

DEPARTMENT OF MATHEMATICS AND ECONOMICS

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Department Overview

The Department of Mathematics and Economics at Virginia State University offers course work leading to the **Bachelor of Science degree in Mathematics** and the **Bachelor of Science degree in Economics and Finance**. The department, in conjunction with the Center for Undergraduate Professional Education Programs, offers a teaching endorsement in Mathematics (6-12). The Mathematics curriculum offers concentrations in Pure/Applied Mathematics, Statistics, Actuarial Science and Secondary Education.

The Economics and Finance program at Virginia State University (VSU) is under the Department of Mathematics and Economics. It is one of the oldest academic programs at VSU which is designed to provide students with theoretical and analytical tools needed for analyzing and solving real-world micro and macroeconomic problems. The Department offers two curricula of study or concentrations leading to the Bachelor of Science Degree (B.S.) in Economics and Finance. It offers comprehensive knowledge on financial and economic theories, principles, and models that underline the operations and behavior of consumers, business firms, financial institutions, and governments in a domestic and global environment. Familiarity with these principles equip graduates to understand, predict, control, and react rationally to today's dynamic and complex business and economic environment.

Students develop critical thinking and quantitative skills that prepare them for careers as economic, financial and business analysts; researchers; consultants; and middle level managers in government, consulting, trade associations, and other private sector positions. They are also prepared to pursue graduate studies in economics, law, data analytics, financial management, business and public administration programs.

Mission Statement

The mission of the department is to provide academic programs that promote rigorous and relevant instruction, research, and advanced study, designed to develop a diverse, productive, and ethical population of graduates and lifelong learners equipped to effectively participate and compete in the national and global workforce and society.

Department Goals

The **Mathematics Program** objectives are as follows:

- **Experiential Learning:** It is anticipated that graduates of the VSU Mathematics Program will become involved in lifelong learning and interested in professional development opportunities, thus building a background for more advanced mathematics study.
- **Employment:** A VSU Mathematics Program graduate is expected to be engaged in professional practice or in pursuit of advanced study in successful careers as mathematicians, statisticians and engineers in industry, private business and government service, or teach mathematics using technological pedagogical content knowledge.
- **Scholarly Activities:** It is also anticipated that many of the graduates of the VSU Mathematics Program will attempt to promote research by offering technical and professional assistance and engaging in research activities for the advancement of science, technology, engineering and mathematics (STEM), and the improvement of teaching.

The **Economics and Finance Program** objectives are as follows:

- Graduates will engage in experiential learning activities such as internships and undergraduate research that will provide them a strong foundation for career development
- Graduates will acquire knowledge and skills to pursue graduate studies in Economics and other related fields.
- Graduates will be able to communicate orally and in writing, learn to access, disseminate, and analyze economic concepts and issues.
- Graduates will have comprehension of economic concepts and the ability to apply problem solving skills

Student Organizations

The Department offers several student-oriented organizations:

- The Walter Johnson Mathematics Club, which provides emphasis on topics and activities of interest to mathematics students,
- The Kappa Mu Epsilon Mathematics National Honor Society (Virginia Alpha Chapter), which provides recognition for academic achievement in mathematics,
- A student chapter of the Mathematical Association of America (MAA),
- Actuarial Science Club,
- The VSU International Diplomacy & Economics Club, and
- Omicron

The Department also offers student membership in Omicron Delta Epsilon, the International Honor Society for Economics. Membership is open to all Economics majors with a minimum grade point average of 3.0.

Program Listings

Bachelor of Science (B.S.) in Mathematics

The Department offers four curricula of study or concentrations leading to the Bachelor of Science Degree (B.S.) in Mathematics.

- The **Pure/Applied Mathematics** concentration provides students with a foundation of pure and applied mathematics enabling employment opportunities or graduate study in mathematics.

- The **Statistics** concentration develops the proficiency in probability and statistics.
- The **Actuarial Science** concentration develops the background necessary for students to pursue opportunities as actuaries in the insurance industry, investment companies, banking, financial management and consulting firms. Emphasis is placed on the understanding of mathematical concepts and the application of statistical and probability procedures employed in the financial sectors.
- The Concentration in **Secondary Education** Program prepares students to obtain a teaching endorsement in mathematics at the secondary school level.

Students who wish to double major need to follow the VSU double major procedure and will need to meet with the coordinator of the undergraduate mathematics program.

