. and M.A. programs or to both the B.S. and M.A. programs.

Students are considered as undergraduates until completion of 120 graduation credits and satisfactory completion of all B.A. or B.S. requirements. Upon meeting B.A. or B.S. requirements, students are automatically considered as graduate students.

Students may apply to the graduate committee of the department for admission to either combined program in mathematics at the beginning of their junior year or after the successful completion of 56 credits, but no later than the accumulation of 100 credits. A cumulative grade point average of 3.2 or higher and three supportive letters of recommendation from faculty are required for consideration.

Combined Mathematics and Master of Business Administration Program:

In this program a student is able to obtain a B.S. degree in mathematics and a M.B.A. degree in a total of five years by taking a coordinated program in mathematics and business administration during the senior year. Application should be made during the second semester of the junior year to the director of the M.B.A. program, School of Business.

Related Program: Interdisciplinary Major in Computer Science and Applied Mathematics:

This major prepares a student to handle mathematically oriented computer applications in engineering and business. Details of the program are listed under Computer Science.

Courses

A Mat 100 Precalculus Mathematics (3)
This course provides a background in those topics that are needed for success in calculus. Topics include graphing techniques, systems of equations, functions, logarithms, and trigonometry. May not be taken for credit by students with credit in any calculus course. Student with credit for the former AMat 103 (College Algebra) may not take A Mat 100 for credit. Prerequisite(s): three years of high school mathematics or permission of department. May not be offered in 2004-2005.

A Mat 101 Algebra and Calculus I (3)
An integrated approach to precalculus and calculus. Elements of algebra and analytic geometry necessary to study calculus of one variable. Functions, limits, continuity, differentiation of algebraic functions, applications of differentiation. May not be taken for credit by students with credit for A Mat 100, 106, 112 or 118. Prerequisite(s): three years of high school mathematics or permission of the department. [MS]

A Mat 102N Mathematics by Visualization (3)
This is a nontraditional course introducing contemporary mathematics primarily by visualization rather than algebra. This will enable the student to learn to see the way mathematicians see. Thus the student will be able to experience creative visualization in mathematics. The content of the course will include fractals; chaos; 4-dimensional geometry; Platonic solids; color maps; Escher tesselations. and impossible figures. A Mat 102F is the writing intensive version of AMat 102N; only one of these may be taken for credit. Prerequisite(s): three years of high school mathematics or permission of instructor.

A Mat 102F Mathematics by Visualization (3)
The course is writing intensive and each student will keep a journal (notebook). A Mat 102F is the writing intensive version of A Mat 102N; only one of these may be taken for credit. Prerequisite(s): three years of high school mathematics or permission of instructor. [WI]

A Mat 105 Finite Mathematics (3)
An introduction to topics of interest to students of the social sciences; sets and logic, partitions and counting, probability, vectors and matrices, theory of games. Prerequisite(s): three years of high school mathematics. [MS]

A Mat 106 Survey of Calculus (3)
An intuitive approach to differentiation and integration of algebraic and transcendental functions, intended only for students who plan to take no more calculus. Does not yield credit toward the major or minor in mathematics. May not be taken for credit by students with credit for A Mat 111, 112 or 118. Prerequisite(s): A Mat 100 or satisfactory performance on the mathematics placement exam. [MS]

A Mat 108 Elementary Statistics (3)
Frequency distributions, measures of central tendency and dispersion, probability and sampling, estimation, testing of hypotheses, linear regression and correlation. Prerequisite(s): three years of high school mathematics. Only one of AMat 108 and B Msi 220 may be taken for credit. [MS]

A Mat 109 Applied Matrix Algebra (3)
Matrix algebra as applied to solving systems of linear equations. Markov chains, linear programming. Emphasizes calculations and applications rather than theory. Prerequisite(s): three years of high school mathematics. [MS]

A Mat 110 Introduction to Maple (2)
A hands-on introduction to the computer algebra system Maple. Basic commands are introduced by way of examples from the areas of algebra, calculus, number theory, graphics, business mathematics, and numerical analysis. Intended for transfer students having no background in Maple. Does not yield credit toward a major in mathematics. Prerequisite(s): AMat 101 or a semester of calculus.

