

Mathematics

Professor John Graef, *Head*

The Department of Mathematics offers two degree programs, the B.A. and the B.S. in Applied Mathematics.

The B.A. is the traditional liberal arts degree with a major in mathematics.

The B.S. in Applied Mathematics is a degree program designed to examine the growing influence of mathematics in business and industrial practices. The student must select a concentration in one of the following two areas: actuarial science or general mathematics.

Students who plan to teach at the secondary school level must meet state licensure requirements. These students need to consult with advisors in the College of Health, Education and Professional Studies and the Department of Mathematics. Through careful course selection, such students should be able to major in both Secondary Mathematics and Applied Mathematics: General.

In addition to its own degree programs, the Department provides extensive support for other programs requiring mathematics courses and for the University's General Education requirements. It also offers a minor in mathematics.

All entering students must take the Mathematics Placement Test with the exception of those satisfying at least one of the following conditions: 1) transferring an appropriate college level mathematics course, 2) receiving advanced placement credit in mathematics, or 3) earning a Math ACT score of 24 or greater (Math SAT score 560 or greater). A student with a Math ACT score of 24 or greater (Math SAT 560 or greater) may take the Mathematics Placement Test without jeopardy in order to become eligible for more courses. For example, a student with an ACT Math score of 24 or 25 who wishes to take Math 136, Math 145 or Math 151 should take the Mathematics Placement Test. The UTC Department of Mathematics uses the ACT and placement test scores both to assess the student's pre-college preparation and to determine whether prerequisites for certain of the 100 and 200 level courses are met. Test schedules are available on line at the Mathematics Department web site.

Applied Mathematics (B.S.)

General Education (see pages 33-35 for list of approved courses)

Rhetoric and Composition: Two approved courses in rhetoric and composition (6 hours)

Mathematics: One approved mathematics course* (3 hours; approved courses listed below will apply)

Statistics: One approved course in statistics at the 300-400 level* (3 hours; approved courses listed below will apply)

Natural Sciences: Two approved natural science courses, at least one including a laboratory component (7-8 hours)

Humanities and Fine Arts: Two approved humanities and fine arts courses, one from fine arts and one from either (6 hours)

Cultures and Civilizations: Option A: Western Humanities I and II and Non-Western Cultures and Civilizations OR Option B: World Civilization I, II, III (9 hours total)

Behavioral and Social Sciences: Two approved behavioral or social science courses in two different disciplines (6 hours; approved related courses in the actuarial concentration below will apply)

Major and Related Courses

Computer Science 150, English 278, and one course from Theatre and Speech 109, 209 or University Honors 214

Mathematics 151[†]/152, 161/162, 212, 245, 255, 300, 350

NOTE: Mathematics sequence may begin with 144 and/or 145 rather than 151/152 depending on preparation.

One of the following concentrations:

2065 - General Mathematics

Mathematics 321 or 412; either Mathematics 307 plus 12 additional hours in Mathematics at the 300-400 level OR Mathematics 407 and 408 plus 9 additional hour in Mathematics at the 300-400 level excluding Mathematics 307.

In addition, the student must choose an established minor or design a program of study approved by the Mathematics Department Curriculum Committee consisting of 18 hours of courses in other disciplines, including at least 8 hours at the 300-400 level. A minimum grade point average of 2.0 must be achieved in these courses. Completion of a second major will satisfy this requirement.

2068 - Actuarial Science

Mathematics 407, 408, 412, 465; one of 414, 420 or 424; plus 9 additional hours in Mathematics at the 300-400 level excluding Mathematics 307; Accounting 201, 202; Economics 101, 102, 324, 325; Finance 302, 337. Strongly recommended electives include Mathematics 401, 420 and Economics 460.

2.0 average in all mathematics courses and also in all 300-400 level mathematics courses.

Minimum of 39 hours of 300 and 400 level courses.

Electives to complete 120 hours.

See page 35 for additional requirements.

1570 - Mathematics (B.A.)