Minor in Mathematics

The minor in mathematics consists of five courses offered by the Department of Mathematics and Economics. The calculus sequence; MATH 260, MATH 261, and MATH 360 is required. In addition two more courses at the 300 level or above may be selected from mathematics courses. Students must earn a grade of "C" or better in all courses pursued towards fulfillment of the requirement.

Minor in Economics

The minor in Economics is designed to give students from other programs in the University the opportunity to diversify and complement their educational experience through a minor in economics. It consists of a minimum of 18 credit hours: (12 credit from core course –ECON 210, ECON 211, ECON 310, ECON 320 and 6 elective credits from ECON 321, ECON 330, ECON 313, ECON 350, ECON 438 and ECON 452).

Bachelor of Science (B.S.) in Economics and Finance

- **The Applied Economics concentration:** provides students with a foundation courses to understand the operations and behavior of consumers, business firms, financial institutions, and governments in a domestic and global environment, and widen graduates' opportunities for gainful employment or graduate study in Economics
- **The Economics and Financial Analytics concentration:** provide students with financial economics and data analytics courses to enable students understand, predict and react rationally to today's dynamic and complex business and economic environment.

Students with associate degrees from community colleges are admitted to the VSU BS in Economics program. These students are exempted from all General Education core courses; the 6 credit hours for the basic Micro and Macroeconomics courses they have taken at the community colleges will be considered to their undergraduate degrees; and they are allowed for the fast-track MA program in Economics after their successful completion of their undergraduate program with an accepted GPA score.

Student Outcomes:

The Student Outcomes for the Economics program are as follows:

- Apply core economics concepts in microeconomics and macroeconomics to analyze regional and global economic issues
- Demonstrate the ability to use qualitative and quantitative analytical skills to solve societal problems using modern tools
- Develop capacity for logical inquiry, thinking, reasoning and critical analysis on economic matters

- Demonstrate an ability to communicate effectively.
- Demonstrate an ability to innovate, acquire leadership skills and to engage in knowledge-based economic activities.

Minor in Economics & Finance

The minor program in economics is designed to give students for other programs in the University the opportunity to diversify and complement their education experience in economics. It consists 18 credit hours, including 4 core economics courses (ECON 210; ECON 211; ECON 310 and ECON 320 and two electives from Economics electives at 300 and 400 levels. Students must earn a grade of "C" or better in all required by the program courses.

Major(s)

- Economics, Bachelor of Science (B.S.) (<http://catalog.vsu.edu/undergraduate/college-engineering-technology/departments-mathematics-economics/economics-major-bs/>)
- Mathematics, Bachelor of Science with a Minor in Secondary Education (B.S.) (<http://catalog.vsu.edu/undergraduate/college-engineering-technology/departments-mathematics-economics/mathematics-with-minor-secondary-education-bs/>)
- Mathematics, Bachelor of Science (B.S.) (<http://catalog.vsu.edu/undergraduate/college-engineering-technology/departments-mathematics-economics/mathematics-major-math-track-bs/>)
- Mathematics, Bachelor of Science with a concentration in Statistics (B.S.) (<http://catalog.vsu.edu/undergraduate/college-engineering-technology/departments-mathematics-economics/mathematics-major-stat-track-bs/>)
- Mathematics, Bachelor of Science with a concentration in Actuarial Science (B.S.) (<http://catalog.vsu.edu/undergraduate/college-engineering-technology/departments-mathematics-economics/mathematics-major-actuarial-science-track-bs/>)

Minor(s)

- Minor in Mathematics (<http://catalog.vsu.edu/undergraduate/college-engineering-technology/departments-mathematics-economics/mathematics-minor/>)
- Minor in Economics (<http://catalog.vsu.edu/undergraduate/college-engineering-technology/departments-mathematics-economics/economics-minor/>)

MATH 112. Basic Mathematics I. (3 Credits)

A course for students who plan to pursue a major in humanities and social sciences. Problem solving, real numbers, algebraic expressions, linear equations, systems of linear equations, proportions, geometry, graphs of linear functions, mathematics of finance. Prerequisite: Two units of high school mathematics and placement criteria 201808.

MATH 113. Basic Mathematics II. (3 Credits)

The second part of a basic mathematics sequence. Sets, logic, probability and statistics. Prerequisite: MATH 112.

