

---

## MATHEMATICS

---

### MATHEMATICS MA

(WITH BROAD SELECTION EMPHASIS,  
MATHEMATICS AND COMPUTER SCIENCE EMPHASIS, OR  
COMMUNITY COLLEGE TEACHING EMPHASIS)

### MATHEMATICS AND STATISTICS MS

### MATHEMATICS EDUCATION MS

(DISCIPLINE-BASED)

College of Science, Engineering, & Technology  
Department of Mathematics and Statistics  
273 Wissink Hall • 507-389-1453

Chair: Larry Pearson, Ph.D.  
Graduate Coordinators: Dan Singer, Ph.D.  
Mathematics Education: Kil S. Lee, Ed. D.

Ernest Boyd, Ph.D.; Maureen H. Fenrick, Ph.D.; Francis T. Hannick, Ph.D.; Pavel Kitsul, Ph.D.; Mary Ann Lee, Ph.D.; Namyong Lee, Ph.D.; R. Bruce Mericle, Ph.D.; Larry Pearson, Ph.D.; Mezbahur Rahman, Ph.D.; Gary Rockswold, Ph.D.; Dan Singer, Ph.D.; Chia-Chi Tung, Ph.D.; Charles Waters, Ph.D.; Mary Wiest, Ph.D.; Mark Zuiker, Ph.D.

---

The Department of Mathematics and Statistics offers five programs leading to a master's degree in Mathematics and Statistics. The Master of Arts programs allow students to study pure mathematics or mathematics for community college teaching. The Master of Science programs allow students to specialize in secondary teaching, statistics or math and computer science.

Fourteen graduate faculty support the graduate programs. Faculty specialties include category theory, differential equations, geometry, group theory, matrix theory, mathematics education, modeling, numerical analysis, real and complex analysis, ring theory, statistics, applied statistics and topology, discrete math and combinatorics.

The graduate programs are small enough to allow one-on-one interaction between faculty and students. Class sizes are small.

Graduates of the program have found employment in a variety of fields, including software engineering, graphic design, insurance, community college teaching, secondary mathematics teaching and as statisticians. Others have gone on to obtain a Ph.D. in mathematics.

Admission. In addition to completing the general admission requirement for the College of Graduate Studies and Research, applicants with grade point averages below 2.75 may qualify by presenting GRE verbal, quantitative and analytical scores of 500 on any one part or a minimum composite of 1350.

Facilities. The Department of Mathematics and Statistics is housed in Wissink Hall. This building is also home to the Academic Computing Center which houses over 400 up-to-date workstations on both PC and Macintosh platforms, and a computer-equipped classroom designed for the teaching of mathematics and statistics. The classroom computers are equipped with mathematical and statistical software including Mathematica, Matlab, SPSS, Geometer's Sketchpad, and Minitab. Students also have access to Unix mainframe machines. The internet is easy to access through the campus wide wireless network.

A new addition to the Memorial Library was recently completed. The library has a wide range of mathematical texts and journals. The library also supports MINITEX, a service which provides access to literature not found in the library's collection.

Financial Assistance. Approximately 15 graduate assistantships are available in the department each year. Graduate assistant duties include teaching or research assistantships.

### MATHEMATICS MA

The Master of Arts program allows students to choose a course of studies devoted to one of three different emphases: a broad selection of courses in mathematics, a sequence of courses in both mathematics and computer science, or preparation for community college teaching.

### MATHEMATICS MA

(Broad Selection Emphasis)  
Thesis Plan - 34 credits  
Alternate Plan Paper - 34 credits

#### Required Core Courses (29-31 credits)

The first four courses (or their equivalent) are required. Only two of them may be counted towards the degree. The other two will be regarded as deficiencies.

