Mathematics 2820, Psychology 2100, or Psychology 2110 (Peabody College) may substitute for Economics 1500. Economics majors must complete 15 hours of credit in FNEC courses to complete the financial economics minor.

Minors may be combined with any departmental or interdisciplinary major; however, the minor in managerial studies must include 15 credit hours that are being counted solely toward the minor.

Students electing a second minor in managerial studies must complete at least 12 credit hours counted solely toward the second minor.

Financial Economics

Course descriptions begin on page 162.

Managerial Studies

Course descriptions begin on page 182.

Program of Concentration in Mathematics

Three tracks are available.

Program I (Standard Track) is intended for most mathematics majors in the College of Arts and Science, Blair School of Music, and Peabody College.

Program II (Applied Track) is intended for students in the School of Engineering who elect a second major in mathematics, but is also available for other students.

Program III (Honors Track) is intended for highly qualified students who either are preparing for graduate studies in mathematics or plan to graduate with departmental honors.

Students who complete this program and, in addition, complete a senior thesis will graduate with departmental honors.

Requirements for the three tracks are summarized below.

Program I (Standard Track).
At least 29 credit hours in mathematics and 6 credit hours outside the department, as follows.
2. Linear algebra and differential equations: 2600 or 2500–2501, and 2610.
3. At least 12 additional credit hours from 2800 or above.
4. The remainder of the credit hours must be chosen from 2800 or above.

Program II (Applied Track).
At least 29 credit hours in mathematics and 6 credit hours outside the department, as follows.
1. A calculus sequence as in Program I.
2. Linear algebra and differential equations—one of the following:
   (a) one of 2410, 2600, or 2500–2501, and one of 2420 or 2610;
   or
   (b) 2400 and either 2600 or 2500–2501.
3. At least 12 additional credit hours from 2800 or above, excluding 3000.
4. The remainder of the credit hours in mathematics must be chosen from 2800 or above.
5. At least 6 credit hours of advanced, mathematically based science or engineering courses approved by the director of undergraduate studies. This requirement is automatically fulfilled by students who complete a physics major or a major in the School of Engineering.

Program III (Honors Track).
At least 38 credit hours in mathematics, as follows.
1. A calculus sequence as in Program I.
2. Linear algebra and differential equations as in Program I.
3. At least 21 additional credit hours of advanced course work,
   (a) including four courses taken from the following three categories, at least one from each category:
      1) Algebra: 3300, 4300, 4301.
      2) Analysis: 3100, 3110, 6100, 6101.
      3) Topology and Geometry: 3200, 3230, 4200, 4201, 4220, 6210.
   (b) The remainder of the 21 credit hours must be chosen from 2800 or above, excluding 4999.
4. The remainder of the credit hours must be chosen from 2800 or above.

Students who complete Program III and, in addition, complete a senior thesis will graduate with departmental honors.
Students planning to teach in secondary school should contact the director of secondary education programs in the Department of Teaching and Learning at Peabody College for course recommendations.

Honors Program

The Honors Program in Mathematics is designed to afford superior students the opportunity to pursue more intensive work within their major field. The program requires:

1. Completion of all the requirements of Program III (Honors Track).
2. A minimum grade point average of 3.6 in mathematics.
3. Completion of a senior thesis in Math 4999 (3 credit hours) in the second semester of the senior year. With approval of the director of undergraduate studies, the thesis may be based on research initiated or completed at another academic institution, such as during an NSF-sponsored REU program.
4. Oral examination on the senior thesis. A committee of at least three faculty members— at least two from the Department of Mathematics, one being the thesis adviser—shall evaluate the thesis and the oral examination. Exceptional achievement on the thesis will earn highest honors.

Interested students may apply to the director of undergraduate studies for admission to the Honors Program in their junior year or the first semester of their senior year. Applicants must meet college requirements for entry to the Honors Program, and must carry a minimum grade point average of 3.6 in mathematics.

The application includes a one- to two-page proposal of the planned thesis and the signature of the faculty member who will be the thesis adviser.