MATH 120. College Algebra. (3 Credits)

A pre-calculus course in algebra. Functions and their graphs, transformation of functions, polynomial, rational, exponential and logarithmic functions, systems of equations; applications of these algebraic concepts to other disciplines. 201608.

MATH 121. Trigonometry. (3 Credits)

Exponential and logarithmic functions, trigonometric functions, analytic trigonometry, and applications of trigonometry. Prerequisite: MATH 120 College Algebra 201608.

MATH 122. Finite Mathematics. (3 Credits)

Solving systems of Linear Equations and Inequalities, Introduction to Matrices and Linear Programming, Mathematics of Finance, Sets, Counting and Probability. Prerequisite: MATH 120 College Algebra 201608.

MATH 130. Number And Operations. (3 Credits)

ONLY for students seeking certification to reach PreK - 3/PreK - 6 Examines number systems and operations, elementary number theory, concepts of integers and rational number, proportions, logic, computational algorithms, and current techniques in a problem-solving environment. Will include student investigations and hands-on activities. Prerequisites: Two units of high school mathematics and placement criteria 201808.

MATH 131. Algebra And Functions. (3 Credits)

ONLY for students seeking certification to teach PreK - 3/PreK - 6 Basic algebraic operations, linear and quadratic equations, linear systems of equations and inequalities, algebraic and trigonometric functions in the context of modeling and various representations of functions (graphical, tabular, and symbolic). Will include student investigations and hands-on activities. Prerequisites: MATH 130 202508.

MATH 150. Precalculus. (4 Credits)

Functions, Polynomial and rational functions, Inverse functions, exponential logarithmic functions, trigonometric functions; and an introduction to sequences and limits. Students successfully completing this course cannot take MATH 120 or MATH 121 for credit. Prerequisites: Two units of high school mathematics and placement criteria.

MATH 212. Business Calculus. (3 Credits)

Calculus for Non-Science and Non-Mathematics majors. Fundamental concepts of limits, continuity, derivatives and integrals of functions and their application to problems in various disciplines. This course cannot be taken as a Mathematics elective by Mathematics majors. Prerequisites: MATH 122 Finite Mathematics 201608.

MATH 230. Geometry And Measurement. (3 Credits)

A basic study of properties and relationships of polygons and polyhedral, transformation geometry, coordinate geometry, construction, deductive and inductive reasoning, the processes of measurement through geometric investigations, and an introduction to non-Euclidean geometries. This course does not satisfy the requirements of MATH 340. ONLY for students seeking certification to reach PreK - 3/PreK - 6 Prerequisites: MATH 131.

MATH 260. Calculus I. (4 Credits)

Analytic Geometry (introduction to conic sections), review of functions and their graphs, limit and rate of change, continuity, derivatives, derivatives of trigonometric functions, chain rule, implicit differentiation, higher derivatives, related rates, applications of differentiation: maximum and minimum values, The Mean Value Theorem, the first and second derivative tests, optimization problems, Antiderivatives, areas, definite integral, Fundamental Theorem of Calculus, indefinite integrals, areas between curves (in the Cartesian Plane), substitution rule Prerequisite: MATH 150 Precalculus or MATH 121 Algebra and Trigonometry 201608.

MATH 261. Calculus II. (4 Credits)

Techniques and applications of integrations, improper integrals, sequences and series, differentiation and integration of power series, Prerequisites: MATH 260.

MATH 280. Discrete Math Computer Science. (3 Credits)

Fundamental techniques in discrete mathematics for application in computer science. Sets, mathematical logic, proof techniques, relations, functions, mathematical induction, counting principle, and analysis of algorithms. Prerequisite: MATH 120 202508.

MATH 284. Discrete Mathematics I. (3 Credits)

Binary number system, computer codes, computer arithmetic, logic and truth table, sets and relations, Boolean algebra, logic gates; simplification of logic circuits, graphs, and directed graphs equivalence relations. Prerequisite: MATH 120 202508.

MATH 285. Discrete Mathematics II. (3 Credits)

Duality, mathematical induction and contradiction, recurrence relations, posets and sorting, vectors and matrices, planar and non-planar graphs, networks, error propagation, combinatorics, circuits, lattices, algebraic systems and machines, algorithms for flowcharting and programming. Prerequisite: MATH 284 Discrete Mathematics I or MATH 280 Discrete Mathematics for Computer Scientists.