MATH 517 Real Analysis I (3)  
MATH 547 Linear Algebra (3)  
MATH 570 Numerical Analysis (4)  
STAT 555 Theory of Statistics I (4) and  
MATH 518 Real Variables II (3)  
MATH 605 Graphs and Algorithms (3)  
MATH 611 Real Analysis (3)  
MATH 620 Applied Mathematics (3)  
MATH 641 Topics in Modern Abstract Algebra (3)  
STAT 653 Linear Models (3)  
MATH 672 Numerical Solutions of Ordinary Differential Equations (2) or  
MATH 674 Computations in Linear Algebra (2)  
MATH 692 Point Set Topology (3)

#### Required Elective Courses (0-4 credits)

500/600 level courses that must be approved by the student's advisor.

#### Required Thesis or Alternate Plan Paper

MATH 694 Alternate Plan Paper (1)  
MATH 699 Thesis (3)

Additional Requirements: At least half of the credits applied to the program must be earned in 600 level courses excluding thesis or alternate plan paper credits. Each student is assigned an initial advisor. After completing 16 credits the student must select a three-member examining committee and form a program of study. A student may choose to write an alternate plan paper or thesis. This program requires a comprehensive exam, and an oral defense of the alternate plan paper or thesis.

### MATHEMATICS MA

(Mathematics and Computer Science Emphasis)  
Thesis Plan - 34 credits  
Alternate Plan Paper - 34 credits

#### Required Core Courses (30-32 credits)

The first four courses (or their equivalent) are required. Only two of them may be counted towards the degree. The other two will be regarded as deficiencies.

MATH 517 Real Analysis I (3)  
MATH 547 Linear Algebra (3)  
MATH 570 Numerical Analysis (4)  
STAT 555 Theory of Statistics I (4) and  
MATH 605 Graphs and Algorithms (3)  
MATH 620 Applied Mathematics (3)  
MATH 672 Numerical Solutions of Ordinary Differential Equations (2) or  
MATH 674 Computations in Linear Algebra (2)  
COMS 520 Computer Organization II (4)  
COMS 560 Operating Systems (4)  
COMS 610 Algorithm Analysis (3)  
COMS 611 Theory of Computation (3)

#### Required Elective Courses (0-4 credits)

500/600 level courses that must be approved by the student's advisor.

#### Required Thesis or Alternate Plan Paper

MATH 694 Alternate Plan Paper (1)  
MATH 699 Thesis (3)

Additional Requirements: At least half of the credits applied to a program must be earned in 600 level courses excluding thesis or alternate plan paper credits. After completing 16 credits the student must select a three-member examining committee and form a program of study. A student may choose to write an alternate plan paper or thesis. This program requires a comprehensive exam, and an oral defense of the alternate plan paper or thesis.

### MATHEMATICS MA

(Community College Teaching Emphasis)

---

Thesis Plan - 34 credits  
 Alternate Plan Paper - 34 credits

Students interested in teaching at the Community College level should see their advisor about identifying methods courses to strengthen their teaching ability. Licensure is not required to teach at the Community College level, but courses in teaching skills are recommended.

Required Core Courses (27-29 credits)

The first four courses (or their equivalent) are required. Only two of them may be counted towards the degree. The other two will be regarded as deficiencies.

- MATH 517 Real Analysis I (3)
- MATH 547 Linear Algebra (3)
- MATH 570 Numerical Analysis (4)
- STAT 555 Theory of Statistics I (4) and
- MATH 518 Real Variables II (3)
- MATH 611 Real Analysis (3)
- MATH 620 Applied Mathematics (3)
- MATH 641 Topics in Modern Abstract Algebra (3)
- STAT 653 Linear Models (3)
- MATH 692 Point Set Topology (3)
- EDFN 671 Learning and Teaching in Higher Education (3)

Required Elective (2-6 credits)

500/600 level courses that must be approved by the student's advisor.

Required Thesis or Alternate Plan Paper

- MATH 694 Alternate Plan Paper (1)
- MATH 699 Thesis (3)

Additional Requirements:

At least half of the credits applied to the program must be earned in 600 level courses excluding thesis or alternate plan paper credits. After completing 16 credits the student must select a three-member examining committee and form a program of study. A student may choose to write an alternate plan paper or thesis. This program requires a comprehensive exam, and an oral defense of the alternate plan paper or thesis.

