

DEPARTMENT OF MATHEMATICS AND STATISTICS

368 SCIENCE AND ENGINEERING BUILDING
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The Department of Mathematics and Statistics offers programs of study leading to the Bachelor of Arts degree with a major in mathematics, Bachelor of Science degree with a major in mathematics or applied statistics, Master of Science degree in industrial applied mathematics, Master of Science degree in applied statistics, Master of Arts degree in mathematics and Doctor of Philosophy degree in applied mathematical sciences. In addition, the department offers courses that are required or recommended as electives in other academic programs. For further information on the graduate programs offered by the department, see the *Oakland University Graduate Catalog*.

Whether in the B.A. or B.S. program, students are encouraged to elect a variety of applied courses, both inside and outside of the department. The greater the familiarity with applications of mathematics, the greater the possibilities of employment in a world that is becoming more mathematics-oriented each year. Concentrations or minors, or even second majors, are available in computer science, the life sciences, the physical sciences, engineering, business administration, the social sciences and linguistics. Mathematics majors are advised to consult department faculty when planning their programs.

Prerequisites and placement

Each student enrolling in a course offered by the Department of Mathematics and Statistics must meet the prerequisites for that course. Students who do not meet the prerequisites will not be permitted to enroll or remain enrolled in the course.

The prerequisites may be met in a number of ways: by completing the stated prerequisite course(s) with a grade of 2.0 or better; by completing an equivalent course at another university, college or community college with a grade of 2.0 or better; or through placement.

Grades below 2.0 in prerequisite courses are not acceptable, nor are high school courses. In rare cases, the department may grant permission to enroll in a course without the formal prerequisites. Students with unusual circumstances should consult the instructor of the course or a department adviser.

Placement into levels E, I, R, or C, described below, is determined by the mathematics ACT Score or by a placement test. For details on this placement, consult an adviser or the department's Web page at www.math.oakland.edu/undergraduate/prereqs.html. The levels of placement are as follows:

- E: The student is ready for MTH 011* or 118.
- I: The student has demonstrated competence through MTH 011* and is ready for MTH 012* or 118.
- R: The student has demonstrated competence through MTH 012* and is ready for MTH 118, 121, 141; MTE 210 or STA 225.
- C: The student has demonstrated competence through MTH 141 and is ready for MTH 118, 121, 122, 154; MTE 210, STA 225 or 227.

Formal course competency credit is not available in MTH 011*, 012* or 141.

*See information concerning these courses below.

Requirements for the liberal arts major in mathematics, B.A. program

To earn the Bachelor of Arts degree with a major in mathematics, students must:

1. Complete a core of eight courses with a grade of at least 2.0 in each: MTH 154, 155, 254, 275, 302, 452, 475 and STA 226.
2. Complete three additional 3- or 4-credit courses in the mathematical sciences chosen from APM 255, 263, MOR 242, and courses labeled MTH, APM, MOR or STA at the 300-400 level, with the exception of MTH 497, with a grade of at least 2.0 in each. Majors in the secondary education program must choose APM 263, MTH 462 and 414 as these three courses. Well-prepared students may substitute 500-level courses with the approval of the departmental adviser.
3. Complete CSE 130 or EGR 141 with a grade of at least 2.0.
4. Complete two additional 3- or 4-credit courses, as approved by the departmental adviser, in science, engineering or computer science, with an average grade of at least 2.0. Courses used to satisfy this requirement may also be used to satisfy university general education and college distribution requirements. Students in the secondary education program will be deemed to have satisfied this requirement with their secondary teaching minor, regardless of its subject area.