General Education (see pages 33-35 for list of approved courses)

Rhetoric and Composition: Two approved courses in rhetoric and composition (6 hours)

Mathematics: One approved mathematics course (3 hours; approved courses below will apply)

Statistics: Mathematics 307* or 408*

Natural Sciences: Physics 230/280*, 231/281*

Cultures and Civilizations: Option A: Western Humanities I and II and Non-Western Cultures and Civilizations OR Option B: World Civilization I, II, III (9 hours total)

Humanities and Fine Arts: Two approved humanities and fine arts courses, one from fine arts and one from either (6 hours)

Behavioral and Social Sciences: 2 approved behavioral or social science courses in two different disciplines (6 hours)

Foreign Language: Through second college year in one foreign language.

Completion of a minor with a minimum 2.0 grade point average.

Major and Related Courses

Computer Science 150, English 278, and one course from Theatre and Speech 109, 209, or University Honors 214

Mathematics 151[†]/152, 161/162, 212, 245, 255, 300, 321, 350

NOTE: Mathematics sequence may begin with 144 and/or 145 rather than 151/152 depending on preparation.

Mathematics 307 or 408[†]

Five additional courses at the 300-400 level (excluding 303) including:

At least one course from 403, 407, 414, 440, 445, 460, 465, 470

At least one course from 408, 410, 412, 422, 424, 428, 450, 454, 466

Physics 230/280[†], 231/281[†]

Decisions concerning the most appropriate 300-400 level courses for each student should be made in consultation with mathematics advisers, particularly for those students who are seeking teacher certification in mathematics and students who are planning graduate study.

2.0 average in all mathematics courses and also in all 300, 400-level mathematics courses

Minimum of 39 hours of 300 and 400 level courses

Electives to complete 120 hours

See page 35 for additional requirements

* Also satisfies requirement in the major.

† Also satisfies general education requirement.

4620 - MATHEMATICS MINOR

Required courses: Mathematics 151/152, 161/162, 212, 245, 255

Elective courses: Three courses totaling at least 9 hours from any 300-400 level mathematics courses

A 2.0 average on the 300-400 level courses as well as on all courses in the minor

At least two of the 300-400 level courses must be taken at this institution

MATHEMATICS COURSES (MATH)

A minimum grade of C must be made on any mathematics course used as a prerequisite for any other mathematics course.

105 Elementary Algebra (4 hours institutional credit)

Review of fractions, percents, and decimals. Basic topics in algebra, including operations with signed numbers and polynomials, linear equations and inequalities, factoring, rational expressions, radicals, basic graphing techniques, and elementary applications. Every semester. *UTC Math Placement Level 05. Credit not applicable toward any degree.*

106 Intermediate Algebra (4 hours institutional credit)

The real number system, first degree equations and inequalities, exponents and polynomials, factoring, rational expressions, rational exponents and roots, linear equations and inequalities in two variables, quadratic equations, systems of equations, absolute value equations, functions and applications. Every semester. *Prerequisite: UTC Math Placement Level 15 or Mathematics 105 with minimum grade of C or Math ACT 19 or above. Credit not applicable toward any degree.*

123 Mathematics in Our Modern World (3)

An introduction to the nature and techniques of mathematics for nontechnical majors. Applications of mathematics to the solution of historical and modern problems will be discussed by selecting topics from the mathematics of finance, the laws of growth and symmetry, graph theory and management science, or the mathematics of social choice and voting schemes. Every semester. *Prerequisites: UTC Math Placement Level 20 or Mathematics 106 with minimum grade of C or Math ACT 22 or above.*

131 College Algebra (3)

This precalculus course is designed primarily for students majoring in business, the life sciences, or the social sciences who intend to take the calculus course Math 136. Topics include polynomial functions, exponential and logarithmic functions, arithmetic and geometric sequences, mathematics of finance, growth and decay, systems of linear equations, matrices, and geometric linear programming. Mathematical models will be taken primarily from the fields of business, biology, and the social sciences. Every semester. *Prerequisites: UTC Math Placement Level 20 or Mathematics 106 with minimum grade of C or Math ACT 24 or above. Credit not allowed in Mathematics 131 after completion of 136 or 144 with a grade of C or better or any other mathematics course for which these are prerequisites. Credit not allowed in both Mathematics 131 and 144.*

136 Calculus for Management, Life, and Social Sciences (3)

Introduction to calculus: limits, differentiation of functions, optimization, marginal analysis, integration, the Fundamental Theorem of Calculus, applications of integration. Every semester. *Prerequisites: UTC Math Placement Level 30 or Mathematics 131 or 144 with minimum grade C or Math ACT 26 or above. Credit not allowed in 136 after completion of 150 or 151 with a grade of C or better.*