A Mat 111 Algebra and Calculus II (4)
The second semester of an integrated approach to precalculus and calculus; serves as a prerequisite to A Mat 113. Applications of differentiation, the definite integral, antiderivatives, logarithms, trigonometry, exponential functions. Only one of A Mat 111, 112 & 118 may be taken for credit. Prerequisite(s): A Mat 101. [MS]

A Mat 112 Calculus I (4)
Calculus of one variable. Limits, continuity, differentiation of algebraic functions, applications of differentiation, antiderivatives, the definite integral, transcendental functions. Prerequisite(s): A Mat 100 or satisfactory performance on the mathematics placement exam. [MS]

A Mat 113 Calculus II (4)
Techniques of integration, applications of the definite integral, conics, polar coordinates, improper integrals, infinite series. Prerequisite(s): A Mat 111 or 112.

A Mat 118 Honors Calculus I (4)
Honors version of first semester calculus. Same topics as AMat 112, but topics are covered in greater depth. This course is for students with more than average ability and more than average interest in mathematics. Presidential Scholars with a strong interest in mathematics or the physical sciences should consider taking A Mat 118 instead of A Mat 112. A Mat 118 substitutes for AMat 112 toward the prerequisite in any course. Only one of A Mat 112 & 118 may be taken for credit. Prerequisite(s): three years of secondary school mathematics and permission of the instructor. Offered fall semester only. [MS]

A Mat 119 Honors Calculus II (4)
Honors version of second semester calculus. Same topics as A Mat 113, but topics are covered in greater depth. This course is for students with more than average ability and more than average interest in mathematics. Presidential Scholars with a strong interest in mathematics or the physical sciences should consider taking AMat 119 instead of AMat 113. A Mat 119 substitutes for AMat 113 toward the prerequisite in any course. Only one of A Mat 113 & 119 may be taken for credit. Prerequisite(s): A Mat 118, a grade of *A* in A Mat 112, or permission of the instructor. Offered spring semester only.

A Mat 180 Calculus Seminar (1)
Topics in mathematics that involve calculus and either elaborate concepts from calculus or apply calculus to problems in other areas or disciplines. The seminar is intended for freshmen who have just completed one semester of calculus and wish to enrich their understanding of calculus. Prerequisite(s): one semester of calculus and permission of instructor.

A Mat 214 Calculus of Several Variables (4)
Curves and vectors in the plane, geometry of three-dimensional space, vector functions in three-space, partial derivatives, multiple integrals, line and surface integrals. Prerequisite(s): A Mat 113 or 119.

A Mat 220 Linear Algebra (3)
Linear equations, matrices, determinants, finite dimensional vector spaces, linear transformations Euclidean spaces. Prerequisite(s): A Mat 113 or 119.

A Mat 221 (= A Csi 221) Introduction to Discrete Mathematics (3)
Topics chosen from sets, relations, induction, binomial theorem, permutations and combinations, counting, and related topics in discrete mathematics. Only one of A Mat 221 & A Csi 221 may be taken for credit. Prerequisite(s) or corequisite(s): AMat 113 or 119.

A Mat 301 (= A Eco 351) Theory of Interest (3)
The basic measures of interest, annuities, sinking funds, amortization schedules, bonds, and installment loans. Recommended as partial preparation for Actuarial Society's Course 2 and Course 3 exams.

A Mat 308 Topics in Statistical Inference (3)
Various statistical techniques such as chi-square tests, multiple regression and correlation; nonparametric statistics, and the analysis of variance as applied to physical, biological, and social sciences. Prerequisite(s): A Mat 108. Offered spring semester only.

A Mat 311 Ordinary Differential Equations (3)
Linear differential equations, systems of differential equations, series solutions, boundary value problems, existence theorems, applications to the sciences. Prerequisite(s): A Mat 214.

A Mat 312 Basic Analysis (3)
Theoretical aspects of calculus including construction of the real numbers, differentiation and integration of functions in one variable, continuity, convergence, sequences and series of functions. A Mat 312Z is the writing intensive version of AMat 312; only one may be taken for credit. Prerequisite(s): A Mat 214.

A Mat 312Z Basic Analysis (3)
A Mat 312Z is the writing intensive version of A Mat 312; only one may be taken for credit. Prerequisite(s): A Mat 214. [WI]

A Mat 313 Introduction to Numerical Methods (3)
Introduction to the theory and techniques in the numerical solution of mathematical problems. Topics include solutions of linear and nonlinear equations, interpolation, numerical integration, and numerical solution of differential equations. Only one of A Mat 313 or A Mat 401 may be taken for credit. Prerequisite(s): A Mat 220.

A Mat 314 Analysis for Applications I (3)
Introduction to topics in mathematical analysis which traditionally have been applied to the physical sciences, including vector analysis, Fourier series, ordinary differential equations, and the calculus of variations. Prerequisite(s): A Mat 214 and 220. Offered fall semester only.