MATH 290. Foundations Of Mathematics. (3 Credits)

A study of the development of mathematical concepts and of the great mathematicians who introduced these concepts; development of integral and differential calculus, development of concepts in modern algebra and the use of rigorous set theory as the foundation for analysis, algebra and topology. Prerequisite: MATH 261 Calculus II or concurrent with MATH 261.

MATH 292. Introduction to Number Theory. (3 Credits)

Divisibility theory and prime numbers, Euclidean algorithm, congruence, residue classes. Euler's function, primitive roots, Chinese remainder theorem. Quadratic residues, continued fractions, and Gaussian integers. Prerequisites: MATH 150 Precalculus or equivalent 201608.

MATH 294. Mathematics of Finance I. (3 Credits)

Interest rates, accumulated and discount function, annuities, forborne and deferred, perpetuities, amortization. schedules and sinking funds, bonds and related securities, depreciation, yield curve, duration, convexity, and immunization. Prerequisite: MATH 120 College Algebra or permission of the instructor 201808.

MATH 295. Mathematics Of Finance II. (3 Credits)

Advanced theory of interest and annuity; non-level annuities under geometric or arithmetic progression, annuities with different payment and conversion periods, amortization schedules, sinking funds, yield rate, bond and stock; introductory financial concepts including derivatives, options, futures, arbitrage opportunities and non-arbitrage models. Prerequisite(s): MATH 294 Mathematics of Finance I and STAT 330 Probability and Statistics I 201808.

MATH 298. Internship in Mathematics I. (1 Credit)

The internship allows students to obtain practical work experience related to mathematics under closely supervised conditions for approximately 45 clock hours. Students must complete a Memorandum of Agreement prior to commencing the internship. Course may be taken more than once for credit but no more than 3 times. Prerequisite: Junior standing and permission of department.

MATH 299. Introd Problem Solving Seminar. (3 Credits)

A seminar-based approach which examines areas including the appropriate uses of technology, cooperative learning projects, problem-solving, and mathematics content on the state mandated licensing examination for secondary mathematics. Mathematical topics will include algebra and number theory, measurement, trigonometry, functions, and calculus and basic probability theory. Prerequisite: MATH 261.

MATH 300. Foundation of Mathematics. (3 Credits)

Conic sections and polar coordinates, indeterminate forms, improper integrals, Taylor's theorem, L'Hopital's rule, Taylor's polynomials, sequences and series, absolute and conditional convergence, differentiation and integration of power series, vectors in the plane and in space, and cylindrical and spherical coordinates. Prerequisite: MATH 201 Calculus II or MATH 261 Calculus II 202508.

MATH 317. Stochastic Processes. (3 Credits)

Conditional probability and conditional expectations, continuous and discrete time stochastic processes including random walks. Markov chains, Poissons process, Brownian motion, and Gaussian processes. Prerequisites: MATH 360 Calculus III, STAT 330 Probability and Statistics I 201901.

MATH 321. Combinatorics. (3 Credits)

Techniques for counting and enumeration including recurrence relations, binomial coefficients, the principle of inclusion and exclusion, graph theory, and networks. Prerequisites: MATH 280 or MATH 284.

MATH 325. Linear Algebra. (3 Credits)

Systems of linear equations, matrices, determinants, vector spaces, bases, dimensions, linear independence, eigenvalues and eigenvectors, and linear transformations. Prerequisite: MATH 260.

MATH 335. Mathematical Modeling. (3 Credits)

Formulation and analysis of mathematical models with applications to Biology, Finance, Engineering and other areas of science, examples include; population dynamics, predator-prey, epidemiology, enzyme kinetics, diffusion and chemical reactions. Prerequisite: MATH 260.

MATH 340. Euclidean & Noneuclid Geomet I. (3 Credits)

A study of the foundations of Euclidean geometry including transformations deductive and inductive reasoning and an introduction to non-Euclidean geometries. Prerequisite: MATH 120 College Algebra 201808.

MATH 341. Euclidean & Noneuclid Geometr II. (3 Credits)

Euclidean geometry, logic and incidence geometry, Hilbert's axioms, projective geometry, neutral geometry, parallel postulate - history and independence, Non-Euclidean geometry, geometric transformations, hyperbolic geometry and philosophical implications. Prerequisite: MATH 340 Modern Geometry 201608.