144 Precalculus I (3)

This precalculus course is designed primarily for students majoring in Mathematics, the physical sciences, and Engineering who intend to take Math 145, Precalculus II, and the calculus courses Math 151/152. Topics include solving polynomial equations and inequalities; complex numbers; the Fundamental Theorem of Algebra; rational functions; graphing techniques; functions; expo-

ponential and logarithmic functions; mathematical induction. Mathematical models will be taken primarily from the fields of engineering, biology, and natural sciences. Every semester. *Prerequisites: UTC Math Placement Level 20 or Mathematics 106 with minimum grade of C or Math ACT 24 or above. Credit not allowed in Mathematics 144 after 136, 145, 150, or 151 with a grade of C or better. Credit not allowed in both Mathematics 131 and 144.*

145 Precalculus II (3)

This precalculus course is designed primarily for students majoring in Mathematics, the physical sciences, and Engineering who intend to take the calculus course Math 151/152. Topics include solving trigonometric identities, and equations; complex numbers; conic sections; sequences; and other selected topics. Every semester. *Prerequisites: UTC Math Placement Level 30 or Mathematics 144 or 131 with minimum grade of C or Math ACT 26 or above. Credit will not be allowed in Mathematics 145 after 150 or 151 with a grade of C or better. Students wishing to use Mathematics 131 as a prerequisite must secure the approval of the Mathematics Department.*

151 Calculus I (3)

The calculus of functions of one real variable for majors in Mathematics, the physical sciences, and Engineering. Precise definitions of limits, derivatives, and integrals including Riemann sums; applications of these concepts and the Fundamental Theorem of Calculus. Every semester. *Prerequisites: UTC Math Placement Level 40 or Mathematics 145 with a minimum grade of C or Math ACT 28 or above with the equivalent of at least one semester of high school trigonometry. Corequisite: Mathematics 152.*

152 Calculus I Laboratory (1)

Calculator and computer treatment of problems and topics in Math 151 using graphical, numerical, and symbolic methods. Laboratory, 2 hours. *Pre- or Corequisite: Mathematics 150 or 151.*

155 Honors Calculus (4)

Calculus of functions of one variable with applications; historical, biographical, philosophical material. Fall semester. *Prerequisite: University Honors Scholar, others by consent of the department head. Credit not allowed in both Mathematics 150 or 151 and 155 or in 136 after 155. May be substituted for Mathematics 151 in meeting all requirements.*

161 Calculus II (3)

Additional topics in the calculus of functions of one real variable. Applications of integration, techniques of integration, infinite series, and convergence tests. Every semester. *Prerequisite: Mathematics 151 with a minimum grade of C. Corequisite: Mathematics 162.*

162 Calculus II Laboratory (1)

Calculator and computer treatment of problems and topics in Math 161 using graphical, numerical, and symbolic methods. Laboratory, 2 hours. *Prerequisites: Mathematics 152 with a minimum grade of C. Pre- or Corequisite: Mathematics 160 or 161.*

199r Special Projects (1-4)

Individual or group projects. On demand. *Maximum credit 4 hours.*

203 Discrete Mathematics for Computer Science (3)

Designed primarily for students majoring in computer information systems. topics will include logic, introduction to mathematical induction, sets, relations, counting methods, graph theory and trees. *Prerequisites: Mathematics 136 or 151/152 with minimum grades of C; Computer Science 150. Credit not allowed in this course after completion of Mathematics 303 or 403 with a grade of C or better.*

210 Introductory Statistics (3)

An introductory course suitable for students in a variety of disciplines. This course will teach students to interpret, develop, and use statistical and probabilistic models of real world phenomena; develop the concepts of uncertainty, probability, and statistical significance; and will indicate how these concepts arose and how they aid our understanding of the universe. Students will learn how to solve practical problems using statistical vocabulary, notation, and appropriate technology. Every semester. *Prerequisites: UTC Math Placement Level 20 or Mathematics 106 with minimum grade of C or Math ACT 22 or above. Credit not allowed in 210 after completion of any other General Education statistics course with a grade of C or better.*