Requirements for the major in mathematics, B.S. program

To earn the Bachelor of Science degree with a major in mathematics, students must:

1. Complete a core of nine courses with a grade of at least 2.0 in each: MTH 154, 155, 254, 275, 302, 452, 453, 475 and STA 226.
2. Complete four additional 3- or 4-credit courses in the mathematical sciences chosen from APM 255, 263, MOR 242, and courses labeled MTH, APM, MOR or STA at the 300-400 level, with the exception of MTH 497, with a grade of at least 2.0 in each. Majors in the secondary education program must include APM 263, MTH 462 and 414 among these four courses. Well-prepared students may substitute 500-level courses with the approval of the departmental adviser.
3. Complete CSE 230 with a grade of at least 2.0.
4. Complete three additional 3- or 4-credit courses, as approved by the departmental adviser, in an area related to mathematics, with an average grade of at least 2.0. The area chosen will normally be in science, engineering, computer science, economics or statistics. Courses used to satisfy this

requirement may also be used to satisfy university general education and college distribution requirements. Students in the secondary education program will be deemed to have satisfied this requirement with their secondary teaching minor, regardless of its subject area.

Requirements for the major in applied statistics, B.S. program

To earn the Bachelor of Science degree with a major in applied statistics, students must:

1. Complete 28 credits in statistics - STA 226, 402, 427, 428 and 12 credits chosen from STA courses numbered above 300 (but not including STA 501-502).
2. Complete MTH 154, 155, 254, 275 and one more course chosen from APM 255, 263, 332, 433, 434; MTH 452; MOR 242, 454, 455, 456.
3. Complete CSE 130 or 141.
4. Complete ENG 380, 381 or 382.
5. Complete a course in ethics given by the Department of Philosophy.
6. Complete 16 credits in a single area outside the Department of Mathematics and Statistics to which statistics could be applied. The 16 credits must include at least one course that is quantitatively oriented. The rest of the 16 credits could come from prerequisite courses or any related courses. These 16 credits must be approved in advance by an adviser in the Department of Mathematics and Statistics. The courses need not be in a single department, but the total package should constitute a substantive examination of a single area.
7. Earn a minimum grade of 2.0 in each mathematical sciences and computer science course used to satisfy the major requirements.

Secondary Teacher Education Program (STEP): Mathematics

The Secondary Teacher Education Program (STEP) at Oakland University is an extended program of study leading to certification. Generally, eligibility into the STEP requires a GPA of 3.00 in both the major and minor, and an overall GPA of 2.80. No single major or minor course grade may be below 2.0. Second undergraduate degree candidates completing major and/or minors may be required to complete additional course work at Oakland University beyond the stated minimums. Students must consult with the secondary education adviser in the department. Students in this program must complete the requirements for a B.A. or B.S. degree in mathematics and include APM 263, MTH 462 and 414 among the mathematics electives. A program in STEP must also include a 20-28 hour secondary teaching minor and a sequence of undergraduate course work in education to include SED 300, FE 345, RDG 538 and SED 427. Extended study including SED 428, 455 and SE 501 is also required. Further details on program and admission requirements and procedures can be found in the School of Education and Human Services portion of the catalog and by consulting advisers in the Department of Mathematics and Statistics and the School of Education and Human Services advising office, 363 Pawley Hall, (248) 370-4182.

Departmental honors

Departmental honors may be awarded to graduating seniors in either the B.A. or the B.S. degree program who have demonstrated outstanding achievement in their mathematical science course work, as evidenced by high grades, high level courses and/or more than a minimum number of courses. Further information is available from the department chairperson. In addition, the department will normally present the Louis R. Bragg Graduating Senior Award each year to the most outstanding graduating mathematics or statistics major.

Requirements for the liberal arts minor in mathematics

To qualify for the liberal arts minor in mathematics, students must take a minimum of 20 credits chosen from MTH 155, 254, 275; APM 255, 263, MOR 242; STA 226 or any 300-400 level courses labeled MTH, APM, MOR or STA, except MTH 497. Each course used to satisfy the minor requirements must be completed with a grade of at least 2.0.

Students majoring in engineering or computer science are not eligible for this program, and should consult Requirements for the applied mathematics minor for students in the School of Engineering and Computer Science below.