MATHEMATICS AND STATISTICS MS

Thesis Plan - 34 credits  
 Alternate Plan Paper - 34 credits

Required Core (27-29 credits)

Two of the following four courses (6-8 credits). The remaining two courses shall be treated as deficiencies if they are not part of the student's academic background.

- MATH 517 Real Analysis I (3)
- MATH 547 Linear Algebra (3)
- MATH 570 Numerical Analysis (4)
- STAT 555 Theory of Statistics I (4) and
- STAT 550 Regression Analysis (3)
- STAT 551 Experimental Designs (3)
- STAT 556 Theory of Statistics II (4)
- STAT 653 Linear Models (3)
- STAT 680 Topics in Statistics (3)
- STAT 696 Statistical Inference Packages (3)
- MATH 672 Numerical Solutions of Ordinary Differential Equations (2) or
- MATH 674 Numerical Linear Algebra (2)

Required Electives (2-6 credits)

500/600 level courses that must be approved by the student's advisor.

Required Thesis or Alternate Plan Paper

- MATH 694 Alternate Plan Paper (1)
- MATH 699 Thesis (3)

Additional Requirements:

At least half of the credits applied to a program must be earned in 600-level courses excluding thesis or alternate plan paper credits. After completing 16 credits the student must select a three-member examining committee and form a program of study. A student may choose to write an alternate plan paper or thesis. This program requires a comprehensive exam, and an oral defense of the alternate plan paper or thesis.

MATHEMATICS EDUCATION MS  
 (DISCIPLINE-BASED)

Thesis Plan - 34 credits  
 Alternate Plan Paper - 34 credits

Teaching licensure is a prerequisite to pursuing this degree which is for teachers interested in a graduate program in teaching mathematics. This degree does not lead to initial teaching licensure. Students who desire initial licensure should consult the Master of Arts in Teaching (MAT) program listed in this bulletin.

Required Core (18 credits)

- MATH 517 Real Analysis I (3)
- MATH 641 Topics in Modern Abstract Algebra (3)
- MATH 661 Mathematical Problem Solving and Modeling for Teachers (3)
- MATH 662 Algebraic Structures in School Mathematics (3)
- MATH 663 Geometric Structures in School Mathematics (3)
- MATH 690 Research in Mathematics Education (3)

Required Professional Education Courses (6 credits)

Any 500/600 level Professional Education courses that must be approved by the student's advisor.

Required Electives (7-9 credits)

Any 500/600 level courses must be approved by student's advisor in order to fulfill the total required hours

Required Thesis or Alternate Plan Paper

- MATH 694 Alternate Plan Paper (1)
- MATH 699 Thesis (3)

Additional Requirements:

At least half of the credits applied to a program must be earned in 600-level courses excluding thesis or alternate plan paper credits. After completing 16 credits the student must select a three-member examining committee and form a program of study. A student may choose to write an alternate plan paper or thesis. This program requires a comprehensive exam, and an oral defense of the alternate plan paper or thesis.

COURSE DESCRIPTIONS

MATHEMATICS

MATH 511 (4) Introduction to Complex Variables  
 Algebra and geometry of complex numbers, analytic functions, power series, Cauchy's theorem and residue theorem.  
 Prerequisite: MATH 223 and 290

MATH 517 (3) Real Analysis I  
 Limits and continuity, sequences and series, differentiation and integration.  
 Prerequisite: MATH 223 and 290

MATH 518 (3) Real Analysis II  
 Topology of Euclidean spaces, continuous functions, sequences of functions, and differentiable mappings.  
 Prerequisite: MATH 417

MATH 522 (4) Partial Differential Equations  
 This course presents the theory, computations, and applications of partial differential equations and Fourier series.  
 Prerequisite: MATH 223 and 321

MATH 525 (4) Mathematical Modeling  
 This course presents topics from mathematical analysis of both discrete and continuous models taken from problems in the natural sciences, economics, and resource management.  
 Prerequisite: MATH 223 and 247

