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THE UNIVERSITY OF TEXAS AT AUSTIN

The Undergraduate Catalog

1994-1996

Dep't. of
Mathematics

The University of Texas at Austin

Dep't of Mathematics U Texas 1994-96

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GRADUATION

The University holds commencement exercises at the end of the spring semester. Each college and school also holds a commencement ceremony in the spring, and many hold graduation exercises in the fall. Graduating students are encouraged to participate. Those who graduate in the summer or fall may attend Commencement the following spring. Each student should consult his or her dean early in the semester of graduation for information about commencement activities and procedures.

No degree will be conferred except on publicly announced dates.

GENERAL REQUIREMENTS

To receive an undergraduate degree from the University of Texas at Austin a student must fulfill all requirements for the degree as set forth in a catalog under which he or she is eligible to graduate and any special requirements of the college or school and department offering the degree, as well as the following minimum general requirements:

1. The student must have a grade point average of at least 2.00 on all courses undertaken at the University (including credit by examination, correspondence, and extension) for which a grade or symbol other than *Q*, *W*, *X*, or *CR* is recorded. Additional requirements imposed by a college or school, if any, are given in the college's chapter of this catalog.
2. A student must fulfill the following requirements regarding coursework taken in residence. Residence credit includes only courses taken at the University of Texas at Austin; it does not include credit by examination or courses taken by extension or correspondence. Additional requirements imposed by a college or school, if any, are given in the college's chapter of this catalog.
   a. The student must complete in residence at least two long-session semesters, or an equivalent period, and at least thirty semester hours of coursework counted toward the degree.
   b. Twenty-four of the last thirty semester hours counted toward the degree must be completed in residence. However, among components of the University of Texas System, a student may transfer additional coursework to the degree-granting institution with the approval of the appropriate dean. A student seeking such a transfer must file a written petition at the degree-granting institution with his or her academic dean, who may approve the transfer of additional credit.
   c. At least six semester hours of advanced coursework in the major must be completed in residence.
3. Coursework in American government and American history (the legislative requirement):
   a. Each student must complete six semester hours of coursework in American government, including Texas government. Because these courses are not electives, they may not be taken on the pass/fail basis at the University. No more than three hours of credit by examination in government may be counted toward the requirement.

      The six hours of coursework used to fulfill the requirement must cover both the United States and the Texas constitutions. Texas colleges and universities differ in the way they include this material in the courses they offer. As a result, some combinations of government courses taken at different institutions do not fulfill the requirement, even though they provide six hours of credit. The following combinations of coursework, some of which include transferred work, fulfill the government requirement at the University:

      - Government 310L and 312L
      - Government 310L and three hours of transfer credit in United States government (entered into the student's University record as "GOV 3 US")
      - Government 310L and three hours of transfer credit in Texas government ("GOV 3 TX")
      - Three hours of transfer credit in United States government ("GOV 3 US") and three hours of transfer credit in Texas government ("GOV 3 TX")

      A number of topics of Government 312L are offered each semester. Because some of these topics deal with state government and some deal with federal government, credit for Government 312L in combination with transfer credit in United States government ("GOV 3 US") or in Texas government ("GOV 3 TX") may fail to fulfill the legislative requirement. If a student has such a combination of credit, his or her dean's office will evaluate the coursework to determine whether both the state and the federal components of the requirement have been met.

      Students in the College of Engineering may count three hours of ROTC coursework (air force science, military science, or naval science) toward fulfillment of this requirement. Students in the College of Pharmacy may substitute three hours of ROTC coursework for Government 312L. In both colleges, ROTC coursework may be counted toward the government requirement only by students who complete the ROTC program and receive a commission.

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b. Each student must complete six semester hours of coursework in American history. Up to three hours in Texas history may be counted toward this requirement. Because these courses are not electives, they may not be taken on the pass/fail basis at the University. No more than three hours of credit by examination in history may be counted toward the requirement.

4. A candidate for a degree must be registered at the University either in residence or in absentia the semester or summer session the degree is to be awarded and must apply to the dean for the degree no later than the date specified in the official academic calendar. To receive a degree from the College of Business Administration, the College of Communication, the College of Education, or the College of Engineering, the student must be registered in the college.

MULTIPLE DEGREES

No second bachelor's degree will be conferred until the candidate has completed at least twenty-four semester hours in addition to those counted toward the bachelor's degree that requires the higher number of hours of credit. The Colleges of Business Administration, Education, and Engineering and the School of Nursing require the student to complete at least twenty-four hours in addition to those counted toward the first bachelor's degree. A student may not receive the same degree twice.

GRADUATION UNDER A PARTICULAR CATALOG

To receive a bachelor's degree, a student must fulfill all the degree requirements in a catalog under which he or she is eligible to graduate; the choices open to students in each college and school are explained below. The student must complete degree requirements within a specified time period; if he or she leaves school to enter military service during a national emergency, the time required to meet the military obligation is excluded from the time allowed for completion of the degree.

A student who transfers to the University from an accredited public Texas junior college has the same catalog choices that he or she would have had if the dates of attendance at the University had been same as the dates of attendance at the junior college.

Since each college and school must retain the flexibility to improve its curriculum, course offerings may be changed during the student's education. If a course required under a previous catalog is no longer offered, students eligible to graduate according to that catalog should consult the dean of the college to learn whether another course may be used to fulfill the requirement.