Requirements for the minor in applied statistics

To qualify for the minor in applied statistics, students must take a minimum of 20 credits of STA courses, including STA 226, STA 402 and at least three other STA courses at the 300 level or above, excluding STA 501 and STA 502. Each course used to satisfy the minor requirements must be completed with a grade of at least 2.0.

Requirements for the secondary teaching minor in mathematics

To qualify for a secondary teaching minor in mathematics, students must take 28 credits consisting of MTH 154, 155; APM 263; STA 226; MTH 302, 462; and SED 426. A cumulative grade point average of 3.00 is required in courses included in the minor, with no single course grade below 2.0. Second undergraduate degree candidates completing the minor may be required to take additional courses at Oakland University beyond the stated minimums. Students must consult with the secondary education adviser in the department.

Requirements for the applied mathematics minor for students in the School of Engineering and Computer Science

To qualify for the applied mathematics minor, students in the School of Engineering and Computer Science (SECS) must complete the following courses with a grade of at least 2.0 in each: MTH 254, 275, 302 and STA 226 (or another statistics course approved by the departmental adviser) and either MTH 452 or 475.

Skill development courses: MTH 011 and MTH 012

MTH 011 and MTH 012 are skill development courses specially designed to aid incoming students who need additional preparation prior to entering one of the university's standard mathematical sciences sequences. Credits earned in these courses, while part of a student's official record, may not be applied toward minimal graduation requirements in any academic program. Grades earned in these courses will be included in the student's grade point average.

*Note that when a student exercises the repeat option and takes MTH 011 or 012 to replace a grade previously earned in MTH 102, 103, 111 or 112, the grade earned in MTH 011 or 012 will replace the former grade and will remove credits that would have counted toward minimal graduation requirements.

Course Offerings

The department offers selected courses from this catalog as warranted by student needs and availability of faculty. Specific offerings for each term may be found in the *Schedule of Classes*.

MATHEMATICS

MTH 011 **Elementary Algebra (4)**

Order of operations, algebra of exponents, radicals, variable expressions, polynomial arithmetic, factoring, algebraic fractions, linear equations and inequalities in one variable; applications and problem solving. *See note above. *This course cannot be used to satisfy minimal graduation requirements in any program.*

MTH 012 **Intermediate Algebra (4)**

Complex numbers, quadratic equations, nonlinear inequalities, analytic geometry (points and lines in the coordinate plane, distance, circles, parabolas, ellipses and hyperbolas), 2 by 2 and 3 by 3 systems of linear

equations, introduction to functions and their graphs, theory of equations, logarithms, applications and problem solving. *See note above. *This course cannot be used to satisfy minimal graduation requirements in any program.*

Prerequisite: MTH 011 with a grade of 2.0 or higher or placement.

MTH 052 Intermediate Algebra Workshop (2)

Students work cooperatively in groups to solve challenging problems based on the mathematics in MTH 012. The students will learn computational and theoretical mathematics taught through discovery rather than by lecture. Open only to students concurrently enrolled in MTH 012.

Corequisite: MTH 012 with a grade of 2.0 or higher.

MTH 118 Mathematical Sciences in the Modern World (4)

Designed for students without an extensive mathematics background who wish to explore the ways people use mathematical sciences to solve problems that arise in modern society. *Satisfies the university general education requirement in the formal reasoning knowledge foundation area.*

MTH 121 Linear Programming, Elementary Functions (4)

Systems of equations, matrices, and linear programming (simplex method); rational, exponential and logarithmic functions. *Satisfies the university general education requirement in the formal reasoning knowledge foundation area.*

Prerequisite: MTH 012 with a grade of 2.0 or higher or placement.

MTH 122 Calculus for the Social Sciences (4)

The basic concepts, theorems and applications to the social sciences of the differential and integral calculus of one and several variables. *Satisfies the university general education requirement in the formal reasoning knowledge foundation area.*

Prerequisite: MTH 121 with a grade of 2.0 or higher or 141 with a grade of 2.0 or higher or placement.