MATH 535 (4) Modern Geometry  
 Geometry of spaces including Euclidean and non-Euclidean and applications of contemporary geometry.  
 Prerequisite: MATH 332 or Con

MATH 542 (4) Theory of Numbers  
 Euclidean algorithm, primes, composites, number theoretic functions, congruences,

---

## MATHEMATICS

---

Diophantine equations, Euler and Fermat theorems, and algebraic number fields.  
Prerequisite: MATH 345

### MATH 546 (4) Abstract Algebra II

A continuation of MATH 345. The course will include topics from groups, rings, and fields.  
Prerequisite: MATH 345

### MATH 547 (3) Linear Algebra II

An in-depth study of linear operators and their related spaces, dimension, rank, matrix representation of linear operators, special matrices, determinants, eigenvectors, and eigenvalues.  
Prerequisite: MATH 345 or Con

### MATH 555 (4) Theory of Statistics I

A mathematical approach to statistics with derivation of theoretical results and of basic techniques used in applications. Includes probability, continuous probability distributions, multivariate distributions, functions of random variables, central limit theorem, and statistical inference. Same as STAT 555  
Prerequisite: MATH 223

### MATH 556 (4) Theory of Statistics II

A mathematical approach to statistics with derivation of theoretical results and of basic techniques used in applications, including sufficient statistics, additional statistical inference, theory of statistical tests, inferences about normal models, and non-parametric methods. Same as STAT 556.  
Prerequisite: MATH/STAT 555

### MATH 570 (4) Numerical Analysis I

This course provides an introduction to techniques and analysis involved with solving mathematical problems using technology. Topics included are errors in computation, solutions of linear and nonlinear equations, numerical differentiation and integration, and interpolation.  
Prerequisite: MATH 122, 247, and FORTRAN

### MATH 571 (4) Numerical Analysis II

This course is a continuation of MATH 470. Topics included are the algebraic eigenvalue problem, least-squares approximation, solutions of systems of nonlinear equations, and numerical solutions of ordinary differential equations.  
Prerequisite: MATH 470 and 223

### MATH 580 (3) History of Mathematics

The development of selected topics from before the Hellenistic time period to the late twentieth century. Familiarity with the content of HIST 180 is beneficial.  
Prerequisite: MATH 345

### MATH 583 (3) Viewpoint of 5-8 School Mathematics

### MATH 584 (3) Technology in 5-12 School Mathematics

This course is designed to inform secondary mathematics teachers about effective utilization of technology in the mathematics curriculum.  
Prerequisite: MATH 345 and CI 447

### MATH 588 (1-3) Seminar

A course of study in which a group of students study a topic by examining results through reports and discussions. May be repeated for credit on each new topic.

### MATH 590 (1-4) Workshop

A short course devoted to a specific mathematical topic. May be repeated for credit on each new topic.

### MATH 591 (1-4) In-Service

A course designed to upgrade the qualifications of persons on-the-job. May be repeated on each new topic.

### MATH 595 (1-4) Selected Topics

A course in an area of mathematics not regularly offered. May be repeated on each new topic.

### MATH 596 (3) Mathematical Logic

Propositional logic, first and second order logic, completeness, consistency, models of theories, and Godel's Incompleteness theorem.  
Prerequisite: MATH 345 and PHIL 411

### MATH 598 (1-12) Internship

Provides a student the opportunity to gain expertise and experience in a special field under the supervision of a qualified person.

### MATH 605 (3) Graphs and Algorithms

Mathematical concepts of graph theory applied to problems that have algorithmic solutions.  
Prerequisite: MATH 417, 375, and 447

### MATH 606 (3) Topics in Discrete Mathematics

Can be used for any graduate level discrete mathematics course not offered as a regular course. Distinct offerings may be repeated for credit.  
Prerequisite: MATH 375 and 447

### MATH 608 (1-4) Seminar in Elementary Mathematics

An opportunity for a group of elementary teachers to study a mutual problem in mathematics.