Catalog choices. The catalog choices open to engineering, nursing, and pharmacy students are described below. In all other divisions, a student may graduate under the catalog covering any academic year in which he or she was enrolled at the University. Whichever catalog the student chooses, all degree requirements must be completed within six years (seven years for the Bachelor of Architecture) of the end of the two-year period covered by that catalog. For example, a student who chooses to graduate according to the requirements in the 1994–1996 catalog must do so by the end of the summer session, 2002 (2003 for the Bachelor of Architecture).[7]

College of Engineering. An engineering student may graduate under the catalog covering any academic year in which he or she was enrolled in the college. Whichever catalog the student chooses, all degree requirements must be completed within six years of the end of the two-year period covered by that catalog. For example, a student who chooses to graduate according to the requirements in the 1994–1996 catalog must do so by the end of the summer session, 2002.

Course substitutions in the degree program are permitted only with the approval of the departmental undergraduate adviser and the dean.

School of Nursing. A nursing student may graduate under the catalog covering any academic year in which he or she was enrolled in the professional nursing sequence. Whichever catalog the student chooses, all degree requirements must be completed within four years of his or her enrollment in the professional sequence. For example, a student who enters the professional sequence in the fall semester, 1998–1999, must complete all degree requirements by the end of the summer session, 2002, to be eligible to graduate under the 1994–1996 catalog.

College of Pharmacy. A pharmacy student may graduate under the catalog in effect immediately preceding the student's admission to the college or the catalog covering any academic year in which he or she was enrolled in the professional curriculum in the college. Whichever catalog the student chooses, all degree requirements must be completed within six years of the end of the two-year period covered by that catalog. For example, a student who chooses to graduate according to the requirements in the 1994–1996 catalog must do so by the end of the summer session, 2002.

7. This policy applies to students who enter the College of Business Administration in the fall semester 1994–1995 or later. The policy printed in *The Undergraduate Catalog, 1992–1994* applies to students registered in the college before fall 1994–1995.

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5. Chemistry 313N; six semester hours of biological science; and three additional semester hours of chemistry, physics, or physical science.
6. Mechanical Engineering 208G.
7. Speech 305 or 319 and three semester hours of advertising, legal environment of business, or marketing.
8. Twelve semester hours in one of the following sequences: (a) architecture sequence: Architecture 310K, 310L, 311K, 311L; (b) art sequence: Studio Art 301K or 320K (Topic: *Basic Drawing Skills*), 302K, 302L, and one of the following: Studio Art 310K, 311K, 312G, 313K, 314K, 317K, 320K (Topic: *Textile Surface Design*). In addition, three semester hours of upper-division coursework, approved by the adviser, in art history and/or architectural history.
9. Fifty-one semester hours in the Department of Human Ecology, consisting of Interior Design 201R, 101S, 202R, 102S, 213R, 313S, 214R, 314S, 335F, 336F, 236R, 136S, 237R, 137S, 245R, 345S, 346R, 346S, 357S, 358S, Textiles and Apparel 205 and 105L, and one of the following courses: Child Development 347, Home Economics 322, 355 (Topic: *Foundation of Home Economics*), and 361. Eighteen semester hours of this requirement must be completed in residence at the University.
10. Thirty-six semester hours of upper-division coursework, of which at least eighteen must be within and at least twelve must be outside the Department of Human Ecology.
11. Enough additional coursework to make a total of 126 semester hours.

(probably not math)

SPECIAL REQUIREMENTS

The student must fulfill the University-wide graduation requirements given on pages 16–17 and the college requirements given on page 329. He or she must also make a grade of at least *C* in each course used to fulfill requirements 6, 8, and 9 of the prescribed work above. A University grade point average of at least 2.50 is a prerequisite for Interior Design 213R, 313S, 214R, 314S, 236R, 136S, 237R, 137S, 245R, 345S, 346R, 346S, 357S, and 358S.

Portfolio requirement. All students must obtain written authorization from the undergraduate adviser in interior design to enroll in Interior Design 245R and 345S. The student obtains authorization by submitting to the portfolio review committee a satisfactory portfolio of selected work he or she has completed in previous courses, such as Interior Design 201R, 101S, 202R, 102S, 213R, 313S, Mechanical Engineering 208G, and art or architecture sequence courses. In addition, students may include any supplementary material that they feel will provide useful information to the reviewing committee in evaluating their progress. Portfolios may be submitted for review during the first week of the fall semester and the first week of the spring semester. The reviewing committee, at its discretion, determines that the student will advance with distinction; advance; advance and retake certain courses with specified faculty members in order to eliminate weaknesses; or complete additional coursework and undergo another review.

ORDER AND CHOICE OF WORK

The student must consult the faculty adviser each semester regarding order and choice of work.

BACHELOR OF SCIENCE IN MATHEMATICS

As an alternative to the Bachelor of Arts degree, the Bachelor of Science in Mathematics is designed with a twofold purpose: to offer students a more extensive scientific program that may better prepare them for graduate study or employment, and to recognize students who choose to pursue a more demanding program. Students are given the opportunity to develop greater breadth and depth in their mathematical programs as well as to combine mathematics with a concentration in another scientific discipline.

To accomplish this, both the minimum number of semester hours of mathematics required and the maximum allowed are increased by nine hours. Specialization in one additional scientific area is encouraged, and the foreign language requirement, while shortened by one semester, must be fulfilled by study of one of the scientific languages, French, German, and Russian. The total number of hours required is increased from 120 to 126.