MATH 348. Introduction to Game Theory. (3 Credits)

Introduction to game theory, the study of strategic behavior among parties having opposed, mixed or similar interests. Formal descriptions of games/conflicts of interest, including zero-sum and non-zero sum games. Identification of equilibria, mixed strategies, and the minimax theorem. Identification and analysis of archetypal strategic situations, including the Prisoner's Dilemma. Dominance, backward induction, Nash equilibrium, and signaling. Applications of formal game theory to professional game design, and game design principles. Prerequisite: MATH 260 201901.

MATH 350. Differential Equations. (3 Credits)

Introduction to differential equations, initial value problems, modeling and solutions of first-order differential equations, solutions of higher-order differential equations, boundary value problems, series solutions, Laplace transform. Prerequisite: MATH 261 201608.

MATH 352. Intro to Mathematical Biology. (3 Credits)

This course is designed to develop mathematical models in biology and study the behavior of such models using numerical techniques and review the mathematical concepts behind many important biological principles. Topics will be drawn from conversation biology, genetics, and physiology. Mathematics and computational methods to be reviewed include functions in biology, difference and differential equations, integration as needed, probability, numerical matrix algebra and curve fitting software. Students can receive credit either for MATH 352 or BIOL 352 but not for both. Prerequisites: MATH 200 Calculus I, BIOL 120 Principles of Biology I and BIOL 121 Principles of Biology II, or consent of instructor. 201608.

MATH 355. Dynamical Systems & Chaos. (3 Credits)

Existence and uniqueness for solutions of ordinary differential equations and difference equations, linear systems, nonlinear systems, stability, periodic solutions, bifurcation theory. Prerequisite: MATH 350 201608.

MATH 360. Calculus III. (4 Credits)

Prerequisite: MATH 261 Calculus II 201808.

MATH 380. Seminar in Actuarial Science. (3 Credits)

Application of the fundamental probability tools to problems encountered in actuarial science. Risk management and insurance, corporate finance, price theory, actuarial models, loss models, simulation and survival models. Course serves as the capstone course in the Actuarial Science track. Co-requisite: MATH 295.

MATH 392. Introduction Linear Programmin. (3 Credits)

Introduction to operation research, modeling with linear programming, the simplex method and sensitivity analysis, duality, degeneracy, and applications. Prerequisite: MATH 260.

MATH 395. Math Problem Solving Seminar. (3 Credits)

A capstone course designed to examine the appropriate uses of technology, cooperative learning projects, problem-solving, mathematics content on the state mandated licensing examination for Secondary Mathematics, and presentations by experienced mathematics educators and business leaders. Mathematical topics include data analysis, probability, matrix algebra and discrete mathematics. Students must register and take the state mandated licensing examination for secondary mathematics as a requirement of the course. (May not be used as a mathematics elective). Prerequisite: Admitted to Teacher Education Candidacy and MATH 299, STAT 330 or STAT 340.

MATH 398. Internship in Mathematics II. (3 Credits)

The internship allows students to obtain practical work experience related to mathematics under closely supervised conditions for approximately 135 clock hours. Students must complete a Memorandum of Agreement prior to commencing the internship. Course may be taken more than once for credit but no more than 2 times. Prerequisite: Junior standing and permission of department advisor 201808.

MATH 400. Advanced Calculus I. (3 Credits)

Introduction to inductive and deductive reasoning, introduction to proofs, proofs of theorems involving sets, functions and inverse functions, composite functions, Study limit and continuity using delta-epsilon approach, limit theorems, properties of continuous functions. Prerequisite: MATH 301 Multivariate Calculus 201608.

MATH 401. Advanced Calculus II. (3 Credits)

Differentiability, Riemann integrals, Riemann-Stieljes, improper integrals, fundamental theorem of calculus, sequence and series of functions, convergence of series, uniform convergence, power series of functions. Prerequisite: MATH 400.

MATH 415. Matrix Theory. (3 Credits)

Matrix algebra, matrix factorization, vector and matrix norms, condition numbers, singular values, diagonalization and similar matrices, Jordan canonical form, unitary and orthogonal transformations, and the eigenvalue problems. Prerequisite: MATH 325 Linear Algebra 201808.