MTH 141 Precalculus (4)

Functions, roots of polynomials, rational, exponential and logarithmic functions, trigonometric functions (including graphs, identities, inverse functions, equations and applications), complex numbers, analytic geometry and conic sections.

Prerequisite: MTH 012 with a grade of 2.0 or higher or placement.

MTH 142 Precalculus Workshop (2)

Students work cooperatively in groups to solve challenging problems based on the mathematics in MTH 141. The students will learn computational and theoretical mathematics taught through discovery rather than by lecture. Open only to students concurrently enrolled in MTH 141.

Corequisite: MTH 141.

MTH 154 Calculus I (4)

A detailed study of limits, continuity, derivatives of algebraic and transcendental functions, applications of derivatives, numerical techniques, integrals and the Fundamental Theorem of Calculus. *Satisfies the university general education requirement in the formal reasoning knowledge foundation area.*

Prerequisite: MTH 141 with a grade of 2.0 or higher or placement.

MTH 155 Calculus II (4)

A detailed study of methods of integration, applications of the integrals, improper integrals, sequences, series and power series, polar coordinates, and parametric curves. *Satisfies the university general education requirement for the knowledge applications integration area. Prerequisite for knowledge applications: completion of the university general education requirement in the formal reasoning knowledge foundation area.*

Prerequisite: MTH 154 with a grade of 2.0 or higher.

MTH 205 Special Topics (2 or 4)

Intermediate study of a selected topic in mathematics. May be repeated for additional credit.

MTH 254 Multivariable Calculus (4)

A study of vectors, polar coordinates, three-dimensional geometry, differential calculus of functions of several variables, exact differential equations, multiple integrals, line and surface integrals, and vector fields.

Prerequisite: MTH 155 with a grade of 2.0 or higher.

MTH 256 Introduction to Linear Algebra (3)

An introduction to the theoretical and computational aspects of linear algebra. Topics covered include linear equations, vectors and matrices, matrix algebra, determinants, Eigenvalues and eigenvectors, linear transformations, vector spaces and inner product spaces.

Prerequisite: MTH 155 with a grade of 2.0 or higher.

MTH 266 Linear Algebra Laboratory (1)

Computational investigation of selected topics in linear algebra.

Prerequisite or corequisite: MTH 275 with a grade of 2.0 or higher (or 256 with a grade of 2.0 or higher).

MTH 275 Linear Algebra (4)

Study of general vector spaces, linear systems of equations, linear transformations and compositions, Eigenvalues, eigenvectors, diagonalization, modeling and orthogonality. Provides a transition to formal mathematics. Replaces MTH 256. Student cannot receive credit for both MTH 256 and MTH 275.

Prerequisite: MTH 155 with a grade of 2.0 or higher.

MTH 290 Independent Study (2 or 4)

Reading or research on some mathematical topic. May be repeated for additional credit.

Prerequisite: permission of department.

MTH 301 Putnam Seminar (0 or 2)

This seminar meets one evening per week. Students solve and present solutions to challenging mathematical problems in preparation for the William Lowell Putnam Mathematical Competition, a national undergraduate mathematics competition. May be repeated three times for additional credit.

Prerequisite: permission of instructor.

MTH 302 Introduction to Advanced Mathematical Thinking (4)

The propositional and predicate calculus, set theory, methods of mathematical proof, inductive and recursive thinking, relations and functions, infinity. Emphasis is on rigorous proofs of mathematical statements. Offered every fall.

Prerequisite: MTH 275 with a grade of 2.0 or higher (or 256 with a grade of 2.0 or higher) or APM 263 with a grade of 2.0 or higher or permission of department.

MTH 352 Complex Variables (4)

A study of analytic functions of a complex variable including differentiation and integration, series representations, the theory of residues and applications.