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PRESCRIBED WORK

1. English 306 and 316K. In addition, in taking courses to fulfill other degree requirements the student must complete two courses certified as having a substantial writing component; one of these courses must be upper-division. If the writing requirement is not fulfilled by courses specified for the degree, the student must fulfill it either with electives or with coursework taken in addition to the number of hours required for the degree. Courses with a substantial writing component are identified in the *Course Schedule*.
2. French, German, or Russian 506 and 507 and a three-semester-hour course in the same language for which 507 is a prerequisite, or as much of this coursework as required by the student's score on the appropriate language placement test. For students who enter the University with fewer than two high school units in a single foreign language, the first two semesters in a language may not be counted toward the total number of hours required for the degree.
3. Six semester hours of American history.
4. Six semester hours of American government, including Texas government.

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5. Three semester hours in anthropology, economics, geography, linguistics, psychology, or sociology.
6. Eight semester hours chosen from one of the following areas: astronomy, biology, botany, chemistry, geology, microbiology and biology, physics, and zoology and biology.
7. Computer Sciences 304P or the equivalent.
8. Six semester hours in architecture, classics (including classical civilization, Greek, Latin), fine arts (including art history, design, drama, ensemble, fine arts, instruments, music, studio art, visual art studies), philosophy, or programs of special concentration. Three of these six semester hours must be taken in architecture, classics, fine arts, or philosophy (excluding courses in logic).
9. No fewer than forty-one but no more than forty-five semester hours of mathematics, including Mathematics 408C and 408D, or the equivalent, 311, either 325K or 328K, 427K, 362K, 365C, 373K, and at least nine additional semester hours of upper-division mathematics. A grade of at least *C* is required in all mathematics courses. Mathematics 301, 304E, 305G, and equivalent courses may not be counted toward the total number of hours required for the degree. Students who enter the University with fewer than three units of high school mathematics at the level of Algebra I or higher must take Mathematics 301 or 304E without degree credit to remove their deficiency.
10. Forty-two semester hours of upper-division coursework. At least six hours of upper-division coursework must be outside both mathematics and the subject areas listed in requirement 6.
11. Eighteen semester hours in mathematics must be completed in residence at the University.
12. Enough additional coursework to make a total of 126 semester hours.

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SPECIAL REQUIREMENTS

The student must fulfill the University-wide graduation requirements given on pages 16–17 and the college requirements given on page 329. He or she must also make a grade of at least *C* in each semester of each course in mathematics taken at the University and used to fulfill requirement 9 of the prescribed work above.

ORDER AND CHOICE OF WORK

The following is recommended as a typical program; it assumes that the student has the prerequisites for Mathematics 408C. Certain approved courses offered in the College of Business Administration may be substituted for economics. The science requirement may be fulfilled by approved courses in the College of Engineering. Additional courses that may be of interest to mathematics majors are offered by various departments in these colleges.

First year: Mathematics 408C and 408D; English 306; courses 506 and 507 in French, German, or Russian; three semester hours to fulfill requirement 5 of the prescribed work above; three semester hours to be counted toward requirement 8 of the prescribed work above; six semester hours of electives.

Second year: Mathematics 311, either 325K or 328K, and 427K; English 316K; three semester hours in French, German, or Russian for which course 507 is prerequisite; six semester hours of American history; Computer Sciences 304P; six semester hours of electives.

Third year: Mathematics 362K, 365C, and six additional semester hours of mathematics, including at least three hours of upper-division coursework; eight semester hours of science to fulfill requirement 6 of the prescribed work above; six semester hours of American government; a three-semester-hour elective to fulfill requirement 1 of the prescribed work above; three semester hours of upper-division electives.

Fourth year: Mathematics 373K and nine additional semester hours of mathematics, including at least six hours of upper-division coursework; three semester hours to be counted toward requirement 8 of the prescribed work above; six semester hours of upper-division nonscience electives; six additional semester hours of upper-division electives; five additional semester hours of electives.

BACHELOR OF SCIENCE IN MEDICAL TECHNOLOGY

This program is designed to enable the student preparing for a career in medical technology both to earn the bachelor's degree in four years and to complete the technical training required for certification by the Registry of Medical Technologists. The purpose of this degree program is to meet the increasing demands of the medical sciences for technologists with a higher level of science background and a greater degree of technical competence than can be attained by satisfying only the minimum registry requirements.

PRESCRIBED WORK

1. English 306 and 316K. In addition, in taking courses to fulfill other degree requirements the student must complete two courses certified as having a substantial writing component; one of these courses must be upper-division. If the writing requirement is not fulfilled by courses specified for the degree, the student must fulfill it either with electives or with coursework taken in addition to the number of hours required for the degree. Courses with a substantial writing component are identified in the *Course Schedule*.
2. Courses 506 and 507 (or the equivalent) in a single foreign language, or as much of this coursework as required by the student's score on the appropriate language placement test. For

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354S. Comparative Physiology of Marine Animals. May count as zoology. Marine Science 354S and 384S may not both be counted. Physiological adaptations of vertebrates and invertebrates to life in estuarine and marine environments. *Prerequisite:* Upper-division standing in biological science, one semester of general or comparative physiology (Zoology 316K, 361K, 365L, or 365N), and consent of instructor. Three lecture hours and six to eight laboratory hours a week for one semester.

354T. Biological Oceanography. Marine Science 354T and 384T may not both be counted. Consideration of marine organisms and the ways they interact with physical, chemical, and biological processes in the oceanic environment. Emphasis is on experimental techniques and understanding of the factors that control primary and secondary productivity in the oceans. *Prerequisite:* Biology 302 and either 303 or 304, and consent of instructor.