MATH 417. Numerical Linear Algebra. (3 Credits)

Numerical methods for solution of linear systems, perturbation theory and linear least square problem, QR factorization, conditioning and stability of linear systems, iterative methods for linear systems, symmetric eigenproblem and singular value decomposition, nonsymmetric eigenvalue problems, discrete and fast Fourier transform. Prerequisite: MATH 325 Linear Algebra 201608.

MATH 425. Abstract Algebra I. (3 Credits)

Abstract groups, subgroups, cyclic groups, groups of symmetries, even and odd permutations, the alternating group cosets, normal subgroups, Lagrange's theorem, quotient groups, solvable groups, mappings, group homomorphisms, isomorphisms. Prerequisite: MATH 201 Calculus II or MATH 261 Calculus II 201608.

MATH 426. Abstract Algebra II. (3 Credits)

Rings, ring homeomorphisms, subrings, ideals, quotient rings, integral domains, polynomial extensions of rings, fields and field extensions. Prerequisite: MATH 425.

MATH 429. Approximation Theory. (3 Credits)

Best approximation in normal spaces, approximation by algebraic polynomials and Weierstrass theorem, trigonometric polynomials, uniform approximation by trigonometric polynomials, Chebyshev polynomials, characterization of the best approximation, and orthogonal polynomials. Prerequisite: MATH 400 Advanced Calculus 201608.

MATH 430. Optimizations Theory. (3 Credits)

Optimization fundamentals, unconstrained and constrained optimization. Lagrange multipliers, nonlinear programming algorithms and convex optimization. Prerequisite: MATH 360 201608.

MATH 432. Complex Variables. (3 Credits)

Brief introduction of Complex numbers and its properties, Elementary functions of Complex variable, Analytic functions and its basic properties, Contour integration, Cauchy's Theorem and Integral formula, Maximum modulus principles, Series representation of analytic functions, Taylor's Theorem, Classification of singularities, Laurent series, Calculation of residues. Prerequisite: MATH 301 Multivariate Calculus or MATH 361 Calculus III 201608.

MATH 445. Introduction to Topology. (3 Credits)

Metric and topological spaces, separation axioms, connectedness, compactness, homeomorphisms and product spaces. Prerequisite: MATH 425 202508.

MATH 452. Numerical Analysis. (3 Credits)

A survey of modern numerical methods with emphasis on those best suited for digital computer application. Polynomial interpolation, iterative methods for solving simultaneous linear and non-linear equations, solutions of algebraic equations, solutions to differential equations. Prerequisite: MATH 261 Calculus II 201808.

MATH 470. History Of Mathematics. (3 Credits)

An introduction to the chronological history of mathematics and the mathematicians who made significant contributions, emphasizing the evolution of basic concepts ranging from primitive number systems through the foundations of set theory. Mathematical analysis, probability, statistics, algebra, trigonometry, calculus, number theory and geometry. Prerequisite: MATH 300 202508.

MATH 473. Discrete Wavelet Transfor/Appl. (3 Credits)

Introduction to digital images, complex numbers and Fourier series, convolution and filters, the Haar wavelet transformation, Daubechies wavelet transformations, wavelet shrinkage. Prerequisites: MATH 325 Linear Algebra and MATH 261 Calculus II 201808.

MATH 475. Introd to Difference Equations. (3 Credits)

Dynamics of first-order difference equations, equilibrium points and their stability, periodic points, cycles and their stability, difference equations associated to differential equations, Euler's method, difference calculus, linear difference equations, first and higher order, homogeneous with constant coefficients, non-homogeneous by the methods of undetermined coefficients, limiting behavior of solutions, nonlinear equations transformable to linear difference equations. Prerequisites: MATH 325 Linear Algebra, MATH 350 Differential Equations 201608.

MATH 490. Graph Theory. (3 Credits)

Basic definitions of graphs, Eulerian and Hamiltonian graphs, graph decompositions, matchings, trees, bipartite graphs, vertex colorings, network algorithms planar graphs, Kuratowski's theorem and the Four-color Theorem. Prerequisites: MATH 284 or MATH 280.

MATH 493. Topics in Mathematics. (3 Credits)

Topics in mathematics not covered in ordinary courses. The course may be repeated once for credit if content is different. Prerequisite: Consent of instructor.

MATH 495. Senior Project. (1-3 Credits)

A capstone course designed to review, unify, and extend concepts and skills developed in previous mathematics courses and give students additional experience in presenting mathematical concepts in oral and written form and improving problem-solving skills and expose students to research. Prerequisite: Senior academic standing 202508.