Prerequisite: MTH 254 with a grade of 2.0 or higher.

MTH 405 Special Topics (2 or 4)

Advanced study of a selected topic in mathematics. May be repeated for additional credit.

Prerequisite: permission of instructor.

MTH 414 History of Mathematics (4)

Mathematics from ancient to modern times, its growth, development and place in human culture. Offered every winter.

Prerequisite: MTH 302 with a grade of 2.0 or higher or permission of instructor.

MTH 415 Foundations of Mathematics: Mathematical Logic and Set Theory (4)

An examination of the logical foundations of mathematics including analysis of the axiomatic method, basic set theory, cardinal and ordinal numbers, and the axiom of choice.

Prerequisite: MTH 302 with a grade of 2.0 or higher.

MTH 452 Advanced Calculus I (4)

The topology of the real number line and of n -dimensional Euclidean space, continuity and uniform continuity, derivatives, the Riemann integral, sequences and series, uniform convergence. Offered every fall. (Students cannot receive credit for both MTH 351 and MTH 452.)

Prerequisite: MTH 254 with a grade of 2.0 or higher and 302 with a grade of 2.0 or higher or permission of department.

MTH 453 Advanced Calculus II (4)

Improper integrals, derivatives and integrals in n -dimensional Euclidean space, implicit and inverse function theorems, differential geometry and vector calculus, and Fourier series. Offered every winter.

Prerequisite: MTH 452 with a grade of 2.0 or higher.

MTH 461 General Topology (4)

A study of topological spaces and continuous functions. Separation and countability properties, connectedness, compactness and local properties.

Prerequisite: MTH 302 with a grade of 2.0 or higher.

MTH 462 Geometric Structures (4)

A study of topics from Euclidean geometry, projective geometry, non-Euclidean geometry and transformation geometry. Offered every fall. (Students cannot receive credit for both MTH 361 and MTH 462.)

Prerequisite or corequisite: MTH 302 with a grade of 2.0 or higher or permission of department.

MTH 465 Differential Geometry (4)

Theory of curves and surfaces in Euclidean space with an introduction to the theory of matrix Lie groups.

Prerequisite: MTH 453 with a grade of 2.0 or higher.

MTH 472 Number Theory with Cryptography (4)

Structure of the integers, prime factorization, congruences, multiplicative functions, primitive roots and quadratic reciprocity, and selected applications including cryptography. (Students cannot receive credit for both MTH 372 and MTH 472.)

Prerequisite: MTH 155 with a grade of 2.0 or higher.

MTH 475 Abstract Algebra (4)

Groups, subgroups, cosets, and homomorphisms; rings and ideals; integral domains; and fields and field extensions. Applications. Offered every winter.

Prerequisite: MTH 302 with a grade of 2.0 or higher or permission of department.

MTH 490 Independent Study (2 or 4)

Reading or research on some mathematical topic. May be repeated for additional credit.

Prerequisite: permission of department.

MTH 497 Apprentice College Teaching (2 or 4)

Open to any well-qualified junior or senior who obtains consent of a faculty member to assist in presenting a regular college course. The apprentice should be capable of assuming limited classroom teaching duties. May be repeated for additional credit. Graded S/U.

Prerequisite: permission of department.

APPLICABLE ANALYSIS AND MATHEMATICAL MODELING**APM 163 Mathematics for Information Technology (4)**

Systems of linear equations, matrix algebra and linear transformations. Elementary combinatorics, recursion and induction, sets and relations. Enrollment is limited to students in the Bachelor of Science in Information Technology program or with permission of the department. APM 163 cannot be used to replace APM 263 or MTH 256 (or MTH 275). *Satisfies the university general education requirement in the knowledge applications integration area. Prerequisite for knowledge application integration: completion of the general education requirement in the formal reasoning knowledge foundation area or in the natural science and technology knowledge exploration area.*

Prerequisite: MTH 122 with a grade of 2.0 or higher or MTH 154 with a grade of 2.0 or higher.

