

MATHEMATICS (MAT)

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Chairperson: George F. Seelinger

Programs Offered

Ph.D. in Mathematics Education; M.S. in Mathematics with sequences in Mathematics, Actuarial Science, Applied Statistics, Biomathematics; and Elementary and Middle School Mathematics Education. At the master's level, concentrations are available in secondary mathematics education, pure mathematics, computational mathematics, and applied mathematics. Concentrations are not listed on a student's transcript.

M.S. in Mathematics**Program Requirements**

Students must complete either Option I or Option II. Option I requires a culminating experience in the form of an approved master's project, comprehensive exam, or professional practice. Thesis Option II requires a master's thesis. Students may complete a sequence in Mathematics, Actuarial Science, Applied Statistics, Biomathematics or in Elementary and Middle School Mathematics Education. Students in the Biomathematics sequence must complete Option II. The culminating experience/thesis project must be approved in advance by the Department's master's program committee.

Note: All master's degree programs require a minimum of 50 percent of the non-thesis credit hours applied to the degree to be 400-level courses or above. All electives are subject to approval by the department's graduate advisor.

Option I—Non-Thesis: This 32 hour option requires:

- 26 hours in mathematics; 16 hours at the 400 level, 12 hours of mathematics courses at the 400 level
- 3 hours: culminating experience in the form of MAT 490 or MAT 498
- Electives as needed to reach required credit minimum

Option II—Thesis : This 30 hour option requires:

- 24 hours in mathematics; 15 hours at the 400 level, 10 hours of mathematics courses at the 400 level
- Electives as needed to reach required credit minimum
- MAT 499 (4-6 hours)

Mathematics Sequence:

- 11 hours: MAT 336, 337, and 347
- 3 mathematics courses numbered 407 or above
- Options I or II

Students with the following interests are advised to take the corresponding courses: (1) Secondary mathematics education: 401, 403, 421, 422; (2) Doctoral study in mathematics: 407, 447; (3) Computational mathematics: 356, 361, 363, 461; (4) Applied mathematics: 340, 341, 345, 356, 361, 362, 363.

Actuarial Science Sequence:

- 1 course selected from: MAT 336, 337, 347

- 12 hours: 3 courses selected from: MAT 355, 380, 381, 383, 384, 443, 480, or 483
- 3 mathematics courses numbered 407 or above
- Options I or II
- The Department reserves the right to enforce professional standards of practice as specified by the Society of Actuaries and the Casualty Actuarial Society. These standards may be taken into consideration in program retention decisions.

Applied Statistics Sequence:

- MAT 350, 351
- 1 course from: 336, 337, or 347
- 3 courses selected from: MAT 450, 453, 455, 456, or 458
- Options I or II

Biomathematics Sequence:

Persons seeking cross-disciplinary training in mathematics and biology may select this sequence. This 30 hour sequence requires:

- Thesis option II
- BioCore: MAT 340, 350, 351, 442; BSC 420A36 taken twice under different topics
- 12 hours from the School of Biological Sciences
- 13 hours at the 400 level from outside of the BioCore
- An area of emphasis may be chosen from the following:

Emphasis in Biostatistics and Modeling: A choice of courses from MAT 353, 356, 362, 450, 453, 455, 456, 458; and BSC 343, 403, 404, 405, 450.37, 471, 486.

Emphasis in Computation and Bioinformatics: A choice of courses from MAT 356, 361, 363, 461; and BSC 350, 353, 355, 415, 419, 467, 470, 471.

Elementary and Middle School Mathematics Education Sequence: Persons who are teaching or who plan to teach at the elementary or middle school level may elect this sequence. *This program does not lead to licensure.*

- MAT 304, 401, 402, 403, and 409
 - Options I or II
 - Students in this sequence who are considering entering the Mathematics Education Ph.D. program at Illinois State University are advised to take MAT 145 and 146 and, as part of their master's program, the following courses: MAT 304, 309 or 330, 312, 315, 320, 326, 409, 421, and 422
- Please see the Ph.D. advisor for more information.

Doctor of Philosophy in Mathematics Education**Program Requirements**

The typical program is approximately 90 hours. A full-time student should expect to complete the required coursework for the program in 3 to 4 years past the bachelor's degree.

Two options are available K-9 or K-12.