367K. Oceanography: Human Exploration and Exploitation of the Sea. Same as Geology 367K. May not be counted toward a degree in geological sciences. Review of major oceanographic expeditions; exploration of continental shelves and deep ocean; exploration and exploitation of marine resources, including energy, hard minerals, and food. Discussion of environmental concerns, the Exclusive Economic Zone, coastal development, marine pollution, dumping at sea, cable, pipelines, and seafloor utilization. *Prerequisite:* Nine semester hours of science, including Chemistry 302 with a grade of at least *C* and one of the following with a grade of at least *C*: Biology 303, 304, Geology 401, 303, 312K; and upper-division standing or consent of instructor.

DEPARTMENT OF MATHEMATICS

The Department of Mathematics offers a wide variety of courses to serve the needs of mathematics majors planning different careers and to serve the mathematical needs of students in other fields. Students majoring in mathematics should obtain a current copy of *Information for Math Majors* from the department and should consult a departmental adviser for help planning a program of study.

A concentration in actuarial studies is available to students majoring in mathematics or another area. Typical programs include three to seven hours of actuarial foundations, twenty-eight hours of mathematics, and twelve hours of coursework in the College of Business Administration. Detailed information is available from the director of actuarial studies in the Department of Mathematics.

PREREQUISITES

Most entry-level courses in the Department of Mathematics have as a prerequisite a specific minimum score on the College Board Achievement Test in Mathematics Level I; therefore, many students planning to take a course in the department must first have taken the Mathematics Level I Test. See the current *Course Schedule* or consult the department for the minimum score required.

Important advice on which entry-level mathematics course to take, based on the student's score on the Mathematics Level I Test, is available from the Measurement and Evaluation Center and the Department of Mathematics.

In courses that have a minimum test score or course grade as a prerequisite, students will be dropped from the course on the twelfth class day if University records do not show that they have met the prerequisite. Students for whom the Mathematics Level I Test score is required must be prepared to present proof of their test score after classes have begun. Students who took the test at a College Board test center must use the official College Board score report as proof; students without the score report can obtain alternate proof from the Measurement and Evaluation Center. Students who took the test at the University must use the test-result slip as the written proof; information about where to obtain the test-result slip is given at the time of the test.

Students who wish to enroll in conference courses in the Department of Mathematics must submit consent of instructor forms to the undergraduate adviser before registering. Forms are available in the department office.

Unless otherwise stated in the description below, each class meets for three lecture hours a week for one semester.

ACTUARIAL FOUNDATIONS: ACF

Lower-Division Courses

309. Theory of Interest. Actuarial Foundations 309 and Actuarial Science 361 may not both be counted. Measurement of interest, present value, accumulated value, annuities, amortization, sinking funds, bonds, and securities. Includes syllabus for Society of Actuaries Exam 140. *Prerequisite:* Credit or registration for Mathematics 408D (or credit for 808B).

110, 210, 310, 410. Conference Course. May be repeated for credit when the topics vary. Some sections are offered on the pass/fail basis only; these are identified in the *Course Schedule*. Supervised study of selected topics by individual arrangement with department and instructor. *Prerequisite:* Written consent of instructor. Conference course.

112K. Actuarial Laboratory on Calculus and Linear Algebra. Actuarial Foundations 112K and Actuarial Science 323 may not both be counted. Problems and supplementary instruction in calculus, matrix algebra, and linear algebra, especially as required for the Society of Actuaries and Casualty Actuarial Society Exam 100. *Prerequisite:* Mathematics 408D (or 808B) with a grade of at least *C*, and credit or registration for Mathematics 311 or 340L. Three laboratory hours a week for one semester.

112L. Actuarial Laboratory on Interest Theory. Problems and supplementary instruction in interest theory, especially as required for the Society of Actuaries Exam 140. *Prerequisite:* Actuarial Foundations 309 with a grade of at least *C* and consent of the director of the concentration in actuarial studies. Three laboratory hours a week for one semester.

112M. Actuarial Laboratory on Probability and Statistics. Actuarial Foundations 112M and Actuarial Science 324 may not both be counted. Problems and supplementary instruction in probability and statistics, especially as required for the Society of Actuaries and Casualty Actuarial Society Exam 110. *Prerequisite:* Mathematics 362K, credit or registration for Mathematics 378K, and consent of the director of the concentration in actuarial studies. Three laboratory hours a week for one semester.

112N. Actuarial Laboratory on Life Contingencies. Actuarial Foundations 112N and Actuarial Science 371 may not both be counted. Problems and supplementary instruction in actuarial mathematics and contingency theory, especially as required for the Society of Actuaries Exam 150. *Prerequisite:* Credit or registration for Mathematics 469L, and consent of the director of the concentration in actuarial studies. Three laboratory hours a week for one semester.

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this course listed again on p 387 with different pre-req.

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Upper-Division Courses

329W. Cooperative Actuarial Studies. This course covers the work period of actuarial studies students in the Cooperative Education program, which provides supervised work experience by arrangement with the employer and the supervising instructor. The student must repeat the course each work period and must take it twice to receive credit toward a degree; at least one of these registrations must be during a long-session semester. No more than three semester hours may be counted toward the major requirement for any degree; no more than six semester hours may be counted toward any degree. The student's first registration must be on the pass/fail basis. *Prerequisite:* Application to become a member of the Cooperative Actuarial Studies Program; Actuarial Foundations 309 or Mathematics 362K, Computer Sciences 304P, Mathematics 408D (or 808B), and Mathematics 311 or 340L, or equivalent coursework; credit for Society of Actuaries and Casualty Actuarial Society Exam 100; and consent of the director of the concentration in actuarial studies. Forty laboratory hours a week for one semester.