APM 255 Introduction to Differential Equations with Matrix Algebra (4)

Introduction to ordinary differential equations, Laplace transforms, linear systems, matrices, vectors, independence, Eigenvalues and eigenvectors, and applications. Replaces APM 257 and students cannot receive credit for both APM 255 and APM 257.

Prerequisite: MTH 155 with a grade of 2.0 or higher.

APM 257 Introduction to Differential Equations (3)

An introduction to the basic methods of solving ordinary differential equations, including the methods of undetermined coefficients, variation of parameters, series, Laplace transforms and numerical methods. Separable, exact and linear equations. Applications.

Prerequisite: MTH 155 with a grade of 2.0 or higher.

APM 263 Discrete Mathematics (4)

Concepts and methods of discrete mathematics with an emphasis on their application to computer science. Logic and proofs, sets and relations, algorithms, induction and recursion, combinatorics, graphs and trees.

Prerequisite: MTH 155 with a grade of 2.0 or higher.

APM 332 Applied Matrix Theory (4)

Eigenvalues, eigenvectors and their applications, matrix calculus, linear differential equations, Jordan canonical forms, and quadratic forms. Time will also be spent on various computational techniques.

Prerequisite: MTH 275 with a grade of 2.0 or higher (or 256 with a grade of 2.0 or higher).

APM 357 Elements of Partial Differential Equations (4)

Partial differential equations of physics, Fourier methods, Laplace transforms, orthogonal functions, initial and boundary value problems, and numerical methods.

Prerequisite: MTH 254 with a grade of 2.0 or higher and APM 255 with a grade of 2.0 or higher (or 257).

APM 367 Design and Analysis of Algorithms (4)

Computer algorithms, their design and analysis. Strategies for constructing algorithmic solutions, including divide-and-conquer, dynamic programming and greedy algorithms. Development of algorithms for parallel and distributed architectures. Computational complexity as it pertains to time and space is used to evaluate the algorithms. A general overview of complexity classes is given. Identical with CSE 361.

Prerequisite: CSE 231 and APM 263 with a grade of 2.0 or higher.

APM 381 Theory of Computation (4)

Formal models of computation, including finite state automata, pushdown automata and Turing machines. Regular and context-free languages. The computational models are used to discuss computability issues. Identical with CSE 343.

Prerequisite: APM 367 with a grade of 2.0 or higher.

APM 405 Special Topics (2 or 4)

Advanced study of a selected topic in applied mathematics. May be repeated for additional credit.

Prerequisite: permission of instructor.

APM 433 Numerical Methods (4)

Propagation of errors, approximation and interpolation, numerical integration, methods for the solution of equations, Runge-Kutta and predictor-corrector methods. Offered fall of even-numbered years.

Prerequisite: MTH 275 with a grade of 2.0 or higher (or 256 with a grade of 2.0 or higher), APM 255 with a grade of 2.0 or higher (or 257 with a grade of 2.0 or higher) and knowledge of a scientific programming language, or permission of the instructor.

APM 434 Applied Numerical Methods: Matrix Methods (4)

Systems of linear equations, Gaussian elimination, LU factorization, approximation and curve fitting, Eigenvalue problems, and nonlinear systems. Offered winter of odd-numbered years.

Prerequisite: MTH 254 with a grade of 2.0 or higher, 275 with a grade of 2.0 or higher (or 256 with a grade of 2.0 or higher) and knowledge of a scientific programming language, or permission of the instructor.

APM 455 Intermediate Ordinary Differential Equations (4)

Review of elementary techniques, existence and uniqueness theory, series methods, systems of equations, oscillation and comparison theorems, Sturm-Liouville theory, stability theory and applications.

Prerequisite: APM 255 with a grade of 2.0 or higher (or 257 with a grade of 2.0 or higher) and MTH 452 with a grade of 2.0 or higher.