The thesis must be submitted no later than two weeks before the end of classes in the semester of graduation. The oral examination will take place by the last day of classes in the semester of graduation. Highest honors will be awarded for a thesis that contains original high-quality research results in combination with an oral defense at the highest quality level.

Students may sign up for Math 4999 during one semester of their senior year. Math 4999 will not count toward the 21 credit hours requirement in Program III.

Please consult the director of undergraduate studies for details.

Minor in Mathematics

The minor in mathematics requires at least 15 credit hours in mathematics, including:

1. Completion of a calculus sequence: 2300 or 2500–2501.
2. Linear algebra and differential equations: as in the Program II major.
3. At least 6 credit hours not used to satisfy item 2 from 2800 or above.

Completion of a single-variable calculus sequence (1200–1201–2200 or 1300–1301) is a prerequisite for the minor, but does not count toward the credit hours of the minor.

Licensure for Teaching

Candidates for teacher licensure at the secondary level in mathematics should refer to the chapter on Licensure for Teaching in the Peabody College section of this catalog.

Calculus

Several calculus sequences are available: 
1100; 1200–1201; 1300–1301–2300.

The courses in these sequences cover similar material, but at different rates, and therefore overlap in content and credit. Students should not switch from one to another without approval of the department. Such switching may result in loss of credit. Students intending to take mathematics classes beyond one year of calculus are advised to enroll in the 1300–1301–2300 sequence.

First-year students with test scores of 5 on the Calculus BC advanced placement examination, thereby earning AP credit for 1300–1301, may choose to enroll in the 2500–2501 sequence. The combination of 2500–2501 is a blend of multivariable calculus and linear algebra, with an emphasis on rigorous proofs.

Duplicate Credit Policies

Deduction of credit caused by duplication proceeds as follows. Students who earned math credit

1. through Advanced Placement/International Baccalaureate in one sequence and complete a course at Vanderbilt from another sequence that duplicates this credit will lose credit from the Advanced Placement/International Baccalaureate earnings.
2. by transfer in one sequence and complete a course at Vanderbilt from another sequence that duplicates this credit will lose credit from the Vanderbilt course.
3. at Vanderbilt in one sequence and complete a course at Vanderbilt from another sequence that duplicates this credit will lose credit from the second Vanderbilt course.

Course descriptions begin on page 182.

Medicine, Health, and Society
LAS 4901. Interdisciplinary Research Methods. [Formerly LAS 290] Principal research methods and sources necessary for the study of Latin America in the social sciences and humanities. [3] (No AXLE credit)

Latino and Latina Studies


Managerial Studies

MGRL 1001. Commons Seminar. [Formerly MGRL 99] Topics vary. General Elective credit only. [1] (No AXLE credit)


MGRL 3105. Negotiation. [Formerly MGRL 185] Contemporary challenges in leading change in organizations and building effective management teams. The context and dynamics of negotiation; components, structure, and management of negotiations; and varying requirements across the spectrum of negotiation types. [3] (SBS)

MGRL 3200. Advanced Marketing. [Formerly MGRL 191] Case study of processes, techniques, and theories of marketing, including branding, advertising, interactive media, sales promotion, and marketing research. Offered on a graded basis only. Prerequisite: 1200. [3] (SBS)

MGRL 3209. Creative Advertising. [Formerly MGRL 192] Examination and practical application of the creative process in advertising; the creation of marketing campaigns, including the integration of various media. Prerequisite: 1200. [3] (SBS)


MGRL 3300. Entrepreneurial Challenge. [Formerly MGRL 195] Simulation of the entrepreneurial experience from idea generation to funding. Development of a complete business plan, including financial projections, and competition for funding from investors. Offered on a graded basis only. Prerequisite: 1100. [3] (SBS)

MGRL 3841. Directed Study. [ Formerly MGRL 290] Directed readings and related field research toward a scholarly project conceived and executed under the supervision of a faculty member. Limited to juniors and seniors. [3] (No AXLE credit)

MGRL 3851. Independent Study in Managerial Studies. [Formerly MGRL 245] A program of independent reading in consultation with an adviser. Written permission of an instructor and the program director required. [Variable credit: 1-3; may not be repeated] (No AXLE credit)