104 Mathematics

The typical program is approximately 90 hours. Program requirements include:

- 6 hours of graduate mathematics content courses
- 30 hours in mathematics education
- 3 hours for a professional project
- 12 hours in research methods
- 6 hours of electives in areas such as mathematics, technology, curriculum, educational psychology, evaluation, supervision, human development, learning theory or measurement
- a minimum of 15 hours of dissertation credit

Students in the program must demonstrate competence in teaching prospective or practicing mathematics teachers. Some of these requirements may be satisfied by work completed prior to acceptance into the program. The student must also meet the other university requirements for Ph.D. programs listed elsewhere in this catalog. Students must meet the Graduate School's residency requirement for a Doctor of Philosophy degree.

Mathematics Courses

302 TEACHING MATHEMATICS IN THE MIDDLE SCHOOL

4 sem. hrs.

Problems, viewpoints, and trends in teaching middle school mathematics. Implications of research related to organization, content and techniques for teaching mathematics. May include Clinical Experience. Formerly TEACHING MATHEMATICS IN GRADES 6-8. Prerequisites: Grade of C or better in MAT 309 and 312 or concurrent registration.

304 MODERN GEOMETRY FOR MIDDLE SCHOOL TEACHERS

4 sem. hrs.

Topics include Euclidean and non-Euclidean geometries and their history, transformations with connections to matrix algebra, fractals, and projective geometry. Department approved graphing calculator required. Prerequisites: Grade of B or better in MAT 131 and 202.

309 NUMBER THEORY FOR MIDDLE SCHOOL TEACHERS

4 sem. hrs.

Focus is on number theory concepts, including divisibility, primes, composites, special number sets, and basic counting principles. Department approved graphing calculator required. Formerly NUMBER THEORY FOR K-8 TEACHERS. Prerequisites: Grade of B or better in MAT 131 and 202.

312 PROBABILISTIC AND STATISTICAL REASONING FOR MIDDLE SCHOOL TEACHERS

4 sem. hrs.

Descriptive statistics, lines of best fit, basic concepts of probability, simulation, probability distributions, expectation and counting techniques. Department-approved graphing calculator required. Formerly PROBABILISTIC AND STATISTICAL REASONING FOR K-8 TEACHERS. Prerequisites: Grade of B or better in MAT 131 and 202.

315 MATHEMATICAL MODELING FOR MIDDLE SCHOOL TEACHERS

4 sem. hrs.

Mathematical modeling and problem-solving with applications

involving networks and communication systems, finance, global positioning, data systems, and various branches of science. Department-approved graphing calculator required. Prerequisites: Grade of B or better in at least one of MAT 309 or 312 and a grade of C or better in the other.

320 HISTORY OF MATHEMATICS

3 sem. hrs.

History of the development of mathematical techniques and ideas from early civilization to present, including connections between mathematics and sciences. Prerequisite: Grade of C or better in MAT 147.

323 TEACHING MATHEMATICS IN THE SECONDARY SCHOOL

3 sem. hrs.

The selection, placement, and teaching of secondary mathematics topics. Analysis of recent trends and practices. Includes clinical experiences, 60 hours. Prerequisites: Grade of C or better in MAT 211 and 223; grade of C or better in MAT 236, or concurrent registration; TCH 216.

326 MATHEMATICAL PROBLEM SOLVING USING TECHNOLOGY

3 sem. hrs.

An advanced exploration of secondary mathematics curriculum through the use of technology. Considers roles of technology for mathematical concept development. Formerly TECHNOLOGY TOOLS FOR SECONDARY SCHOOL MATHEMATICS. Department-approved graphing calculator required. Prerequisite: Grade of C or better in MAT 211.

330 NUMBER THEORY

3 sem. hrs.

Divisibility, primes, unique factorization, linear congruences and Diophantine equations, number-theoretic functions, primitive roots, quadratic reciprocity, continued fractions or cryptography. Prerequisite: Grade of C or better in MAT 260.

336 ADVANCED ABSTRACT ALGEBRA

3 sem. hrs.

Permutation, symmetry, matrix, and cyclic groups, subgroups, cosets, homomorphisms, quotient groups, the fundamental theorem of finite abelian groups, Sylow theorems. Prerequisite: Grade of C or better in MAT 236 or consent of the instructor.

337 ADVANCED LINEAR ALGEBRA

4 sem. hrs.

Abstract vector spaces, linear transformations and matrices, inner product spaces, eigenvalues and eigenvectors, diagonalization. Applications to geometry, the physical and social sciences. Prerequisites: Grade of C or better in MAT 175

340 DIFFERENTIAL EQUATIONS I

3 sem. hrs.

