

DEPARTMENT OF MATHEMATICS

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Mathematics is the language of science and a necessary ingredient for preparing to live in a dynamic, technological age. Combined with the College's required general education courses, mathematics majors are enabled to integrate their specialized understanding of mathematics into the entire range of human knowledge and behavior.

The Department offers a traditional and challenging curriculum with an excellent blend of courses in both pure and applied mathematics. Graduates of the mathematics program are valued for their problem-solving skills and their ability to think rationally. Students who satisfy the mathematics major can create a firm foundation for further education or a career. By supplementing their major courses with work from other departments, they are qualified to pursue graduate degrees in mathematics, statistics, or education. They are equally well prepared to enter a career in education, actuarial work, computer, or information science. Occasionally, a mathematics major will enter graduate school in business or pursue a career in medicine or law.

To be successful in post-graduate pursuits, mathematics majors must have the ability to locate, evaluate and use information, possess some basic technical literacy, and display excellent speaking and writing skills. With this in mind, Math 488, Seminar in Mathematics, is designed to give students Writing Intensive (WI) and Speaking Intensive (SI) instruction; and to gain experience in processing Information Literacy (IL) knowledge. Students will gain this experience with a sophisticated computer algebra system in the calculus sequence (Math 161, 162, 261) and a working knowledge of a computer language in Computer 141.

Course Requirements for Bachelor of Science Degree in Mathematics

Math Core Requirements (34 hours):

Mathematics 162, 211, 222, 261, 421 or 422, 465, and 488.

At least three hours from Mathematics 303, 365, or 466.

A minimum of sixteen hours from 300 or 400-level Mathematics.

A one-year sequence from Mathematics 325-326, 331-332, or 465-466.

Major-Related Requirements (7 hours):

A minimum of three semester hours from Computer 141 or 220.

Physics 101.

NOTE: Credits in Mathematics 111, 117, 141, 151, 152, 161, 231, 237, and 240 do not apply toward the thirty-four credit hours required for mathematics major. With the exception of Math 161, grades in these courses will not be used in calculating the major QPA.

Course Requirements for Mathematics Major leading to (7-12) certification in Mathematics

This program fulfills the requirements of the full mathematics major and the requirements of the Commonwealth of Pennsylvania for secondary mathematics certification.

Math Core Requirements (37 hours):

Mathematics 162, 211, 222, 240, 261, 303, 331, 421 or 422, 465, and 488.

A minimum of sixteen hours from 300 or 400-level Mathematics.

A one-year sequence from Mathematics 325-326, 331-332, or 465-466.

Major-Related Requirements (7 hours):

A minimum of three semester hours from Computer Science 141 or 220.

Physics 101.

Professional Education Requirements (36 hours):

Education 201, 202, 305A, 306, 361, 371, 431. and 488.

Computer Science 204.

Psychology 102.

NOTE: Credits in Mathematics 111, 117, 141, 151, 152, 161, 231, and 237 do not apply toward the thirty-seven credit hours required. Mathematics Secondary Education majors must have a minimum MQPA of 2.75 in all Mathematics courses excluding Mathematics 111, 117, 141, 151, 152, 231, and 237.

Course Requirements for a minor in Mathematics (22 hours):

A minor in Mathematics will consist of 22 hours including Mathematics 211 or 213 and 222 but excluding Mathematics 111, 117, 141, 151, 152, 231, 237, and 240.

The normal sequence for students to follow includes the following: Mathematics 162 in the freshman year; 211, 222, and 261 in the sophomore year; 421 and 465 in the junior year; and 488 in the senior year.

Mathematics majors are strongly advised to take Philosophy 201.

Knowledge of the content of Calculus I is required for Calculus II. If a student feels qualified to begin with Calculus II or higher, he/she should discuss the situation with the department chair. Students who are enrolled in Math 141, Math 161, Math 162, or Math 261 and find that their background is inappropriate for the course may change to another course on or before the sixteenth class meeting. Those in Math 261 may change to Math 162 or 161; those in Math 162 may change to Math 161; and those in Math 161 or Math 141 may switch to Math 111. The student must have the approval of the current instructor and the instructor of the course in which the student intends to enroll. The student must complete and return an Add/Drop Form to the Registrar's Office.

Students are expected to contact their advisors for a detailed schedule of courses recommended to meet requirements for a major.

College Math Courses Taken in High School

Transfer credit will be awarded for any mathematics courses that are equivalent or comparable to those offered by the Grove City College Department of Mathematics and completed with a grade of "C" or better. Any such courses taken before entering Grove City College must be listed in the catalog of the college of transfer as courses offered for degree credit to that college's undergraduates, must be taken in a classroom setting where

most of the students are college undergraduates, and must be organized and taught by college faculty.