MATH 499. Gre Mathematics Review. (3 Credits)

Whole numbers, fractions, decimals, percent's, signed numbers, averages and medians, powers, exponents and roots, algebraic expressions, equations, verbal problems, counting problems, ratio and proportions, sequence and progressions, inequalities, lines, polygons, tri-angles, quadrilaterals, circles, area and perimeter, coordinate geometry, tables, circle, line and bar graphs, cumulative graphs, analytical reasoning tactics, and logical reasoning tactics. A considerable part of the course will be devoted to practice tests similar to quantitative tests of GRE in order to develop the problem-solving and test-taking techniques required.

STAT 210. Elementary Statistics I. (3 Credits)

An introductory statistics course without a calculus prerequisite. Presentation of data, frequency distributions, descriptive statistics, elementary concepts of probability, random variables, binomial and normal distributions, sampling procedures, student's t-test, linear correlation. Interpretation of examples of data which occur in daily life. This course cannot be taken as a mathematics elective by mathematics majors. Prerequisites: MATH 112 Basic Mathematics I; MATH 113 Basic Mathematics II or the equivalent 201608.

STAT 211. Elementary Statistics II. (3 Credits)

Sampling of attributes, comparison of several samples, one-way analysis of variance, sign test, median test, Kruskal-Wallis test and test for randomness, simple regression analysis and Statistical software. Prerequisite: STAT 210 201608.

STAT 330. Probability and Statistics I. (3 Credits)

An introductory course in probability and statistics with an elementary calculus prerequisite. Elementary descriptive statistics, basic probability rules, conditional probability, independence, Bayes' theorem, discrete and continuous probability distributions, probability density functions, binomial, Poisson, hypergeometric, negative binomial, geometric and normal distributions. Prerequisite: MATH 201 Calculus II or MATH 261 Calculus II 201608.

STAT 340. Probability Stat Cmptr Scienti. (3 Credits)

Introduction to the concepts of probability, random variables, estimation, hypothesis testing, regression, and analysis of variance with emphasis on application. Prerequisites: MATH 261.

STAT 380. Probability & Statistics II. (3 Credits)

Mathematical derivations, computational formulas, and applications and interpretations associated with the techniques of probability theory and elementary statistical inference will be emphasized. Moment-generating functions, basic sampling distribution theory, t and chi-square distributions, one-sample estimation and tests of hypotheses. Prerequisites: MATH 360; STAT 330 or STAT 340.

STAT 382. Introduction To Sampling Metho. (3 Credits)

A course that presents the basic ideas of sampling: random, stratified, systematic and cluster sampling, ratio and regression estimates, estimation of sample size, sampling methods in social, economic and biological surveys, sources of error in surveys. Prerequisite: STAT 380 201808.

STAT 385. Analysis Of Variance. (3 Credits)

Theory, methodology, and practical applications of analysis of variance (ANOVA). Topics will include: one-factor and two-factor ANOVA; multiple comparisons; two-factor and three-factor balanced factorial designs with interactions; random, fixed and mixed-effect models; contrasts and confounding; and the regression approach to ANOVA. Prerequisite: STAT 380 201608.

STAT 410. Advanced Statistical Methods. (3 Credits)

A course designed for students who plan to apply statistical methods in the context of research problems in social sciences, natural sciences, agriculture and education. Uses of computers and packaged computer programs are emphasized. Prerequisite: STAT 380 202508.

STAT 480. Probability & Statistics III. (3 Credits)

A course emphasizing the statistical techniques which are useful in the treatment of multiple samples. Topics include the properties of joint discrete and continuous probability distributions, conditional and marginal distributions, covariance, independent random variables, estimation and hypothesis testing of population parameters in the two-sample case, chi-square tests, and simple linear regression and correlation. Prerequisite: STAT 380 202508.

STAT 481. Nonparametric Statistics. (3 Credits)

A course which examines statistical techniques which are applicable even if the form of the sampled population is unknown. Wilcoxon rank-sum test, Mann-Whitney U-test, sign test, Wilcoxon signed-rank test, tests for randomness, Spearman's correlation, Kolmogorov-Smirnov statistics, Turkey's quick test, Friedman and Cochran's test, computer programs. Prerequisite: STAT 380 202508.