MGRL 3891. Selected Topics in Managerial Studies. [Formerly MGRL 235] May be repeated for credit more than once if there is no duplication in topic. Students may enroll in more than one section of this course each semester. [3] (No AXLE credit)

Mathematics

MATH 1001. Commons Seminar. [Formerly MATH 99] Topics vary. General Elective credit only. [1] (No AXLE credit)

MATH 1005. Pre-calculus Mathematics. [Formerly MATH 133] Inequalities, functions and graphs, trigonometric identities, theory of equations. Designed for students who plan to take either 1200-1201 or 1300-1301 but need a stronger background in algebra and trigonometry. [3] (No AXLE credit)

MATH 1010. Probability and Statistical Inference. [Formerly MATH 127A] For students not planning to major in science, engineering, or mathematics. Discrete and continuous probability models (binomial, Poisson, normal). Law of large numbers; conditional probability and Bayes theorem; counting techniques and combinatorics. Descriptive statistics: measures of central tendency and dispersion, histograms. [3] (No AXLE credit)

MATH 1011. Probability and Statistical Inference. [Formerly MATH 127B] For students not planning to major in science, engineering, or mathematics. Linear regression, correlation hypothesis testing. Confidence intervals, sampling distributions, statistical inference. Prerequisite: 1010. [3] (MNS)

MATH 1100. Survey of Calculus. [Formerly MATH 140] A basic course in the rudiments of analytic geometry and differential and integral calculus with emphasis on applications. Designed for students who do not plan further study in calculus. Students who have earned credit for 1200 or 1300 will earn only one credit for this course. Students who have earned credit for 1201 will earn only three credits for this course. [4] (MNS)

MATH 1111. First-Year Writing Seminar. [Formerly MATH 115F] Independent learning and inquiry in an environment in which students can express knowledge and defend opinions through intensive class discussion, oral presentations, and written expression. May be repeated for credit once. [3] (MNS)

MATH 1200. Single-Variable Calculus I. [Formerly MATH 150A] Review of algebra and trigonometry. Exponential functions; inverse functions and logarithms. Limits; differentiation of algebraic and transcendental functions; rules of differentiation; related rates. Three hours of lecture and one hour of recitation period per week. No credit for students who have earned credit for 1100. Students who have earned credit for 1100 will earn only one credit for this course. [3] (MNS)

MATH 1201. Single-Variable Calculus II. [Formerly MATH 150B] Maximum and minimum values; curve sketching. Antiderivatives; the Fundamental Theorem of Calculus; areas and volumes; techniques of integration. Three hours of lecture and one hour of recitation period per week. Students who have earned credit for 1100 or 1301 will earn only two credits for this course. Students who have earned credit for 1300 will earn only one credit for this course. Prerequisite: 1200. [3] (MNS)

MATH 1300. Accelerated Single-Variable Calculus I. [Formerly MATH 155A] Functions, limits, differentiation of algebraic functions, integration, applications including extrema problems, areas, volumes, centroids, and work. Students who have earned credit for 1100 or 1301 will earn only one credit for this course. Students who have earned credit for 1200 or 1201 will earn only two credits for this course. [4] (MNS)

MATH 1301. Accelerated Single-Variable Calculus II. [Formerly MATH 155B] Differentiation and integration of transcendental functions, applications, methods of integration, coordinate geometry, polar
coordinates, infinite series. Students who have earned credit for 1201 will earn only three credits for this course. Students who have earned credit for 2200 will earn only one credit for this course. Prerequisite: 1300 or 1201. [4] (MNS)

MATH 2200. Single-Variable Calculus III. [Formerly MATH 170] Analytic geometry, parametric equations, polar coordinates, infinite series, Taylor series. Repeat credit for students who completed 170a prior to fall 2008. No credit for students who have earned credit for 1301. Prerequisite: 1201. [3] (MNS)

MATH 2300. Multivariable Calculus. [Formerly MATH 175] Vectors, curves, and surfaces in space. Functions of several variables, partial derivatives, multiple integrals. Vector integral calculus, including line and surface integrals. Repeat credit for students who completed 170b prior to fall 2008. No credit for students who have earned credit for 2501. Students who have earned credit for 2500 will earn only one credit for this course. Prerequisite: 1301 or 2200. [3] (MNS)