212 Elementary Linear Algebra (3)

Systems of linear equations, matrix algebra, determinants, geometric vectors, vector spaces, linear transformations, eigenvalues and eigenvectors, inner product spaces. Every semester. *Prerequisite: Mathematics 150 or 151 with a minimum grade of C.*

215 Mathematics for Elementary and Middle School Teachers I (3)

This is the first course in a two semester sequence designed for elementary, middle school, and special education majors. The purpose is to develop a thorough understanding of the mathematics taught in the schools. Topics include the arithmetic properties and operations for the natural numbers, whole numbers, integers, rational and irrational number systems; elementary number theory including prime and composite numbers, factors and divisibility criteria, the Fundamental Theorem of Arithmetic, greatest common divisors and least common multiples; place values, percents, decimals, and other numeration systems. Every semester. *Prerequisites: UTC Math Placement Level 20 or Mathematics 106 with a grade of C or better or Math ACT 24 or above. Credit not allowed in both Math 214 and Math 215.*

216 Mathematics for Elementary and Middle School Teachers II (3)

This is the second course in a two semester sequence designed for elementary, middle school, and special education majors. The purpose is the continuation of the study of mathematical topics from Math 215 with an emphasis on algebraic notation, sets and functions, basic geometric concepts of measurement, length, area, perimeter, surface area, volume, and the Pythagorean Theorem. Some elementary probability and statistics, including some educational statistics, will be included. Every semester. *Prerequisites: UTC Math Placement Level 30 or Mathematics 214 or 215 with a grade of C or better or Math ACT 26 or above or approval of the Mathematics Department. This course will meet General Education Mathematics requirement, but not General Education Statistics requirement.*

245 Introduction to Differential and Difference Equations (3)

First order and second order linear differential and difference equations, systems of equations and transform methods. Every semester. *Prerequisite: Mathematics 160 or 161 with a minimum grade of C. Pre- or Corequisite: Mathematics 212 with a minimum grade of C.*

255 Multivariable Calculus (3)

Lines, curves, and surfaces; partial derivatives, gradients, divergence and curl; multiple integrals and vector analysis. Every semester. *Prerequisites: Mathematics 160 or 161 and 212 with minimum grades of C.*

256 Multivariable Calculus Laboratory (1)

Calculator and computer treatment of problems and topics in Math 255 using graphical, numerical, and symbolic methods. Spring semester. Laboratory 2 hours. *Pre- or Corequisite: Mathematics 255.*

300 Foundations of Mathematics (3)

Introductory concepts of sets, functions, equivalence relations, ordering relations, logic, methods of proof, and axiomatic theories with topics from combinatorics, graph theory, or abstract algebra. Fall and spring semesters. *Prerequisite: Mathematics 160 or 161 and 162 with minimum grade of C. This course is a prerequisite for Mathematics 321, 350, 403, 410, 412, 422, 430 and 452. Mathematics majors should enroll in it at the end of the sophomore year or beginning of the junior year.*

303 Discrete Structures (3)

Concepts and techniques of several areas of discrete mathematics with emphasis on areas often applied to computer science. Topics will include induction, algorithms, combinatorics, graph theory with emphasis on trees, formal language, grammars. Fall and spring semesters. *Prerequisites: Mathematics 161/162 and Computer Science 150 with minimum grades of C. Credit not allowed on both Mathematics 303 and 403.*

307 Applied Statistics (3)

Introduction to probability and statistical methods with applications to various disciplines. A study of some basic statistical distributions, sampling, testing of hypotheses, and estimation problems. Fall and spring semesters. *Prerequisite: Mathematics 160 or 161 with minimum grade of C. Credit not allowed in both Mathematics 307 and 407-408.*

321 Introduction to Modern Algebra (3)

Integral domains, rings, fields, groups, elementary number theory, and other selected topics. Spring semester. *Prerequisites: Mathematics 212 and 300 (or approval of instructor) with minimum grades of C.*

350 Fundamental Concepts in Analysis (3)

Classical treatment of the basic concepts of calculus: limits, continuity, differentiation, Riemann integration, sequences and series of numbers and functions. Fall semester. *Prerequisites: Mathematics 245, 255, and 300 with minimum grades of C.*