### MATH 611 (3) Real Analysis

Measure theory, integration, metric spaces, and Banach spaces.  
Prerequisite: MATH 417

### MATH 613 (3) Topics in Analysis

Can be used for any graduate level analysis course not offered as a regular course. Distinct offerings may be repeated for credit.  
Prerequisite: MATH 417, or Con

### MATH 618 (3) Functional Analysis

An introduction to the basic concepts and principles of functional analysis. Normed spaces, Banach spaces, Hilbert spaces, and approximation theory are studied.  
Prerequisite: MATH 417 and 447

### MATH 620 (3) Applied Mathematics

Applications of discrete and continuous mathematics to deterministic problems in the natural sciences, computer science, engineering, and economics. Applied problems will be developed within the mathematical framework of dimensional analysis, asymptotic analysis, perturbation theory, stability, and bifurcation.  
Prerequisite: MATH 321, 417, and 447

### MATH 621 (3) Topics in Applied Mathematics

Can be used for any graduate level applied mathematics course not offered as a regular course. Distinct offerings may be repeated for credit.  
Prerequisite: MATH 417, 422, and 447

### MATH 625 (3) Complex Variables

The theory of functions of one complex variable. Complex numbers, contour integration, analytic functions, residues, and power series.  
Prerequisite: MATH 417

### MATH 635 (3) Topics in Geometry

This course presents selected topics in projective, transformational, and differential geometry.  
Prerequisite: Con

### MATH 641 (3) Topics in Modern Abstract Algebra

A rigorous excursion through some of the topics of abstract algebra, which are essential components of the background of a masters level graduate student.  
Prerequisite: MATH 345

### MATH 645 (3) Topics in Algebra

This course will cover advanced topics such as (but not limited to) free abelian groups, group rings, noetherian/generalized noetherian rings, coherent/generalized coherent rings, homological algebra, homological dimension theory, representation theory of finite fields, galois theory of equations, field theory, valuation theory, and semigroups.  
Prerequisite: MATH 641 or equivalent

### MATH 661 (3) Mathematical Problem Solving & Modeling for Teachers

Heuristics in mathematical problem solving and mathematical modeling for teachers.

### MATH 662 (3) Algebraic Structures in School Mathematics

---

Algebraic concepts and procedures interpreted and related from the perspectives of abstract algebra, cognitive research on the learning of algebra, and professional curriculum and instruction programs.

Prerequisite: MATH 345, or Con

MATH 663 (3) Geometric Structures in School Mathematics

The Van Hiele model of the development of geometric thought and recent developments of geometric theory and applications which are related to the school mathematics curriculum.

Prerequisite: MATH 332

MATH 672 (2) Numerical Solutions to Differential Equations

This course is an in-depth study of solving ordinary differential equations numerically. Both Runge-Kutta methods and general multi-step methods are discussed. Error control and step size changing for both stiff and nonstiff equations are analyzed.

Prerequisite: MATH 315 and 470

MATH 674 (2) Computations in Linear Algebra

This course will be an in-depth study of solving linear systems both directly and iteratively and solving the algebraic eigenvalue problem. Applications may also be included.

Prerequisite: MATH 447 and 470

MATH 677 (1-4) Individual Study

Independent individual study under the guidance and direction of a graduate faculty member.

Prerequisite: con

MATH 680 (1-4) Topics in Mathematics

A graduate course in an area of mathematics not regularly offered. May be repeated for credit on each new topic

Prerequisite: will vary with topic

MATH 689 (1-3) Readings in Mathematics

Independent readings in mathematics under the direction of a graduate faculty member.

Prerequisite: con

MATH 690 (3) Research in Mathematics Education

Examination of cognitive theories guiding research in mathematics education; analysis and interpretation of research procedures applied in experimental, qualitative, program evaluation, survey, meta-analysis, theory-generating, and action research studies in mathematics education.