A Mat 315 Analysis for Applications II (3)
Continuation of A Mat 314. Series solutions of differential equations, partial differential equations, complex variables, and integral transforms. Prerequisite(s): AMat 314. Offered spring semester only.

A Mat 326 Classical Algebra (3)
Elementary number theory. Elementary theory of equations over rational, real, and complex fields. A Mat 326Z is the writing intensive version of A Mat 326; only one may be taken for credit. Prerequisite(s): A Mat 113 or 119.

A Mat 326Z Classical Algebra (3)
A Mat 326Z is the writing intensive version of A Mat 326; only one may be taken for credit. Prerequisite(s): A Mat 113 or 119. [WI]

A Mat 327 Elementary Abstract Algebra (3)
Basic concepts of groups, rings, integral domains, fields. A Mat 327Z is the writing intensive version of A Mat 327; only one may be taken for credit. Prerequisite(s): A Mat 220, and either 326 or 326Z.

A Mat 327Z Elementary Abstract Algebra (3)
A Mat 327Z is the writing intensive version of A Mat 327; only one may be taken for credit. Prerequisite(s): AMat 220, and either 326 or 326Z. [WI]

A Mat 331 Transformation Geometry (3)
Classical theorems of Menelaus, Ceva, Desargues, and Pappus. Isometries, similarities, and affine transformations for Euclidean geometry. A Mat 331Z is the writing intensive version of A Mat 331; only one may be taken for credit. Prerequisite(s): A Mat 220. Offered spring semester only.

A Mat 331Z Transformation Geometry (3)
A Mat 331Z is the writing intensive version of A Mat 331; only one may be taken for credit. Prerequisite(s): A Mat 220. Usually offered spring semester. [WI]

A Mat 342 Elementary Topology (3)
Networks, map coloring problems, surfaces, topological equivalence, the Euler number, the polygonal Jordan curve theorem, homotopy, the index of a transformation, and the Brouwer Fixed Point Theorem. A Mat 342Z is the writing intensive version of AMat 342; only one may be taken for credit. Prerequisite(s): AMat 214 and 220. Offered fall semester only.

A Mat 342Z Elementary Topology (3)
A Mat 342Z is the writing intensive version of A Mat 342; only one may be taken for credit. Prerequisite(s): AMat 214 and 220. Usually offered fall semester. [WI]

A Mat 367 Discrete Probability (3)
Introduction to combinatorial methods and discrete probability models. Binomial, Poisson, hypergeometric, negative binomial distributions. Selected classical problems; e.g., gamblers' ruin. Expected value and variance. Conditional probability. Weak law of large numbers and the central limit theorem. Optional topics; joint

probability mass functions, correlations, Markov chains. Mat 367Z is the writing intensive version of Mat 367; only one may be taken for credit. Prerequisite(s): A Mat 113 or 119 plus 6 credits at the 200 level or above in either mathematics or computer science.

A Mat 367Z Discrete Probability (3)
Writing intensive version of A Mat 367; only one of the two courses may be taken for credit. Prerequisite(s): A Mat 113 or 119 plus 6 credits at the 200 level or above in either mathematics or computer science. Prerequisite(s): A Mat 113 or 119 plus 6 credits at the 200 level or above in either mathematics or computer science. [WI]

A Mat 368 Statistics and Continuous Probability (3)
Continuous random variables, including the normal, exponential, t, and chi-square. Maximum likelihood and unbiased estimators. Confidence intervals and hypothesis tests, mainly for normal means and variances, based on one and two samples. F distribution. Behrens-Fisher problem. May not be taken for credit by students with credit for Mat 362 or Mat 362Z. Mat 368Z is the writing intensive version of Mat 368; only one of Mat 368 and Mat 368Z may be taken for credit. Prerequisite(s): A Mat 214 or A Mat 367 or A Mat 367Z.

A Mat 368Z Statistics and Continuous Probability (3)
Writing intensive version of A Mat 368; only one may be taken for credit. Mat 368Z may not be taken for credit by students with credit for Mat 362 or Mat 362Z. Prerequisite(s): A Mat 214 or A Mat 367 or A Mat 367Z. [WI]

A Mat 369 Statistics and Data Analysis (3)
Continuation of Mat 368. Chi-squared tests for goodness-of-fit and for independence. Introduction to regression (cf. AMat 465). Analysis of variance. Distribution free methods. Robustness, transformations of data. Students will use a statistical computer package (usually Minitab), no prior knowledge of which is assumed. The course will normally be taught in a computer classroom. Normally offered spring semester only. Prerequisite(s): AMat 368 or A Mat 368Z and A Mat 214.