401 Mathematics of Interest (3)

Mathematical theory of interest with applications, including accumulated and present value factors, annuities, yield rates, amortization schedules and sinking funds, depreciation, bonds and related securities. Recommended for students planning to take actuarial exams. Fall semester alternate years. *Prerequisites: Mathematics 160 or 161 with a minimum grade of C, or approval of the instructor.*

403 Graph Theory and Combinatorics (3)

Planar graphs, circuits, graph coloring, trees, general counting principles, generating functions, recurrence relations with applications to computer science including tree traversal, grammars, languages, and finite-state machines. Fall semester. *Prerequisites: Mathematics 300 with a minimum grade of C, and either Computer Science 118 or 150 or equivalent. Credit not allowed in both Mathematics 403 and 303.*

407 Introduction to Probability and Statistics (3)

Introduction to the theory of probability and its applications, counting techniques, sample spaces, random variables and their distributions, mathematical expectation, moment generating functions, binomial, Poisson, and normal distributions, Central Limit Theorem. Fall semester. *Prerequisite: Mathematics 255 with minimum grade of C.*

408 Mathematical Statistics (3)

A continuation of Math 407 with an introduction to the theories of point and interval estimation, hypothesis testing, regression and correlation analysis, goodness of fit, chi-square, t and F distributions. Spring semester. *Prerequisite: Mathematics 407 with minimum grade of C.*

410 Number Theory (3)

Divisibility, primes, congruencies, Fermat's Theorem, number theoretic functions, primitive roots and indices, the quadratic reciprocity law. Summer on demand. *Prerequisite: Mathematics 300 with a minimum grade of C.*

412 Linear Algebra and Matrix Theory (3)

Vector spaces, linear transformations, eigenvalue and similarity transformations, orthogonal and unitary transformations, normal matrices, Jordan form. Fall semester. *Prerequisites: Mathematics 212, 245, 300 with minimum grades of C.*

414 Operations Research (Linear) (3)

Introduction to linear programming, duality, transportation and assignment problems, integer programming. Spring semester alternate years. *Prerequisites: Computer Science 118 or 150 or equivalent, Mathematics 212 with minimum grade of C, or approval of instructor.*

420 Applied Statistical Methods (3)

Intermediate applied statistical analysis and model building. Covers One and Two Factor Analysis of Variance, Simple and Multiple Regression and Correlation, and Time Series Analysis. Spring semester. This course is recommended for students planning to take actuarial exams. *Prerequisite: Mathematics 307 or 407 or Engineering 322 with a minimum grade of C, or approval of the instructor.*

422 Introduction to Point Set Topology (3)

Introductory set theory, topologies and topological spaces, continuous mappings, compactness, connectedness, separation axioms and metric spaces. Summer on demand. *Prerequisite: Mathematics 300 with minimum grade of C.*

424 Operations Research (Non-Linear) (3)

Network flows, Markov chains and applications, queuing theory and applications, inventory theory, decision theory, and games. Spring semester alternate years. *Prerequisites: Computer Science 118 or 150 or equivalent, Mathematics 307 or 407 with minimum grades of C, or approval of instructor.*

428 Packages for Mathematical Computations (3)

The nature of libraries of procedures for solving mathematical problems, including the design parameters, selection of algorithms, problems with reliability and transportation. Several major mathematical packages will be examined in detail, including IMSL, LINPACK, EISPACK, MINPACK. On demand. *Prerequisites:* Computer Science 118 or consent of instructor; Mathematics 245 and one of the following: Mathematics 308 or Engineering 225 or Computer Science 231 with minimum grades of C.

430 The Historical Development of Mathematics (3)

Examination of central ideas, major developments, and important issues in mathematics from ancient times to the present. Historical overview of the evolution of the discipline through comparative examination of specific theories and results. Alternate fall and summer. *Prerequisite:* Mathematics 300 with a minimum grade of C.

440 Applied Analysis (3)

Vector analysis through Stokes' Theorem and the Divergence Theorem. Topics in advanced calculus including implicit functions, Jacobians, interchange of limit processes, and uniform convergence of series of functions; introduction to power series solutions of differential equations. *Prerequisites:* Mathematics 245, 255 with minimum grades of C.