First and second order differential equations, linear differential equations, power series methods, Laplace transform methods, numerical and computational methods, applications. Prerequisites: Grade of C or better in MAT 147 and 175.

341 DIFFERENTIAL EQUATIONS II

3 sem. hrs.

Linear systems of differential equations, numerical methods, Fourier series, boundary-value problems, partial and nonlinear differential equations and applications. Prerequisites: Grade of C or better in MAT 175 and 340 or an elementary differential equation course.

345 ADVANCED CALCULUS**4 sem. hrs.**

Calculus of functions of several variables; Taylor's series of several variables, maxima and minima, Lagrange multipliers, inverse and implicit function theorems, multiple integration, line integrals, Green's, Stokes' and the divergence theorems. Prerequisites: Grade of C or better in MAT 147 and 175.

347 ADVANCED REAL ANALYSIS**4 sem. hrs.**

Topology of metric spaces, properties of sequences, continuous functions, limits of functions, differentiation, integration. Prerequisite: Grade of C or better in MAT 247 or 345 or consent of the instructor.

349 INTRODUCTION TO COMPLEX ANALYSIS**4 sem. hrs.**

An introduction to complex analysis, including elements of topology and geometry, with applications to advanced calculus, differential equations and physics. Prerequisite: MAT 147.

350 APPLIED PROBABILITY MODELS**4 sem. hrs.**

Sample spaces, discrete and continuous random variables, probability functions, density, moment generating functions, important distributions. Multivariate distributions. Central Limit Theorem. Prerequisite: Grade of C or better in MAT 147.

351 STATISTICS AND DATA ANALYSIS**4 sem. hrs.**

Statistical estimation. Point and interval estimators. Consistency, unbiasedness, minimum variance. Hypothesis testing. Likelihood ratio tests. Regression, analysis of variance. Prerequisite: Grade of C or better in MAT 350 or consent of the instructor.

352 PROBABILITY AND STATISTICAL INFERENCE FOR EDUCATORS**4 sem. hrs.**

Sample spaces, discrete and continuous random variables, distributions, Central Limit Theorem. Point and interval estimation. Hypothesis testing. Regression, analysis of variance. Not for credit if had MAT 350 or 350A01. Prerequisite: Grade of C or better in MAT 147.

353 REGRESSION AND TIME SERIES ANALYSIS**4 sem. hrs.**

Regression and time series methods for business and economic applications, including exponential smoothing and Box-Jenkins methods. A computer statistical package will be used. Also offered as ECO 353. Prerequisite: MAT 351 or equivalent or consent of the instructor.

354 NONPARAMETRIC STATISTICS**3 sem. hrs.**

Order statistics, run test, goodness-of-fit tests, rank test, sign test, two-sample tests, and nonparametric measures of dependence. Prerequisite: Grade of C or better in MAT 351 or equivalent or consent of the instructor.

356 STATISTICAL COMPUTING**4 sem. hrs.**

Application of SAS and SPSS programs to real data emphasizing regression, and analysis of variance. Prerequisites: Grade of C or better in MAT 351; some facility with matrices.

361 TOPICS IN DISCRETE MATHEMATICS**2-4 sem. hrs.**

Study of selected areas of discrete mathematics. Multiple enrollments allowed if content is different. Prerequisite: Grade of C or better in MAT 260 or consent of the instructor.

362 LINEAR OPTIMIZATION**4 sem. hrs.**

Modeling and solution of problems using the simplex method. Duality, sensitivity, integer programming. Transportation problems. Prerequisite: Grade of C or better in MAT 175.

363 GRAPH THEORY**4 sem. hrs.**

Introduction to graph theory, connectivity, matching, coloring, network flows with applications. Prerequisite: Grade of C or better in MAT 260 or consent of the instructor.

380 ACTUARIAL MODELS I**4 sem. hrs.**

Markov Processes. Survival distributions. Life tables. Life insurance, life annuities and pensions. Premiums and reserves. Applications of multiple states models. Prerequisites: Grade of B or better in MAT 280 and 350 or consent of the instructor.

381 ACTUARIAL MODELS II**4 sem. hrs.**

Multiple lives. Multiple decrements. Models including expenses. Multiple state models. Universal life insurance. Prerequisites: Grade of B or better in MAT 380 or consent of the instructor.

383 ACTUARIAL MODELS III**4 sem. hrs.**

Derivative securities and their actuarial models. Arbitrage-free models. Valuation of derivative securities. Elements of financial risk management. Formerly ACTUARIAL MODELS II. Prerequisites: Grade of B or better in MAT 280 and 350 or consent of the instructor.