MATHEMATICS: M

Lower-Division Courses

301. College Algebra. May not be counted toward the major requirement for the Bachelor of Arts, Plan I, degree with a major in mathematics or toward the Bachelor of Science in Mathematics degree. In some colleges of the University, Mathematics 301 may not be counted toward the Area C requirement or toward the total number of hours required for a degree. Credit for Mathematics 301 may not be earned after a student has received credit for any calculus course with a grade of *C* or better. Topics include a brief review of elementary algebra; linear, quadratic, exponential, and logarithmic functions; polynomials; systems of linear equations; applications. Usually offered only in the summer session.

302. Introduction to Mathematics. Only one of the following may be counted: Mathematics 302, 303D, 303F. A student may not earn credit for Mathematics 302 after having received credit for any calculus course. May not be counted toward the major requirement for the Bachelor of Arts, Plan I, degree with a major in mathematics or toward the Bachelor of Science in Mathematics degree. May be used to fulfill the Area C requirement for the Bachelor of Arts, Plan I, degree or the mathematics requirement for the Bachelor of Arts, Plan II, degree. Intended primarily for general liberal arts students seeking knowledge of the role and nature of mathematics as well as training in mathematical thinking and problem solving. Topics include number theory, probability, and statistics; additional topics are chosen by the instructor. *Prerequisite:* Three units of high school mathematics at the level of Algebra I or higher.

303D. Applicable Mathematics. Only one of the following may be counted: Mathematics 302, 303D, 303F. May not be counted toward the major requirement for the Bachelor of Arts, Plan I, degree with a major in mathematics or toward the Bachelor of Science in Mathematics degree. A student may not earn credit for Mathematics 303D after having received credit for Mathematics 305G or any calculus course. An entry-level course for the nontechnical student, dealing with some of the techniques that allow mathematics to be applied to a variety of problems. Topics include linear and quadratic equations, systems of linear equations, matrices, probability, statistics, exponential and logarithmic functions, and mathematics of finance. *Prerequisite:* A satisfactory score on the College Board Achievement Test in Mathematics Level I.

403K. Calculus I for Business and Economics. May not be counted by students with credit for Mathematics 408C (or 808A), 308K (or 608EA), or 308L (or 608EB). May not be counted toward the major requirement for the Bachelor of Arts, Plan I, degree with a major in mathematics or toward the Bachelor of Science in Mathematics degree. Differential and integral calculus of algebraic, logarithmic, and exponential functions with applications; introduction to mathematics of finance. *Prerequisite:* A satisfactory score on the College Board Achievement Test in Mathematics Level I, or Mathematics 301 with a grade of at least *B*, or Mathematics 304E or 305G with a grade of at least *C*. Three lecture hours and two discussion sessions a week for one semester.

403L. Calculus II for Business and Economics. Only one of the following may be counted: Mathematics 403L, 408D (or 808B), 308M (or 318K). May not be counted toward the major requirement for the Bachelor of Arts, Plan I, degree with a major in mathematics or toward the Bachelor of Science in Mathematics degree. Differential and integral calculus of functions of several variables with applications, infinite series, improper integrals; introductions to probability, differential equations, matrices, systems of linear equations, and linear programming. *Prerequisite:* Mathematics 403K, 408C (or 808A), or 308L (or 608EB) with a grade of at least *C*. Three lecture hours and two discussion sessions a week for one semester.

305G. Elementary Functions and Coordinate Geometry. Mathematics 304E and 305G may not both be counted. Only one of the following may be counted toward the major requirement for the Bachelor of Arts, Plan I, degree with a major in mathematics or toward the Bachelor of Science in Mathematics degree: Mathematics 304E, 305E, 305G. Credit for Mathematics 305G may not be earned after a student has received credit for any calculus course with a grade of *C* or better. Study of elementary functions, their graphs and applications, including polynomial, rational, and algebraic functions, exponential, logarithmic, and trigonometric functions. *Prerequisite:* A satisfactory score on the College Board Achievement Test in Mathematics Level I, or Mathematics 301 with a grade of at least *B*.

408C. Differential and Integral Calculus. May not be counted by students with credit for Mathematics 403K, 808A, 308K (or 608EA), or 308L (or 608EB). Introduction to the theory and applications of differential and integral calculus of functions of one variable; topics include limits, continuity, differentiation, the mean value theorem and its applications, integration, the fundamental theorem of calculus, and transcendental functions. Certain sections are designated as honors sections for well-prepared students of mathematics and mathematically oriented sciences who wish to investigate more thoroughly the foundations of calculus. *Prerequisite:* Four years of high school mathematics and a satisfactory score on the College Board Achievement Test in Mathematics Level I, or Mathematics 304E or 305G with a grade of at least *C*. Three lecture hours and two discussion hours a week for one semester.

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408D. Sequences, Series, and Multivariable Calculus. Only one of the following may be counted: Mathematics 403L, 408D (or 808B), 308M (or 318K). Introduction to the theory and applications of sequences and infinite series, including those involving functions of one variable, and to the theory and applications of differential and integral calculus of functions of several variables; topics include parametric equations, sequences, infinite series, power series, vectors, vector calculus, functions of several variables, partial derivatives, gradients, and multiple integrals. Certain sections are designated as honors sections for well-prepared students of mathematics and mathematically oriented sciences who wish to investigate more thoroughly the foundations of calculus. *Prerequisite:* Mathematics 408C (or 808A) or the equivalent with a grade of at least *C*. Three lecture hours and two discussion hours a week for one semester.