MATH 2410. Methods of Linear Algebra. [Formerly MATH 194] Vectors and matrix operations. Linear transformations and fundamental properties of finite dimensional vector spaces. Solutions of systems of linear equations. Eigenvalues and eigenvectors. No credit for students who have earned credit for 2400, 2501, or 2600. Students who have earned credit for 2500 will earn only two credits for this course. Prerequisite or corequisite: 2300. [3] (MNS)

MATH 2420. Methods of Ordinary Differential Equations. [Formerly MATH 198] Linear first-order differential equations, applications, higher order linear differential equations, complementary and particular solutions, applications, Laplace transform methods, series solutions, numerical techniques. No credit for students who have earned credit for 2400 or 2610. Prerequisite: 2300 or 2501. [3] (MNS)

MATH 2500. Multivariable Calculus and Linear Algebra. [Formerly MATH 205A] Vector algebra and geometry; linear transformations and matrix algebra. Real and complex vector spaces, systems of linear equations, inner product spaces. Functions of several variables and vector-valued functions: limits, continuity, the derivative. Extremum and nonlinear problems, manifolds. Multiple integrals, line and surface integrals, differential forms, integration on manifolds, theorems of Green, Gauss, and Stokes. Eigenvectors and eigenvalues. Emphasis on rigorous proofs. No credit for students who have earned credit for 2501, 2300, 2410, or 2600. Open only to first-year students with a test score of 5 on the Calculus-BC Advanced Placement examination. [4] (MNS)

MATH 2501. Multivariable Calculus and Linear Algebra. [Formerly MATH 205B] Continuation of 2500. Vector algebra and geometry; linear transformations and matrix algebra. Real and complex vector spaces, systems of linear equations, inner product spaces. Functions of several variables and vector-valued functions: limits, continuity, the derivative. Extremum and nonlinear problems, manifolds. Multiple integrals, line and surface integrals, differential forms, integration on manifolds, theorems of Green, Gauss, and Stokes. Eigenvectors and eigenvalues. Emphasis on rigorous proofs. No credit for students who have earned credit for 2501, 2300, 2410, or 2600. Prerequisite: 2500 and first-year standing. [4] (MNS)

MATH 2600. Linear Algebra. [Formerly MATH 204] Algebra of matrices, real and complex vector spaces, linear transformations, and systems of linear equations. Eigenvalues, eigenvectors, inner product spaces, and orthonormal bases. Designed primarily for mathematics majors. No credit for students who have earned credit for 2410 or 2501. Students who have earned credit for 2500 will earn only two credits for this course. Prerequisite or corequisite: 2300. [3] (MNS)

MATH 2610. Ordinary Differential Equations. [Formerly MATH 208] First- and second-order differential equations, applications. Matrix methods for linear systems; stability theory of autonomous systems; existence and uniqueness theory. Intended for mathematics and advanced science majors. No credit for students who have earned credit for 2400 or 2420. Prerequisite: concurrent enrollment in 2501 or prior credit for either 2501 or both 2300 and either 2410 or 2600. [3] (MNS)


MATH 2820. Introduction to Probability and Mathematical Statistics. [Formerly MATH 218] Discrete and continuous probability models, mathematical expectation, and joint densities. Laws of large numbers, point estimation, and confidence intervals. Hypothesis testing and applications. Students taking 2820 are encouraged to take 2820L concurrently. No credit for students who have earned credit for 2810. Prerequisite: 2300 or 2501. [3] (MNS)

MATH 2820L. Statistics Laboratory. [Formerly MATH 218L] Applications of the theory developed in 2820. Emphasis on data analysis and interpretation. Topics include the one- and two-sample problems, paired data, correlation and regression, chi-square, and model building. Pre- or corequisite: 2810 or 2820. [1] (No AXLE credit)


MATH 3000. History of Mathematics. [Formerly MATH 252] Major developments in mathematics from ancient times to the early twentieth century. Emphasis both on the historical perspective and the mathematics; assignments include many exercises and theorems. Highly recommended for teacher candidates. Prerequisite: 2501 or both 2300 and either 2410 or 2600. [3] (MNS)