APM 463 Graph Theory and Combinatorial Mathematics (4)

Introduction to combinatorics. Topics include techniques of enumeration, fundamental concepts of graph theory, applications to transport networks, matching theory and block design. Offered every fall.

Prerequisite: MTH 275 with a grade of 2.0 or higher (or 256 with a grade of 2.0 or higher) and APM 263 with a grade of 2.0 or higher.

APM 477 Computer Algebra (4)

The mathematics and algorithms for symbolic computation. Includes theory of algebraic extensions, modular and p-adic methods, Groebner bases, factorization and zeros of polynomials, solutions to systems of polynomial equations, applications to automatic geometric theorem proving and closed form solutions to differential equations.

Prerequisite: MTH 275 with a grade of 2.0 or higher (or 256 with a grade of 2.0 or higher) and knowledge of a scientific computer programming language, or permission of instructor.

APM 490 Independent Study (2 or 4)

Reading or research on some topic in applied mathematics. May be repeated for additional credit.

Prerequisite: permission of department.

STATISTICS**STA 225 Introduction to Statistical Concepts and Reasoning (4)**

Statistical ideas and thinking relevant to public policy, quality improvement, and physical and social sciences. Data collection and presentation; association; normal distribution; probability and simulation;

and confidence intervals, p-values, and hypothesis testing. *Satisfies the university general education requirement in the formal reasoning knowledge foundation area.*

Prerequisite: MTH 012 with a grade of 2.0 or higher or placement.

STA 226 Applied Probability and Statistics (4)

Introduction to probability and statistics as applied to the physical, biological and social sciences and to engineering. Applications of special distributions and nonparametric techniques. Regression analysis and analysis of variance. *Satisfies the university general education requirement in the formal reasoning knowledge foundation area.*

Prerequisite or corequisite: MTH 122 with a grade of 2.0 or higher or 154 with a grade of 2.0 or higher.

STA 227 Introduction to Statistical Methods (4)

Introduction to statistical thinking and applications to industrial and similar processes. Descriptive statistics, distributions, and probability models useful in process control and systems reliability; confidence intervals, hypothesis testing, regression, and basic experimental design. Statistical concepts to be reinforced with case studies promoting problem solving skills and statistical thinking. STA 227 cannot be used to replace STA 226.

Prerequisite: MTH 121 with a grade of 2.0 or higher or MTH 141 with a grade of 2.0 or higher or placement.

STA 402 Applied Linear Models I (4)

Basic results from probability and statistics, linear regression, model testing and transformations, matrix methods in multiple regression, polynomial regression, indicator variables, basics of experimental design, one-way ANOVA with fixed and random effects.

Prerequisites: STA 226 with a grade of 2.0 or higher or permission of instructor.

STA 403 Applied Linear Models II (4)

Multi-way ANOVA, randomized block and Latin square designs, incomplete blocks, factorial and fractional factorial designs, confounding, response surface methods, random and mixed models, introduction to generalized linear models.

Prerequisites: STA 402 with a grade of 2.0 or higher or permission of instructor.

STA 405 Special Topics (2 or 4)

Advanced study of a selected topic in statistics. May be repeated for additional credit.

Prerequisite: permission of instructor.

STA 424 Analysis of Categorical Data (4)

Analysis techniques for data obtained by counting responses in different categories. Discrete distributions, goodness of fit, contingency tables, association and agreement measures, loglinear and logit models.

Prerequisites: STA 402 with a grade of 2.0 or higher or permission of instructor.

STA 425 Elements of Stochastic Processes (4)

Random walk models, Markov chains and processes, birth and death processes, queuing processes, diffusion processes and non-Markov processes.

Prerequisite: STA 427 with a grade of 2.0 or higher or permission of instructor; APM 255 with a grade of 2.0 or higher (or 257 with a grade of 2.0 or higher) recommended.