308K. Differential Calculus. This course is available for transfer credit but is not taught in residence. Only one of the following may be counted: Mathematics 403K, 408C (or 808A), 308K (or 608EA). Introduction to the theory and applications of differential calculus of functions of one variable; topics include limits, continuity, differentiation, and the mean value theorem and its applications.

308L. Integral Calculus. Only one of the following may be counted: Mathematics 403K, 408C (or 808A), 308L (or 608EB). Introduction to the theory and applications of integral calculus of functions of one variable; topics include integration, the fundamental theorem of calculus, transcendental functions, parametric equations, and sequences. *Prerequisite:* Mathematics 308K (or 608EA) or the equivalent with a grade of at least *C*.

308M. Multivariable Calculus. Only one of the following may be counted: Mathematics 403L, 408D (or 808B), 308M (or 318K). Introduction to the theory and applications of infinite series, including those involving functions of one variable, and to the theory and applications of differential and integral calculus of functions of several variables; topics include infinite series, power series, vectors, vector calculus, functions of several variables, partial derivatives, gradients, and multiple integrals. Certain sections are designated as honors sections for well-prepared students of mathematics and mathematically oriented sciences who wish to investigate more thoroughly the foundations of calculus. *Prerequisite:* Mathematics 308L (or 608EB) or the equivalent with a grade of at least *C*.

110, 210, 310, 410. Conference Course. May be repeated for credit when the topics vary. Some sections are offered on the pass/fail basis only; these are identified in the *Course Schedule*. *Prerequisite:* Written consent of instructor. Supervised study in mathematics, with hours to be arranged.

311. Linear Algebra and Matrix Theory. Mathematics 311 and 340L may not both be counted. Vector spaces, linear transformations, matrices, linear equations, determinants. Some emphasis on rigor and proofs. *Prerequisite:* Mathematics 408D (or 808B) with a grade of at least *C*. Mathematics majors are expected to take Mathematics 311 immediately after 408D.

316. Elementary Statistical Methods. Only one of the following may be counted: Mathematics 316, 360K (Topic 1: *Applications of Probability Theory*), 362K. May not be counted toward the major requirement for the Bachelor of Arts, Plan I, degree with a major in mathematics or toward the Bachelor of Science in Mathematics degree. Graphical presentation, frequency functions, distribution functions, averages, standard deviation, variance, curve-fitting, and related topics. *Prerequisite:* A satisfactory score on the College Board Achievement Test in Mathematics Level I.

316K. Foundations of Arithmetic. May not be counted toward the major requirement for the Bachelor of Arts, Plan I, degree with a major in mathematics or toward the Bachelor of Science in Mathematics degree. Credit for Mathematics 316K may not be earned after the student has received credit for any calculus course with a grade of *C* or better. An analysis, from an advanced perspective, of the concepts and algorithms of arithmetic, including sets; numbers; numeration systems; definitions, properties, and algorithms of arithmetic operations; and percents, ratios, and proportions. Problem solving is stressed. *Prerequisite:* Mathematics 303D, 304E, 305G, or 316 with a grade of at least *C*.

316L. Foundations of Geometry, Statistics, and Probability. May not be counted toward the major requirement for the Bachelor of Arts, Plan I, degree with a major in mathematics or toward the Bachelor of Science in Mathematics degree. Credit for Mathematics 316L may not be earned after the student has received credit for any calculus course with a grade of *C* or better. An analysis, from an advanced perspective, of the basic concepts and methods of geometry, statistics, and probability, including representation and analysis of data; discrete probability, random events, and conditional probability; measurement; and geometry as approached through similarity and congruence, through coordinates, and through transformations. Problem solving is stressed. *Prerequisite:* Mathematics 316K with a grade of at least *C*.

119S, 219S, 319S, 419S, 519S, 619S, 719S, 819S, 919S. Topics in Mathematics. May be repeated for credit when the topics vary. This course is used to record credit the student earns while enrolled at another institution in a program administered by the University's Study Abroad Office. Credit is recorded as assigned by the study abroad adviser in the Department of Mathematics. University credit is awarded for work in an exchange program; it may be counted as coursework taken in residence. Transfer credit is awarded for work in an affiliated studies program.

Upper-Division Courses

325K. Discrete Mathematics. Provides a transition from the problem-solving approach of Mathematics 408C and 408D to the rigorous approach of advanced courses. Topics include logic, set theory, relations and functions, combinatorics, graph theory and graph algorithms, matrix operations, and elementary linear algebra. *Prerequisite:* Mathematics 408D (or 808B) with a grade of at least *C*, or consent of instructor.

427K. Advanced Calculus for Applications I. Infinite series, ordinary and partial differential equations. *Prerequisite:* Mathematics 408D (or 808B) with a grade of at least *C*. Five class hours a week for one semester.

427L. Advanced Calculus for Applications II. Matrices, elements of vector analysis and calculus of functions of several variables, including gradient, divergence, and curl of a vector field, multiple integrals and chain rules, length and area, line and surface integrals, Green's theorems in the plane and space, and, if time permits, complex analysis. *Prerequisite:* Mathematics 408D (or 808B) with a grade of at least *C*. Five class hours a week for one semester.

328K. Introduction to Number Theory. Mathematics 328K and 360K (Topic 2: *Number Theory*) may not both be counted. Provides a transition from the problem-solving approach of Mathematics 408C and 408D to the rigorous approach of advanced courses. Properties of the integers, divisibility, linear and quadratic forms, prime numbers, congruences and residues, quadratic reciprocity, number theoretic functions. *Prerequisite:* Mathematics 311 with a grade of at least *C*.