MATH 3010. Intensive Problem Solving and Exposition. [Formerly MATH 200] Intended to develop widely-applicable mathematical skills. Basic principles such as induction, the pigeonhole principle, symmetry, parity, and generating functions. Prerequisite: 2300 or 2500. [3] (MNS)

MATH 3100. Introduction to Analysis. [Formerly MATH 260] Properties of real numbers, compactness and completeness. Limits, sequences and series, uniform convergence, and power series. Basic properties of functions on the real line, and the elementary theory of differentiation and integration. Emphasis on methods of proof used in advanced mathematics courses. Prerequisite: 2501 or both 2300 and either 2410 or 2600. [3] (MNS)

MATH 3101. Complex Variables. [Formerly MATH 261] Complex numbers, analytic and elementary functions, transformations of regions. Complex integrals, Cauchy’s integral theorem and formula, Taylor and Laurent series. The calculus of residues with applications, conformal mappings. Prerequisite: 2300 or 2501. [3] (MNS)

MATH 3120. Introduction to Partial Differential Equations. [Formerly MATH 234] Initial- and boundary-value problems for partial differential equations using separation of variables in conjunction with Fourier series and integrals. Explicit solutions of problems involving the heat equation, the wave equation, and Laplace’s equation. Prerequisite: Either 2410, 2600, or 2501 and either 2420, 2420, or 2610. [3] (MNS)

MATH 3130. Fourier Analysis. [Formerly MATH 263] Fourier series topics including convolution, Poisson kernels, Dirichlet kernels, and pointwise and mean-square convergence. Integral transforms including one-dimensional and multidimensional Fourier integrals, Fourier inversion formula and Plancherel theorem, Poisson summation formula, Radon transform, and X-ray transform. Fourier analysis on Abelian groups including finite Fourier analysis and fast Fourier transform. Applications to signal processing,
Shannon sampling theory, and/or compressed sensing. Repeat credit for students who completed 267 section 1 in spring 2011 or spring 2013. Prerequisite: Either 2501 or both 2300 and either 2410 or 2600. [3] (MNS)

MATH 3165. Advanced Calculus. [Formerly MATH 259] Advanced treatment of multivariable calculus. Differentiation of functions of several variables, including inverse and implicit function theorems. Vector differential calculus. Integration of functions of several variables. Vector integral calculus, including Stokes’ theorem. No credit for students who have earned credit for 3160. Prerequisite: 2501 or both 2300 and either 2410 or 2600. [3] (MNS)


MATH 3210. Transformation Geometry. [Formerly MATH 240] Transformations of the plane, groups of transformations, reflections, glide reflections, classification of the isometries of the plane, frieze groups, analysis of frieze patterns, wall paper groups, and analysis of wall paper patterns. Especially recommended for prospective teachers of mathematics. Prerequisite: 2410, 2600, or 2501. [3] (MNS)

MATH 3230. Introduction to Differential Geometry. Smooth maps, tangent space, and surfaces and hypersurfaces in n-dimensional Euclidean space. Inverse and Implicit Function theorems. Sard’s theorem. Transversality. Degree of a map; intersection theory modulo 2. Orientability and oriented intersection number. No credit for students who have earned credit for 4220. Prerequisite: 2501 or both 2300 and either 2410 or 2600. [3] (MNS)


MATH 3310. Introduction to Mathematical Logic. [Formerly MATH 250] Development of the first order predicate calculus and fundamental metamathematical notions. Prerequisite: 2410, 2600, or 2501. [3] (MNS)

MATH 3320. Error-Correcting Codes and Cryptography. [Formerly MATH 253] Applications of algebra to reliability and secrecy of information transmission. Error-correcting codes, including linear, Hamming, and cyclic codes, and possibly BCH or Reed-Solomon codes. Cryptography, including symmetric-key, DES and RSA encryption. Prerequisite: 2410, 2600, or 2501. [3] (MNS)