Prerequisite: STAT 550 or 551 or con

MATH 691 (1-4) In-Service

A course designed to upgrade the qualifications of persons on-the-job. May be repeated for credit on each new topic.

MATH 692 (3) Point-Set Topology

Topological spaces, continuity, product spaces, connectedness, separation, compactness, and metric spaces

Prerequisite: MATH 417

MATH 693 (3) Topics in Topology

Will cover topics at the discretion of the instructor, such as, but not limited to, those in the following list: algebraic topology, homotopy theory, homology theory, differential topology, topological groups, topological vector spaces, categorical topology, catastrophe theory, Lie Groups, algebras of continuous functions, and uniform structures.

Prerequisite: MATH 692

MATH 694 (1) Alternate Plan Paper

Research under the supervision of the student's advisor leading to an alternate plan paper.

Prerequisite: con of advisor

MATH 695 (1-4) Workshop

A short course devoted to a specific mathematical topic. May be repeated for credit on each new topic.

MATH 698 (1-12) Internship

Provides a student the opportunity to gain expertise and experience in a special field

under the supervision of a qualified person.

Prerequisite: con

MATH 699 (1-4) Thesis

Research under the supervision of the student's advisor leading to a thesis.

Prerequisite: con of advisor

## STATISTICS

STAT 550 (3) Regression Analysis

Simple and multiple regression, correlation, analysis of variance and covariance.

Prerequisite: MATH/STAT 354 or 455 or con

STAT 551 (3) Experimental Designs

Completely randomized, randomized block, fractional factorial, incomplete block, split-plot, Latin squares, expected mean squares, response surfaces, confounding, fixed effects, and random effects models.

Prerequisite: MATH/STAT 354 or 455 or con

STAT 555 (4) Theory of Statistics I

A mathematical approach to statistics with derivation of theoretical results and of basic techniques used in applications. Includes probability, continuous probability distributions, multivariate distributions, functions of random variables, central limit theorem, and statistical inference. Same as MATH 555.

Prerequisite: MATH 223

STAT 556 (4) Theory of Statistics II

A mathematical approach to statistics with derivation of theoretical results and of basic techniques used in applications, including sufficient statistics, additional statistical inference, theory of statistical tests, inferences about normal models, and nonparametric methods. Same as MATH 556.

Prerequisite: MATH/STAT 455

STAT 588 (1-3) Seminar

The study of a particular topic primarily based upon recent literature. May be repeated for credit on each new topic.

STAT 591 (1-4) In-Service

STAT 598 (1-12) Internship

Provides a student the opportunity to gain expertise and experience in a special field under the supervision of a qualified person.

STAT 653 (3) Linear Models

Matrix theory, multivariate normal distribution of quadratic forms, estimation and hypothesis testing in the general linear model, and applications of linear models.

Prerequisite: MATH/STAT 455 or con

STAT 677 (1-4) Individual Study

Independent individual study under the guidance and direction of a graduate faculty member.

Prerequisite: con

STAT 680 (1-4) Selected Topics

A graduate course in a particular area of statistics not regularly offered. May be repeated for credit on each new topic.

Prerequisite: will vary with topic

STAT 694 (1) Alternate Plan Paper

Research under the supervision of the student's advisor leading to an alternate plan paper.

Prerequisite: con of advisor

STAT 696 (4) Statistical Inference Packages

Statistical package programs used in data collection, transformation, organization, summarization, interpretation and reporting, statistical description and hypothesis testing with statistical inference, interpreting outputs, chi-square, correlation, regression, analysis of variance, nonparametrics, and other designs, accessing and using large files (U.S. Census data, National Health Survey, etc.) Same as COMS 696

Prerequisite: one statistics course

---

## MATHEMATICS

---

### STAT 698 (1-12) Internship

Provides a student the opportunity to gain expertise and experience in a special field under the supervision of a qualified person.

Prerequisite: con

### STAT 699 (1-4) Thesis

Research under the supervision of the student's advisor leading to a thesis. Prerequisite: con of advisor

---