A Mat 372 Linear Programming and Game Theory (3)
Operation and theory of the simplex algorithm for solving linear programming problems, duality theory, and matrix games. AMat 372Z is the writing intensive version of AMat 372; only one may be taken for credit. Prerequisite(s): A Mat 109 or 220. Usually offered spring semester.

A Mat 372Z Linear Programming and Game Theory (3)
A Mat 372Z is the writing intensive version of A Mat 372; only one may be taken for credit. Prerequisite(s): A Mat 109 or 220. Usually offered spring semester. [WI]

A Mat 374 Operations Research (3)
Operations research techniques and applications, linear programming, queuing theory, including birth and death processes, decision theory, network analysis, simulation. Prerequisite(s): A Mat 367 or 367Z or permission of instructor. Offered spring semester only.

A Mat 401 Numerical Analysis (3)
Error analysis, numerical solution of nonlinear equations, interpolation and polynomial approximation, numerical differentiation and integration, direct methods for solving linear systems. Not more than one of A Mat 313 or A Mat 401 may be taken for credit. Prerequisite(s): A Mat 220. Offered fall semester only.

A Mat 403A Life Contingencies (3)
Treatment of the contingencies of a single life including: mortality functions, life annuities, life insurance functions, annual premiums, net level premium reserves, the expense factor, and more complex benefits. Recommended as partial preparation for Course 3 actuarial exam. Prerequisite(s): A Mat 301, 367.

A Mat 403B Life Contingencies (3)
Expansion of Mat 403A with emphasis on two or more lives in combination and on multiple causes of decrement. Topics include population theory, multi-life statuses, multi-life functions, reversionary annuities, multiple-decrement functions, primary and secondary decrements, and applications of multiple-decrement functions. Recommended as partial preparation for Course 3 actuarial exam. Prerequisite(s): A Mat 403A.

A Mat 409 Vector Analysis (3)
Classical vector analysis presented heuristically and in physical terms. Topics include the integral theorems of Gauss, Green, and Stokes. Prerequisite(s): A Mat 214. Offered spring semester only.

A Mat 412 Complex Variables for Applications (3)
The elementary functions, differentiation, conformal transformations, power series, integral theorems, Taylor's theorems, Taylor's and Laurent's expansions, applications of residues. AMat 412Z is the writing intensive version of AMat 412; only one may be taken for credit. Prerequisite(s): A Mat 214. Offered fall semester only.

A Mat 412Z Complex Variables for Applications (3)
A Mat 412Z is the writing intensive version of A Mat 412; only one may be taken for credit. Prerequisite(s): A Mat 214. Usually offered fall semester. [WI]

A Mat 413/413Z and 414 Advanced Calculus (3, 3)
A rigorous presentation of the traditional topics in the calculus of several variables and their applications. Topics include the implicit function theorem, Taylor's theorem, Lagrange multipliers, Stieltjes integral, Stokes' theorem, infinite series, Fourier series, special functions, Laplace transforms. A Mat 413Z is the writing intensive version of AMat 413, only one may be taken for credit. Prerequisite(s): A Mat 312 or 312Z; AMat 413 or 413Z is a prerequisite for 414. [WI]

A Mat 416 Partial Differential Equations (3)
The partial differential equations of classical mathematical physics. Separation of variables, eigenvalue problems, Fourier series and other orthogonal expansions. First order equations, Green's functions, Sturm-Liouville theory, and other topics as time permits. Prerequisite(s): a course in Ordinary Differential Equations. Offered fall semester only.

A Mat 420 Abstract Algebra (3)
Topics in group theory, especially finite group theory, algebraic field extensions, and Galois theory. Prerequisite(s): A Mat 327 or 327Z.

A Mat 424 Advanced Linear Algebra (3)
Duality, quadratic forms, inner product spaces, and similarity theory of linear transformations. Prerequisite(s): A Mat 220. Offered fall semester only.

A Mat 425 Number Theory (3)
Divisibility, congruencies, quadratic reciprocity, Diophantine equations, sums of squares, cubes, continued fractions, algebraic integers. Prerequisite(s): A Mat 326 or 326Z. Offered spring semester only.