MATH 3620. Introduction to Numerical Mathematics. [Formerly MATH 226] Numerical solution of linear and nonlinear equations, interpolation and polynomial approximation, non-numerical differentiation and integration. Least-squares curve fitting and approximation theory, numerical solution of differential equations, errors and floating point arithmetic. Application of the theory to problems in science, engineering, and economics. Student use of the computer is emphasized. Familiarity with computer programming is expected. Prerequisite: Either 2410, 2600, or 2501, and either 2400, 2420, or 2610. [3] (MNS)

MATH 3630. Mathematical Modeling in Biology and Medicine. [Formerly MATH 262] Basic mathematical modeling tools, such as interpolation, least-squares regression, difference equations, and ordinary and partial differential equations. Statistical analysis of data, support vector machines, and computer simulation. Familiarity with computer programming is expected. Prerequisite: Either 2410, 2600, or 2501, and either 2400, 2420, or 2610. [3] (MNS)

MATH 3640. Probability. [Formerly MATH 247] Combinatorics, probability models (binomial, Poisson, normal, gamma, etc.) Stochastic independence, generating functions, limit theorems and types of convergence, bivariate distributions, transformations of variables. Markov processes, applications. Except for students with extremely strong backgrounds, 2820 should be taken prior to 3640. Prerequisite: 2501 or both 2300 and either 2410 or 2600. [3] (MNS)

MATH 3641. Mathematical Statistics. [Formerly MATH 248] Distribution theory, order statistics, theory of point estimation and hypothesis testing, normal univariate inference, Bayesian methods, sequential procedures, regression, nonparametric methods. Students interested in applications may take 2820L. Prerequisite: 3640. [3] (MNS)

MATH 3650. Introduction to Actuarial Mathematics. [Formerly MATH 246A] Applications of calculus and probability to actuarial science. The foundations of financial mathematics, including the theory of interest. Prerequisite: 2300 or 2501. Prerequisite or corequisite: 2810, 2820, or 3640. [3] (MNS)


MATH 3700. Discrete Mathematics. [Formerly MATH 215] Elementary combinatorics including permutations and combinations, the principle of inclusion and exclusion, and recurrence relations. Graph theory including Eulerian and Hamiltonian graphs, trees, planarity, coloring, connectivity, network flows, some algorithms and their complexity. Selected topics from computer science and operations research. Prerequisite: 2410, 2600, or 2501. [3] (MNS)


MATH 3859. Independent Study. [Formerly MATH 298] Reading and independent study in mathematics under the supervision of an advisor. Designed primarily for honors candidates, but open to others with approval by department chair. [Variable credit: 1-3 each semester, not to exceed 6 without departmental permission] (No AXLE credit)

MATH 3890. Selected Topics for Undergraduates. [Formerly MATH 267] Topics vary. May be repeated for a total of 12 credits in 3890 and 3895 combined if there is no duplication in topic. Students may enroll in more than one section of this course each semester. Prerequisite: 2501 or both 2300 and either 2410 or 2600. [1-3; maximum of 12 credits total for all semesters of MATH 3890 and 3895 combined] (No AXLE credit)

MATH 4110. Partial Differential Equations. [Formerly MATH 294] Classification of equations: equations of elliptic, parabolic, and hyperbolic type. Separation of variables, orthornormal series, solutions of homogeneous and nonhomogeneous boundary value problems in one-, two-, and three-dimensional space. Possible additional topics include subharmonic functions and the Perron existence theorem for the Laplace equation of Sturm-Liouville theory. Prerequisite: Either 2410, 2600, or 2501, and either 2400, 2420, or 2610. [3] (MNS)


MATH 4220. Differentiable Manifolds. [Formerly MATH 243] Manifolds in n-dimensional Euclidean space, smooth maps; inverse and implicit function theorems. Regular value theorem, immersions and submersions, Sard’s theorem, and transversality. Degree of a map; winding numbers and the Fundamental Theorem of Algebra; intersection theory modulo 2. Prerequisite: 2501 or both 2300 and either 2410 or 2600. [3] (MNS)


MATH 4301. Modern Algebra. [Formerly MATH 283B] Introductory theory of commutative rings and fields, and additional topics such as Galois theory, modules over a principal ideal domain and finite dimensional algebras. Prerequisite: 4300. [3] (MNS)