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129S, 229S, 329S, 429S, 529S, 629S, 729S, 829S, 929S. Topics in Mathematics. May be repeated for credit when the topics vary. This course is used to record credit the student earns while enrolled at another institution in a program administered by the University's Study Abroad Office. Credit is recorded as assigned by the study abroad adviser in the Department of Mathematics. University credit is awarded for work in an exchange program; it may be counted as coursework taken in residence. Transfer credit is awarded for work in an affiliated studies program.

329W. Cooperative Mathematics. This course covers the work period of mathematics students in the Cooperative Education program, which provides supervised work experience by arrangement with the employer and the supervising instructor. The student must repeat the course each work period and must take it twice to receive credit toward the degree; at least one of these registrations must be during a long-session semester. No more than three semester hours may be counted toward the major requirement; no more than six semester hours may be counted toward the degree. The student's first registration must be on the pass/fail basis. *Prerequisite:* Application to become a member of the Cooperative Mathematics Program; Computer Sciences 304P, Mathematics 408D (or 808B), and a grade of at least *C* in two of the following courses: Mathematics 311, 325K, 427K, 362K, 378K; and consent of the undergraduate adviser. Forty laboratory hours a week for one semester.

also listed p 385. + Prereq

333L. Structure of Modern Geometry. Axiom systems, transformational geometry, introduction to non-Euclidean geometries, and other topics in geometry; use of these ideas in teaching geometry. *Prerequisite:* Mathematics 408D (or 808B) with a grade of at least *C*, or upper-division standing and consent of instructor.

340L. Matrices and Matrix Calculations. Mathematics 311 and 340L may not both be counted. Techniques of matrix calculations and applications of linear algebra. *Prerequisite:* One semester of calculus with a grade of at least *C* or consent of instructor.

343K. Introduction to Algebraic Structures. Students who have received a grade of *C* or better in Mathematics 373K may not take Mathematics 343K. Elementary properties of groups and rings, including symmetric groups, properties of the integers, polynomial rings, elementary field theory. *Prerequisite:* Mathematics 311 with a grade of at least *C* and either 325K or 328K with a grade of at least *C*.

360K. Topics in Modern Mathematics I. May be repeated for credit when the topics vary. May not be counted toward the major requirement for any degree in mathematics. Designed especially for applied learning and development majors with a mathematics concentration. *Prerequisite:* Mathematics 408C (or 808A) and 316L with a grade of at least *C* in each, or written consent of the undergraduate mathematics education adviser.

Topic 1: *Applications of Probability Theory.* Only one of the following may be counted: Mathematics 316, 360K (Topic 1), 362K. A problem-oriented, problem-solving approach to an in-depth development of discrete probability theory and the normal distribution.

Topic 2: *Number Theory.* Mathematics 328K and 360K (Topic 2) may not both be counted. An investigative approach to classical number theory, closely paralleling its historical development, with emphasis on discovery and development.

Topic 3: *Problem Solving.* A study of problem solving, heuristics, strategies, pitfalls, and approaches to proofs. Emphasizes improving the ability to solve challenging problems.

360M. Mathematics as Problem Solving. Discussion of heuristics, strategies, and methods of evaluating problem solving, and extensive practice in both group and individual problem solving. Communicating mathematics, reasoning, and connections among topics in mathematics are emphasized. *Prerequisite:* Mathematics 408D (or 808B) with a grade of at least *C* and written consent of instructor.

361. Theory of Functions of a Complex Variable. Elementary theory and applications of analytic functions, series, contour integration, and conformal mappings. *Prerequisite:* Mathematics 427K or 427L with a grade of at least *C* or consent of instructor.

361K. Introduction to Real Analysis. Students who have received a grade of *C* or better in Mathematics 365C may not take Mathematics 361K. A rigorous treatment of the real number system, of real sequences, and of limits, continuity, derivatives, and integrals of real-valued functions of one real variable. *Prerequisite:* Mathematics 311 with a grade of at least *C* and either 325K or 328K with a grade of at least *C*.

362K. Probability I. Only one of the following may be counted: Mathematics 316, 360K (Topic 1: *Applications of Probability Theory*), 362K. An introductory course in the mathematical theory of probability, fundamental to further work in probability and statistics. *Prerequisite:* Mathematics 408D (or 808B) with a grade of at least *C*.

362M. Introduction to Stochastic Processes. Introduction to Markov chains, birth and death processes, and other topics. *Prerequisite:* Mathematics 362K.

364K. Vector and Tensor Analysis I. Invariance, vector algebra and calculus, integral theorems, general coordinates, introductory differential geometry and tensor analysis, applications. *Prerequisite:* Mathematics 427K or 427L with a grade of at least *C*.

364L. Vector and Tensor Analysis II. Continuation of Mathematics 364K, with emphasis on tensor and extensor analysis. Riemannian geometry and invariance. *Prerequisite:* Mathematics 364K with a grade of at least *C*.

365C. Real Analysis I. Mathematics 665A and 365C may not both be counted. Students who have received a grade of *C* or better in Mathematics 365C may not take Mathematics 361K. A rigorous treatment of the real number system, Euclidean spaces, metric spaces, continuity of functions in metric spaces, differentiation and Riemann integration of real-valued functions of one real variable, and uniform convergence of sequences and series of functions. *Prerequisite:* Mathematics 311 with a grade of at least *C* and either 325K or 328K with a grade of at least *C*. Students who receive a grade of *C* in 325K or 328K are advised to take 361K before attempting 365C.

365D. Real Analysis II. Mathematics 665B and 365D may not both be counted. A rigorous treatment of selected topics in real analysis, such as Lebesgue integration, or multivariate integration and differential forms. *Prerequisite:* Mathematics 365C (or 665A) with a grade of at least *C*. Recommended for students planning to undertake graduate work in mathematics.