384 ACTUARIAL MODELING**4 sem. hrs.**

Severity models. Frequency models. Aggregate loss models. Risk measures. Ruin theory. Survival models estimation. Parametric and nonparametric models estimation. Credibility theory. Simulation. Prerequisite: Grade of C or better in MAT 351 or consent of the instructor.

401 CURRENT RESEARCH IN SCHOOL MATHEMATICS**3 sem. hrs.**

Analysis of research in mathematics education and its implications for instruction in school programs.

402 INSTRUCTIONAL STRATEGIES FOR THE MIDDLE SCHOOL TEACHER**3 sem. hrs.**

Selecting, utilizing and evaluating instructional organization, laboratory materials and pedagogical techniques for middle school mathematics programs. Prerequisites: MAT 401 and 403 are recommended.

403 THEORIES OF MATHEMATICS LEARNING**3 sem. hrs.**

Overview of theories of how students learn mathematics and the implications of these theories for classroom teaching and research.

404 ISSUES AND TRENDS IN SCHOOL MATHEMATICS**4 sem. hrs.**

Analysis of issues and trends related to teaching and learning mathematics in local, national, and international political and social arenas. Prerequisites: MAT 401 or 403, or consent of the instructor.

406 ADVANCED TOPICS IN ASSESSMENT IN ELEMENTARY AND JUNIOR HIGH MATHEMATICS**2-3 sem. hrs.**

Analytical approaches and instructional procedures for assessment and evaluation in elementary and junior high school mathematics.

407 ABSTRACT ALGEBRA**4 sem. hrs.**

Group theory including the Sylow theorems and other advanced topics; ring theory. Prerequisite: MAT 336 or consent of the instructor.

408 THE TEACHING AND LEARNING OF RATIONAL NUMBERS**3 sem. hrs.**

Current research on the teaching and learning of numeration and number sense, with a focus on rational numbers. Not for credit if had MAT 489.30. Prerequisites: MAT 401 or consent of the instructor.

409 TOPICS IN ALGEBRA AND COMBINATORICS FOR K-8 TEACHERS**3 sem. hrs.**

Algebra and counting topics related to elementary, middle school, or junior high curriculum. Prerequisite: Admission into a graduate mathematics or mathematics education program or consent of the instructor.

410 TOPICS IN NUMBER THEORY**3-4 sem. hrs.**

Topics vary, but are often chosen from Diophantine equations, continued fractions, Diophantine approximations. Additional topics and applications will be covered if taken for 4 credits. Prerequisite: MAT 330 or consent of the instructor.

411 SELECTED TOPICS IN ADVANCED MATHEMATICS**3 sem. hrs.**

Advanced topics in mathematics (knot theory and applications, category theory, complex analysis, differential topology and geometry, dynamical systems, etc.). Prerequisite: MAT 336 or 337 or 347 or consent of the instructor.

421 TOPICS IN ALGEBRA FOR TEACHERS**3 sem. hrs.**

Problems in teaching of secondary school algebra. Investigation of reports, research, and recent trends in this area. Prerequisites: MAT 175 or 236 and teaching experience.

422 TOPICS IN GEOMETRY FOR TEACHERS**3 sem. hrs.**

Problems in teaching secondary school geometry. Investigation of reports, research, and recent trends. Objectives and content of secondary school geometry. Prerequisite: MAT 211.

442 QUANTITATIVE BIOMATHEMATICS**3 sem. hrs.**

Theory and biological applications of linear and non-linear difference and differential equations and of partial differential equations. Prerequisite: MAT 340.

443 STATISTICAL LEARNING AND DATA MINING**3 sem. hrs.**

This course provides a case-based introduction to the field of statistical learning for analyzing massive datasets. Prerequisite: Grade of C or better in MAT 351.

447 REAL ANALYSIS I**4 sem. hrs.**

Inadequacy of Riemann integration, theories of measure and integration, function spaces, Hilbert spaces, linear functionals, orthogonal functions and Fourier series. Prerequisites: MAT 337 and 347.

450 FINITE SAMPLING**3-4 sem. hrs.**

Application and theory of sampling, mathematical sampling; simple, stratified, and cluster. Evaluation of plans with respect to precision and cost. Additional topics and applications will be covered if taken for 4 credits. Prerequisite: MAT 350.

453 REGRESSION ANALYSIS**3-4 sem. hrs.**

Linear regression models and the F-test. Model Fitting: analysis of residuals, transformations, and the selection of variables. The analysis of variance via regression. Additional topics and applications will be covered if taken for 4 credits. Pre-requisites: MAT 175 and 351.