MATH 4310. Set Theory. [Formerly MATH 280] The basic operations on sets. Cardinal and ordinal numbers. The axiom of choice. Zorn’s lemma, and the well-ordering principle. Introduction to the topology of metric spaces, including the concepts of continuity, compactness, connectivity, completeness, and separability. Product spaces. Applications to Euclidean spaces. Strongly recommended for beginning graduate students and for undergraduates who plan to do graduate work in mathematics. Prerequisite: 2501 or both 2300 and either 2410 or 2600. [3] (MNS)


MATH 4610. Methods of Mathematical Physics. [Formerly MATH 292] Linear operators on vector spaces, matrix theory, and Hilbert spaces. Functions of a complex variable and calculus of residues. Ordinary and partial differential equations of mathematical physics, boundary value problems, special functions. Prerequisite: Either 2410, 2600, or 2501, and either 2400, 2420, or 2610. [3] (MNS)

MATH 4620. Linear Optimization. [Formerly MATH 288] An introduction to linear programming and its applications. Formulation of linear programs. The simplex method, duality, complementary slackness, dual simplex method and sensitivity analysis. The ellipsoid method. Interior point methods. Possible additional topics include the primal-dual algorithm, cutting planes, or branch-and-bound. Applications to networks, management, engineering, and physical sciences. Prerequisite: either 2410, 2600, or 2501, and either CS 1101 or 1103. [3] (MNS)

MATH 4630. Nonlinear Optimization. [Formerly MATH 287] Mathematical modeling of optimization problems. Theory of unconstrained and constrained optimization, including convexity and the Karush-Kuhn-Tucker conditions. Derivative- and non-derivative-based methods. Familiarity with computer programming is expected. Prerequisite: 2501 or both 2300 and either 2410 or 2600. [3] (MNS)

MATH 4650. Financial Stochastic Processes. [Formerly MATH 249A] The theory of stochastic processes and applications to financial economics. Brownian motion; martingales; Itô’s Lemma; stochastic integration. Monte Carlo simulations with variance reduction techniques. Applications include discretetime option pricing and delta hedging. Prerequisite: 3650 and either 2810, 2820, or 3640. [3] (MNS)


MATH 4700. Combinatorics. [Formerly MATH 274] Elements of enumerative analysis including permutations, combinations, generating functions, recurrence relations, the principle of inclusion and exclusion, and Polya’s theorem. Some special topics will be treated as class interest and background indicate (e.g., Galois fields, theory of codes, and block designs). Students unfamiliar with permutations, combinations, and basic counting techniques should take 3700 prior to 4700. Prerequisite: 2410, 2600, or 2501. [3] (MNS)


MATH 4999. Senior Thesis. [Formerly MATH 269] A written presentation of research results, original for the student but not usually original in the larger sense. The regulations governing the writing of a master of arts thesis in mathematics will apply to the writing of the senior thesis. [3] (No AXLE credit)

Medicine, Health, and Society

MHS 1001. Commons Seminar. [Formerly MHS 99] Topics vary. General Elective credit only. [1] (No AXLE credit)

MHS 1111. First-Year Writing Seminar. [Formerly MHS 115F] Independent learning and inquiry in an environment in which students can express knowledge and defend opinions through intensive class discussion, oral presentations, and written expression. May be repeated for credit once if there is no duplication of topic, but students may earn only up to 3 credits in any 1111 course per semester of enrollment. [3; maximum of 6 credits total for all semesters of 1111] (AXLE credit category varies by section)


MHS 1930. Social Dimensions of Health and Illness. [Formerly MHS 201] Multidisciplinary introduction to health conditions from perspectives of anthropology, economics, history, political science and policy studies, philosophy, religious studies, and sociology. Guest lectures by representatives of various disciplines. [3] (P)


MHS 1950. Disabled Bodies, Cyborg Cultures. [Formerly MHS 189] Historical and cultural evolution of disability and assistive technologies, including prosthetics and artificial limbs. Shifts in social views resulting from disability communities, war, economics, and design. No credit for students who have earned credit for 290-02 in fall 2013. [3] (HCA)