MATHEMATICS (MATH)

111. PRE-CALCULUS. Designed to help prepare students for success in Business Calculus or Calculus I, this course offers a thorough treatment of algebra, analytic geometry and exponential and logarithmic functions. Additional topics such as trigonometry and limits may be included. A basic understanding of high school algebra and analytic geometry is presumed. *Semester course, three hours.*

117. FINITE MATHEMATICS. This course will consist of a survey of a number of mathematical ideas on an introductory level. Topics may include: sets and relations, matrices, linear programming, combinatorics, probability, statistics, graph theory, fair-division algorithms, and voting theory. *Semester course, three hours.*

141. BUSINESS CALCULUS. The differential and integral calculus of elementary functions with applications in business and economics. Students may not receive credit for Math 141 and 161. Math 161, not 141, is the prerequisite for 162. *Semester course, four hours.*

151. SURVEY OF MATHEMATICS I. This course (along with Math 152) is part of a two-course, six-hour mathematics requirement specifically designed for elementary education and early childhood majors. Content studied includes critical thinking and problem solving; logic; sets; relations and functions; whole numbers and numeration; integers; informal geometry; measurement and metrics; and transformational geometry. *Fall semester only, three hours.*

152. SURVEY OF MATHEMATICS II. A general introduction to various topics in mathematics, including consumer mathematics, probability theory, elementary number theory, rational and real numbers, and statistics. Required of elementary education majors. *Spring semester only, three hours.*

161. CALCULUS I. A first course in calculus that assumes no prior study of the subject. Topics include: limits and continuity, differentiation, curve sketching, definite and indefinite integration, and applications. This course, along with Computer 141 and Math 488, fulfills the Information Literacy (IL) requirement for the Mathematics major. Prerequisite: High school mathematics including algebra, analytic geometry, and trigonometry. Students may not receive credit for Math 141 and 161. *Semester course, four hours.*

162. CALCULUS II. A continuation of Math 161 covering the topics: exponential, logarithmic and inverse trigonometric functions, techniques of integration, parametric equations, sequences, infinite series, and Taylor series. This course, along with Computer 141 and Math 488, fulfills the Information Literacy (IL) requirement for the Mathematics major. Prerequisite: Math 161 or knowledge of its content. *Semester course, four hours.*

211. DISCRETE MATHEMATICS. An introduction to the theory of discrete mathematical methods including set theory, mathematical logic, a variety of proof techniques, number systems, functions and relations, graphs and digraphs, binary trees, combinatorics, recurrence relations, and analysis of algorithms. Students may not receive credit for both Math 211 and Math 213. Prerequisite: Math 161 or knowledge of its content. *Fall semester only, three hours.*

213. DISCRETE MATHEMATICS FOR COMPUTER SCIENCE. A study of the foundations of mathematics with an emphasis on concepts related to theoretical mathematical methods and computer science. Topics include mathematical logic, set theory, algorithms, complexity of algorithms, integers, a variety of proof techniques, program correctness, combinatorics, recurrence relations, graphs and digraphs, trees, Boolean functions, languages and grammars, and finite state machines. Students may not receive credit for both Math 211 and Math 213. Prerequisite: Math 161 or knowledge of its content. *Fall semester only, four hours.*

222. LINEAR ALGEBRA. A study of the theory of matrices and their applications including systems of linear equations, determinants, vector spaces, eigenvalues and eigenvectors, linear transformations, diagonalization, and Gram-Schmidt orthogonalization. Prerequisite: Math 162. *Spring semester only, four hours.*

231. STATISTICAL METHODS. An introduction to basic concepts and techniques of statistical inference including descriptive measures, probability distributions, tests of hypotheses, interval estimation, and analysis of variance. Offered periodically. *Semester course, three hours.*

237. TOPICS FOR ELEMENTARY EDUCATION MAJORS. This course will be taught in an independent format covering mathematical material useful for elementary education majors. Open only to elementary education majors with a science/mathematics concentration. Students may only receive credit for this course once. *Semester course, one hour.*

240. MATHEMATICS FOR SECONDARY EDUCATION. A course designed for the secondary teacher candidate in mathematics. Topics covered are: history and culture of mathematics; readings in mathematics; problem solving and critical thinking; intuitive geometry; number theory; and other material applicable to secondary teachers of mathematics. Required for mathematics secondary education majors. Open to elementary education majors with mathematics concentration. *Spring semester only, three hours.*

261. CALCULUS III. The final course in the three-semester calculus sequence. Students receive instruction in the following topics: polar coordinates, vectors and the geometry of three-dimensional space, vector functions, partial derivatives, multiple integrals and vector calculus. This course, along with Computer 141 and Math 488, fulfills the Information Literacy (IL) requirement for the Mathematics major. Prerequisite: Math 162. *Semester course, four hours.*

262. DIFFERENTIAL EQUATIONS. A study of the elementary theory and methods for analytic solution of ordinary differential equations, with applications, including first order equations, higher order linear equations, Laplace transform methods, and series solutions. Prerequisite: Math 162. *Spring semester only, three hours.*

263. NUMERICAL DIFFERENTIAL EQUATIONS. The study and application of numerical methods for solving differential equations including Euler's method, Runge-Kutta methods, multi-step methods, and solution of systems of equations. Prerequisite/corequisite: Math 262. *Spring semester only, one hour.*