STA 426 Nonparametric Methods (4)

Permutation and rank tests for location and scale, bootstrapping, power of competing tests, confidence intervals, nonparametric regression and analysis of variance methods, density estimation.

Prerequisite or corequisite: STA 402 with a grade of 2.0 or higher or 427 with a grade of 2.0 or higher or permission of instructor.

STA 427 Introduction to Mathematical Statistics I (4)

The distribution of random variables, conditional probability and stochastic independence, special distributions, functions of random variables.

Prerequisite: STA 226 with a grade of 2.0 or higher, MTH 254 with a grade of 2.0 or higher, MTH 275 with a grade of 2.0 or higher (or MTH 256 with a grade of 2.0 or higher).

STA 428 Introduction to Mathematical Statistics II (4)

Interval estimation, sufficient statistics and completeness, point estimation, tests of hypothesis and analysis of variance.

Prerequisite: STA 427 with a grade of 2.0 or higher.

STA 490 Independent Study (2 or 4)

Reading or research on some statistical topic. May be repeated for additional credit.

Prerequisite: permission of department.

OPERATIONS RESEARCH**MOR 242 Elementary Models in Operations Research (4)**

Basic techniques in deterministic modeling. Linear, combinatorial, and nonlinear models of real life applications are constructed, solved with optimization software and critically analyzed. Substantial writing component.

Prerequisite: MTH 155 with a grade of 2.0 or higher.

MOR 454 Linear and Integer Optimization (4)

Topics include linear and integer programming models, simplex method, complementary slackness, duality, sensitivity analysis, interior point methods, systems of alternatives and branch-pricecut.

Prerequisite: MTH 254 with a grade of 2.0 or higher and MTH 275 with a grade of 2.0 or higher (or 256 with a grade of 2.0 or higher).

MOR 455 Nonlinear Optimization (4)

Topics include nonlinear programming, convex programming, unconstrained optimization, first and second order conditions, constrained optimization, KKT conditions, quadratic programming and separable convex programming.

Prerequisite: MOR 454 with a grade of 2.0 or higher.

MOR 456 Stochastic Models in Operations Research (4)

Stochastic processes including Markov chains with applications to the development and analysis of queuing models. Further topics drawn from such areas as reliability, decision analysis, stochastic inventory control and simulation.

Prerequisite: MTH 254 with a grade of 2.0 or higher and MTH 275 with a grade of 2.0 or higher (or 256 with a grade of 2.0 or higher) and STA 226 with a grade of 2.0 or higher.

MATHEMATICS FOR ELEMENTARY EDUCATION MAJORS**MTE 210 Numerical Structures (4)**

Elementary set and number theory. Components of the real number system. History of numeration. Algorithms of arithmetic. Other general algebraic structures. Problem solving. Enrollment limited to elementary education majors.

Prerequisite: MTH 012 with a grade of 2.0 or higher or placement.

MTE 211 Structures of Geometry (4)

An informal approach to geometry including topics from Euclidean and transformational geometries. Stress is placed on topics close to the elementary school curriculum such as mensuration formulae, ruler

and compass construction, symmetries, congruence and similarity, and figures in two and three-dimensional Euclidean spaces. Enrollment is limited to elementary education majors.

Prerequisite: MTE 210 with a grade of 2.0 or higher.

MTE 405 Special Topics (2 or 4)

Study of mathematical topics particularly relevant for prospective teachers of elementary and middle school mathematics. May be repeated for additional credit.

Prerequisite: MTE 211 with a grade of 2.0 or higher or permission of instructor.

MTE 410 Elementary School Mathematics and the Computer (4)

An introduction to creative uses of computers in teaching mathematics in the elementary school, including program design, machine architecture, and the BASIC and LOGO computing languages. Enrollment is limited to elementary education majors.

Prerequisite: MTE 211 and STA 225 with a grade of 2.0 or higher.