A Mat 432 Foundations of Geometry (3)
Axiomatic development of absolute geometry, theory of parallels, introduction to non-Euclidean geometry, isometries of the Bolyai-Lobachevsky plane. A Mat 432Z is the writing intensive version of AMat 432; only one may be taken for credit. Prerequisite(s): A Mat 220. Offered fall semester only.

A Mat 432Z Foundations of Geometry (3)
A Mat 432Z is the writing intensive version of A Mat 432; only one may be taken for credit. Prerequisite(s): AMat 220. Normally only the writing intensive version of this course is offered. [WI]

A Mat 441 Introduction to Differential Geometry (3)
Differential geometry of curves and surfaces in Euclidean space, frames, isometries, geodesics, curvature, and the Gauss-Bonnet theorem. Prerequisite(s): A Mat 214 and 220. Offered fall semester only.

A Mat 442 Introduction to Algebraic Topology (3)
Two-dimensional manifolds, the fundamental group and Van Kampen's theorem, covering spaces, graphs, and applications to group theory. Prerequisite(s): A Mat 214 and 220.

A Mat 452 History of Mathematics (3)
History of the development of mathematics, emphasizing the contributions of outstanding persons and civilizations. AMat 452Z is the writing intensive version of AMat 452; only one may be taken for credit. Prerequisite(s): A Mat 214, 326 or 326Z, and either 331 or 331Z or 432 or 432Z. Normally only the writing intensive version of this course is offered.

A Mat 452Z History of Mathematics (3)
A Mat 452Z is the writing intensive version of A Mat 452; only one may be taken for credit. Prerequisite(s): AMat 214, 326 or 326Z, and either 331 or 331Z or 432 or 432Z. Offered fall semester only. [WI]

A Mat 464 Applied Stochastic Processes (3)
An overview of various stochastic processes found in practice with particular emphasis on Markov chains. Introduction to queuing theory. Particular attention given to estimation. Examples of applications. Recommended as partial preparation for Course 3 actuarial exam. Prerequisite(s): AMat 367 or 367Z or 467. Offered spring semester only.

A Mat 465 Applied Statistics (3)
A second or third course in statistics. Central theme is forecasting; i.e., simple and multiple regression and time series. Recommended as partial preparation for Course 3 and Course 4 actuarial exams. Offered in fall semester only.

A Mat 465Z Applied Statistics (3)
Writing intensive version of AMat 465; only one of the two courses may be taken for credit. Prerequisite(s): A Mat 220 and either A Mat 368 or A Mat 468. [WI]

A Mat 467 Continuous Probability and Mathematical Statistics (3)
One and two dimensional calculus applied to probability. Continuous random variables in one and two dimensions, including the normal, bivariate normal, exponential, gamma (including chi-square) and beta. Density functions of transformations of random variables. Moment generating functions, weak law of large numbers, central limit theorems, convergence of random variables. Maximum likelihood and unbiased estimators. Confidence intervals, mainly for normal means and variances. Recommended as partial preparation for Course 1 actuarial exam. Prerequisite(s): AMat 367 or Mat 367Z, Mat 214 and Mat 220. Offered fall semester only.

A Mat 468 Mathematical Statistics (3)
Neyman-Pearson theory (hypothesis testing), type I and II errors, power functions, generalized likelihood ratio tests. Two-sample confidence intervals and hypothesis tests. Sampling distributions, including the t, chi-square and F, all rigorously defined. Sufficient statistics, Fisher information, minimum variance estimators. Introduction to regression. Prerequisite: A Mat 467. Offered spring semester only.

A Mat 469 Actuarial Probability and Statistics (1)
Drill in problem solving for Course 1 exam of The Society of Actuaries. Prerequisite(s): A Mat 467. Offered spring semester only. *S/U Graded.*

A Mat 481A Senior Seminar (3)
Study of topics in mathematics, chosen at the discretion of the instructor. Prerequisite(s): permission of instructor.

A Mat 481B Senior Seminar (3)
Study of topics in mathematics, chosen at the discretion of the instructor. Prerequisite(s): permission of instructor. [OD, WI]

A Mat 497 Independent Study in Mathematics (1–3)
Individual, independent study of selected topics not covered in a regularly scheduled course. Open only to majors in mathematics. May be repeated for credit. Prerequisite(s): junior or senior class standing, and permission of instructor with whom student wishes to study.

A Mat 499Z Undergraduate Thesis (3)
Individual, independent study leading to an undergraduate thesis under the direction of faculty chosen by the student. The thesis may be used to fulfill the thesis requirement in the honors program with the approval of the department. Prerequisite(s): permission of instructor. [WI]