445 Advanced Differential Equations (3)

Systems of differential equations; existence and uniqueness theorems; linear systems; phase plane analysis; stability theory; applications. Fall semester alternate years. *Prerequisite:* Mathematics 245, 255 with minimum grades of C.

450 Modern Analysis (3)

Differentiation; inverse and implicit function theorems; functions of bounded variation. Integration and measure; integration on manifolds; Stokes' and Green's Theorems; other selected topics. On demand. *Prerequisite:* Mathematics 350 with a minimum grade of C.

452 Basic Concepts of Geometry (3)

Deficiencies in Euclidean geometry, Euclid's parallel postulate, introduction to non-Euclidean geometry, consistency and validity of non-Euclidean geometry, incidence geometries, affine geometries, linear, planar, and spatial order properties. Alternate fall and summer semesters. *Prerequisite:* Mathematics 300 with a minimum grade of C, or approval of instructor.

454 Abstract Algebra (3)

A study of special topics from advanced algebra, various algebraic structures, and the applications of algebra. On demand. *Prerequisite:* Mathematics 321 or 412 with a minimum grade of C, or approval of instructor.

460 Techniques of Applied Mathematics (3)

Additional topics in vector calculus; series of orthogonal functions; integral transforms; treatment of some elementary partial differential equations arising in applications. Spring semester alternate years. *Prerequisites:* Mathematics 245, 255 with minimum grades of C.

465 Numerical Analysis I (3)

Numerical solutions of equations in one variable; interpolation and polynomial approximation; numerical differentiation and integration; initial value problems for ordinary differential equations; direct methods for solving systems of linear equations. *Prerequisites:* Mathematics 212 and 245 with minimum grades of C, and a background in computer programming (for example, Computer Science 150).

466 Numerical Analysis II (3)

Iterative techniques for solving systems of linear equations; approximation theory; eigenvalue and eigenvector approximation; boundary value problems for ordinary differential equations; numerical solution to partial differential equations. *Prerequisite:* Mathematics 465 with a minimum grade of C, or approval of instructor.

470 Introductory Complex Variables (3)

Complex numbers; differentiation and integration of functions of a complex variable; analytic functions; Cauchy's Theorem; power series; residues and poles; conformal mapping; contour integration. Fall semester alternate years. *Prerequisites:* Mathematics 245, 255 with minimum grades of C.

475 Research Seminar (1)

Investigation of special topics in mathematics using the directed research technique. On demand. *Prerequisite:* approval of department. Graded satisfactory/no credit.

495r Departmental Honors

(1-3 hours per term, 4 hours for the two terms)

On demand. See "Departmental Honors," page 39.

497r Research (1-4)

On demand.

498r Individual Studies (1-4)

On demand.

499r Group Studies (1-4)

On demand.

Music

Cadek Department of Music

Associate Professor Lee Harris, Head

The requirements for entrance and graduation as set forth in the catalog are in accordance with the published regulations of the National Association of Schools of Music and the Tennessee regulations for certification of teachers.

The Cadek Department of Music offers two degree programs at the undergraduate level: Bachelor of Arts with a major in music and the Bachelor of Music. The B.M. degree provides four concentrations for the major: instrumental performance, vocal performance, sacred music, and theory/composition. The B.M. degree in music education provides two concentrations for the major: instrumental and vocal.

The B.A. degree is offered students who desire a strong liberal arts background with a major in music. Approximately one-third of the four-year B.A. program is in music, and numerous elective hours outside the department permit considerable study in other academic areas. The B.M. degree affords the student a more concentrated course of study in the major area: approximately two-thirds of the four-year program is in music. The B.M. degree in music education is especially appropriate for students who plan a career teaching music in elementary, middle, or secondary schools. It combines general education with music content and teaching methodology in a highly structured course of study. Successful completion of the program gains the student teaching certification. All three degree programs represent appropriate preparation for graduate study.

In addition to University admission standards, prospective music majors will stand an audition in their primary performing area which will determine the appropriate applied music course level and degree program. All music majors are required to participate in an ensemble for each semester of residence appropriate to the concentration, and must accumulate a minimum of eight hours credit (seven hours for music education majors). For all music majors, a 2.0 average in music courses is required for enrollment in 300 and 400 level music courses. A senior educational experience is required of all majors.

In addition to degree requirements herein listed, other regulations for music majors appear in the current *Music Student Handbook*.