303. COLLEGE GEOMETRY I. This course explores various modern geometries from an axiomatic point of view. Topics such as sets of axioms and finite geometries, Euclidean and non-Euclidean geometries, geometric transformations, and possibly neutral geometry will be thoroughly examined. Prerequisite: Math 211 and 222. *Spring semester only, three hours each semester.*

325. NUMERICAL ANALYSIS I. An introductory course in numerical analysis that covers error analysis, computer arithmetic, algorithms, and convergence. Also covered are topics in numerical linear algebra such as direct and iterative methods for solutions of linear systems and numerical calculation of eigenvalues and eigenvectors. Prerequisites: Computer Science 141; Math 222. *Semester course, three hours.*

326. NUMERICAL ANALYSIS II. A second course in numerical analysis that covers the solution of non-linear equations; interpolation and approximation; numerical differentiation and integration; and solutions of systems of non-linear equations. Prerequisite: Math 162. *Alternate Spring semesters, three hours.*

331. THEORY OF STATISTICS I. An introduction to probability and mathematical statistics, including counting techniques; probability spaces; independence; conditional probability; distributions of discrete and continuous random variables; expected valued, moments and moment-generating functions; random vectors and their distributions. A computer algebra system is used. Prerequisite: Math 261. *Fall course, three hours.*

332. THEORY OF STATISTICS II. The continued study of mathematical statistics including transformations of random variables and vectors; sampling distributions; the Central Limit Theorem; properties of point estimates of parameters; maximum-likelihood estimates; confidence intervals; hypothesis testing; contingency tables; simple and linear regression; and one-way analysis of variance. Statistical software and a computer algebra system are used. Prerequisite: Math 331. *Spring course, three hours.*

365. COMPLEX VARIABLES. An introduction to the theory of functions of a complex variable including complex numbers; analytic functions; derivatives and integrals of functions of a complex variable; Taylor and Laurent series; and mappings by functions of a complex variable. Prerequisite: Math 261. *Alternate Fall semesters, three hours.*

388. TOPICS IN MATHEMATICS. A series of lectures/discussions on topics from such areas as: partial differential equations, numerical analysis, algebra, geometry, statistics, computer applications, analysis, or topology. Prerequisite: Permission of the instructor. *Semester course, one, two or three hours.*

421. ABSTRACT ALGEBRA. A study of the structure of formal axiomatic systems and the elementary theory of groups, rings, integral domains, and fields. Students contemplating graduate school are strongly advised to take Math 421 and two credits of Math 422. Prerequisite: Math 211 and 222. *Fall semester only, three hours.*

422. INTRODUCTION TO ABSTRACT ALGEBRA AND NUMBER THEORY. The first portion of this course is a survey of abstract algebra covering groups; subgroups; Lagrange's Theorem; normal subgroups and homomorphisms; permutation groups; and rings. Topics for the number theory portion include: the theory of congruences and modular arithmetic; special numbers; arithmetic functions; Euler's Theorem; quadratic reciprocity; and Fermat's Last Theorem for $n = 3$ or 4 . Students taking both portions of the course will receive three credits. Those taking the number theory portion only will receive two credits. Note: Majors can only take 422 for two credits if they have already taken 421. If not, they must take 422 for 3 credits. Prerequisites: Math 211 or 213, 222, and Math 421 for the two-credit portion. *Spring semester only, two or three hours.*

460. INDEPENDENT STUDY. An opportunity for junior and senior students, with a minimum of eighteen hours in mathematics, to do intensive independent study of specialized topics. Prerequisite: Junior standing. *Semester course, one, two or three hours.*

465. CLASSICAL ANALYSIS. This course is an introduction to real analysis and includes a rigorous treatment of the structure of the real number system; sequences; limits; continuity; uniform continuity; open and closed sets; compact sets; differentiation; the Riemann integral; infinite series; sequences and series of functions; pointwise and uniform convergence; and possibly generalizations to n -dimensional or metric spaces. Prerequisite: Mathematics 211 or 213 and Mathematics 261. *Semester course, three hours.*

466. INTERMEDIATE ANALYSIS. A continuation of the study of real analysis through rigorous treatment of material in several of the following areas: topology; metric spaces and continuity; multivariable calculus; convergence and completeness; extensions of integration; and functional analysis. Prerequisites: Math 222 and 465. *Alternate Fall semesters, three hours.*

488. SEMINAR IN MATHEMATICS. A course for seniors that includes independent reading and research, student presentations, and faculty lectures on advanced topics in mathematics. Seminar in Mathematics is designed to fulfill the requirements for a Writing Intensive (WI), Speaking Intensive (SI), and Information Literacy (IL) course for the mathematics major. Prerequisite: Senior standing. *Semester course, one hour.*

499. HONORS IN MATHEMATICS. A course available to junior and senior students on an individual basis. Prerequisite: Consent of the department chairman; Junior standing. *Semester course, one, two or three hours.*