455 APPLIED STOCHASTIC PROCESSES**3-4 sem. hrs.**

Processes important in numerous applications. Finite and countable state Markov chains, the Poisson process, birth-death processes, elementary queueing theory, renewal processes, and others. Prerequisite: MAT 350.

456 MULTIVARIATE STATISTICS**3-4 sem. hrs.**

Review of regression and analysis of variance. The multivariate normal distribution, discriminant analysis, multivariate analysis of variance, factor analysis. Computational procedures. Prerequisites: MAT 175, 351.

458 THE DESIGN OF EXPERIMENTS**3-4 sem. hrs.**

Linear models and the logic of planned experimentation, choice of statistical technique, and analysis of data. Additional topics and applications will be covered if taken for 4 credits. Prerequisite: MAT 351.

461 ADVANCED TOPICS IN DISCRETE MATHEMATICS**3-4 sem. hrs.**

Study of selected advanced topics in discrete mathematics. Consult class directory for topic and hours in a given semester. Multiple enrollments allowed if content is different. Prerequisite: Consent of the instructor.

480 APPLICATIONS OF ACTUARIAL PRINCIPLES**4 sem. hrs.**

Basic actuarial principles applicable to various financial security systems: life, health, and property and casualty insurance, annuities, retirement programs. Prerequisites: MAT 380 and 383, or consent of the instructor.

483 MATHEMATICAL MODELS IN FINANCE AND INVESTMENTS**4 sem. hrs.**

Mathematical models of capital markets, valuation of derivatives and other financial instruments, principles of portfolio management and asset-liability management. Prerequisites: MAT 380 and 383, or consent of the instructor.

490 RESEARCH IN MATHEMATICS, MATHEMATICS EDUCATION, AND APPLIED MATHEMATICS**1-3 sem. hrs.**

Individual research projects or case studies in mathematics, mathematics education, applied mathematics, statistics, or actuarial science. May constitute a culminating experience for master's degree. Multiple enrollments are allowed; no more than 3 credit hours may count toward the degree. Credits do not count toward 400-level course requirements for degree. Prerequisite: Consent of the instructor.

498 PROFESSIONAL PRACTICE**1-4 sem. hrs.**

Refer to General Courses. Practical supervised work experience in mathematics. Credits do not count toward 400-level course requirements for the degree. Multiple enrollments allowed. A maximum of 4 credit hours count toward the degree.

499 MASTER'S THESIS**1-6 sem. hrs.**

Refer to General Courses.

580 MATHEMATICAL THINKING AND LEARNING**3 sem. hrs.**

Analysis of theories in mathematical thinking and learning as they relate to instruction and research in mathematics education. Prerequisite: MAT 403.

581 SEMINAR IN RESEARCH AND DEVELOPMENT IN MATHEMATICS EDUCATION**3 sem. hrs.**

Analysis of research in strategies or methods for teaching mathematics and in the learning of mathematics. Analysis of curriculum projects as they relate to these research findings. Analysis of current research and consideration of the implications of this research for new curricular innovations, and for classroom teaching. Prerequisite: Admission to Ph.D. program in mathematics education.

582 HISTORY OF MATHEMATICS EDUCATION CURRICULUM**3 sem. hrs.**

Study of the development of mathematics education curriculum since colonial times. Readings of major books, recommendations, and papers.

583 PROFESSIONAL PROJECTS IN MATHEMATICS EDUCATION**3 sem. hrs.**

Designed to provide intensive work under direct supervision of faculty on a project in mathematics education. Prerequisite: Approval of the Ph.D. director.

585 TOPICS IN MATHEMATICS EDUCATION SEMINAR**1-3 sem. hrs.**

Intensive inquiry into topics in mathematics education through research, discussion, and reports. Multiple enrollments allowed with approval of Ph.D. director. Prerequisite: Admission to Ph.D. program in mathematics education.

586 MATHEMATICS TEACHING AND TEACHER EDUCATION**3 sem. hrs.**

Analysis of the research in mathematics teaching and teacher education.

599 DOCTORAL RESEARCH**1-15 sem. hrs.**

Refer to General Courses. Research, library search, curriculum study, and writing related to Doctor of Philosophy dissertation requirement. Prerequisite: Approval of the Ph.D. director.

599A90 DISSERTATION FINAL TERM**1 sem. hr.**

Refer to General Courses.