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367K. Topology I. An introduction to topology, including sets, functions, cardinal numbers, and the topology of metric spaces. *Prerequisite:* Mathematics 325K or 328K with a grade of at least *C* or consent of instructor.

367L. Topology II. Various topics in topology, primarily of a geometric nature. *Prerequisite:* Mathematics 367K with a grade of at least *C* or consent of instructor.

368K. Numerical Mathematics for Applications. Only one of the following may be counted: Computer Sciences 367, 368K, Mathematics 368K, Physics 329. Introduction to numerical methods for applied problems in science and engineering. Topics include linear equations, approximation, differential equations. *Prerequisite:* A grade of at least *C* in Mathematics 427K and in either 311 or 340L, and knowledge of FORTRAN programming.

369E. Applied Statistical Methods for Actuaries. Introduction to analysis of variance, regression analysis, and time series. Includes the syllabus for the Society of Actuaries and Casualty Actuarial Society Exam 120. *Prerequisite:* A grade of at least *C* in Mathematics 378K and in either 340L or 311.

369G. Operations Research for Actuaries. Introduction to linear programming, project scheduling, dynamic programming, queueing theory, decision analysis, and simulation of distributions. Includes the syllabus for the Society of Actuaries Exam 130. *Prerequisite:* A grade of at least *C* in Mathematics 362K and in either 340L or 311.

369J. Credibility Theory and Loss Distributions. Introduction to statistical techniques for modeling and approximating the probabilistic distribution of insurance losses, including measuring the credibility of the resulting models. Includes the syllabus for the Casualty Actuarial Society Exam 4B. *Prerequisite:* Mathematics 378K with a grade of at least *C*.

469K. Actuarial Mathematics I. Only one of the following may be counted: Actuarial Science 369, Mathematics 469K, 389L. Probabilistic theory of single-event losses, with applications to insurance. With Mathematics 469L, includes the syllabus for the Society of Actuaries Exam 150. *Prerequisite:* Actuarial Foundations 309 and Mathematics 362K with a grade of at least *C* in each, and consent of the director of the concentration in actuarial studies. Four lecture hours a week for one semester.

469L. Actuarial Mathematics II. Only one of the following may be counted: Actuarial Science 370, Mathematics 469L, 389M. Probabilistic theory of multiple-event losses, with applications to insurance. With Mathematics 469K, includes the syllabus for the Society of Actuaries Exam 150. *Prerequisite:* Mathematics 469K with a grade of at least *C*, and consent of the director of the concentration in actuarial studies. Four lecture hours a week for one semester.

372. Fourier Series and Boundary Value Problems. Discussion of differential equations of mathematical physics and representation of solutions by Green's functions and eigenfunction expansions. *Prerequisite:* Mathematics 427K or 370K with a grade of at least *C*.

373K. Algebraic Structures I. Students who have received a grade of *C* or better in Mathematics 373K may not take Mathematics 343K. A study of groups, rings, and fields, including structure theory of finite groups, isomorphism theorems, polynomial rings, and principal ideal domains. *Prerequisite:* Mathematics 311 with a grade of at least *C* and either 325K or 328K with a grade of at least *C*, or consent of instructor. Students who receive a grade of *C* in Mathematics 325K or 328K are advised to take 343K before attempting 373K.

373L. Algebraic Structures II. Topics from vector spaces and modules, including direct sum decompositions, dual spaces, canonical forms, and multilinear algebra. *Prerequisite:* Mathematics 373K with a grade of at least *C*. Recommended for students planning to undertake graduate work in mathematics.

374. Fourier and Laplace Transforms. Operational properties and application of Laplace transforms; some properties of Fourier transforms. *Prerequisite:* Mathematics 427K with a grade of at least *C*.

374K. Fourier and Laplace Transforms. Continuation of Mathematics 374. Introduction to other integral transforms, such as Hankel, Laguerre, Mellin, Z. *Prerequisite:* Mathematics 374 with a grade of at least *C*.

175, 275, 375, 475. Conference Course. May be repeated for credit when the topics vary. *Prerequisite:* Upper-division standing in mathematics and written consent of instructor. Supervised study in mathematics, with hours to be arranged.

175C, 375C. Conference Course (Computer-Assisted). May be repeated for credit when the topics vary. *Prerequisite:* Upper-division standing in mathematics and written consent of instructor. Supervised study in mathematics on material requiring use of computing resources, with hours to be arranged.

378K. Introduction to Mathematical Statistics. Estimation of parameters and testing of hypotheses. Mathematics 362K and 378K form the core sequence for students in statistics. *Prerequisite:* Mathematics 362K with a grade of at least *C*.

379H. Honors Tutorial Course. Directed reading, research, and/or projects, under the supervision of a faculty member, leading to an honors thesis. *Prerequisite:* Admission to the Mathematics Honors Program, a grade point average of at least 3.50 in Mathematics 365C (or 665A) and 373K, and approval of the honors adviser. Conference course.

MICROBIOLOGY

See Division of Biological Sciences, page 360.

NATURAL SCIENCE

The term "natural science" refers to courses in the biological sciences, such as biology, botany, microbiology, and zoology; those in the physical sciences, such as astronomy, chemistry, and physics; those that include both the biological and the physical sciences, such as geology and marine science; and computer sciences and mathematics.

NUTRITION

See Department of Human Ecology, page 375.

PHYSICAL SCIENCE

See Department of Physics, page 389.

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