STAT 482. Applied Multivariate Statistic. (3 Credits)

Multivariate methods using matrix algebra and applied statistics to analyze several correlated measurements made on each experimental unit. Multivariate normal distribution, estimation and hypothesis testing in multiple regression, Hotelling's T, one-way multivariate analysis of variance, introduction to discriminant and factor analysis, principal components and canonical correlations and statistical software. Prerequisite: STAT 410 201608.

STAT 484. Applied Probability. (3 Credits)

Probability theory applied to the study of phenomena in engineering, management science, operations research, and the natural sciences. Markov's inequality, conditional expectation, Markov chains, Chapman-Kolmogorov equation, interarrival and waiting time distributions. Prerequisite: STAT 480.

STAT 490. Probability Theory. (3 Credits)

A rigorous development and proofs of the theory of probability. Formal probability systems, conditional probability, sequences of events, independence of events, random variables, probability density and distribution functions, joint distributions, independence of random variables, functions and transformations of random variables, fundamental limit theorems. Prerequisites: At least two 400-level statistics courses or consent of the instructor.

MAED 402. Student Teaching In Mathematic. (3 Credits)

This course is designed to provide supervision in the content area for pre-service secondary mathematics candidates. Prerequisite: Departmental Approval.

MAED 460. Teach Math Primary & Elem Grad. (3 Credits)

Methods, materials, and experiences to equip students to teach mathematics in a variety of settings, relevant to early childhood and elementary levels. The activities of the course will develop techniques and strategies of teaching concepts associated with sets, numeration systems, geometry, arithmetic operation, measurements, functions and relations, graphs, logic, number theory and patterns, probability and statistics. Concepts from the psychology of learning will be explored. Prerequisite: MATH 230.

MAED 464. Teaching Math In Middle Grades. (3 Credits)

A study of modern instructional strategies for teaching, planning and directing mathematics in the middle school. Prerequisites: EDUC 202 Introduction to Teaching II.

MAED 473. Teach Math Secondary Schools I. (3 Credits)

A study of modern instructional strategies for teaching, planning and directing mathematics learning in secondary schools. Prerequisite: EDUC 201, EDUC 202 202508.

COGNATE COURSES**MATH 280 DISCRETE MATHEMATICS FOR COMPUTER SCIENTISTS - 3 semester hours**

Fundamental techniques in discrete mathematics for application in computer science. Sets, mathematical logic, proof techniques, relations, functions, mathematical induction, counting principle, and analysis of algorithms.

Prerequisite: MATH 150

STAT 340 PROBABILITY AND STATISTICS FOR COMPUTER - 3 semester hours

Introduction to the concepts of probability, random variables, estimation, hypothesis testing, regression, and analysis of variance with emphasis on application.

Prerequisites: MATH 261

**MATHEMATICS WITH A CONCENTRATION
IN SECONDARY EDUCATION (6-12)**

MAED 402 STUDENT TEACHING IN MATHEMATICS - 3 semester hours

This course is designed to provide supervision in the content area for pre-service secondary mathematics candidates.

Prerequisite: MATH 299, MATH 360

MAED 460 THE TEACHING OF MATH IN ELEMENTARY SCHOOLS - 3 semester hours

Methods, materials, and experiences to equip students to teach mathematics in a variety of settings, relevant to early childhood and elementary levels. The activities of the course will develop techniques and strategies of teaching concepts associated with sets, numeration systems, geometry, arithmetic operation, measurements, functions and relations, graphs, logic, number theory and patterns, probability and statistics. Concepts from the psychology of learning will be explored.

Prerequisite: MATH 230

MAED 473 THE TEACHING OF MATHEMATICS IN SECONDARY SCHOOLS - 3 semester hours

A study of modern instructional strategies for teaching, planning and directing mathematics learning in secondary schools. A comparative analysis of national and state mathematics teaching standards is conducted. (Students are strongly recommended to complete EDUC 201 and EDUC 202 before taking this course.)

Prerequisite: MATH 299, MATH 360

****Minor Electives (18 credits)**

Students can minor in any degree-granting discipline outside their major. A minor is not required for graduation. If a student who is a Mathematics major does not choose a minor, then those 18 credits can be replaced by any courses in the list of Restricted Electives. The minor is designed for students who are not majoring in mathematics and requires minimum credit hours as set by the academic department in which that discipline is housed. A student must formally declare the minor for it to appear on their official academic transcript. A student must go to the departmental office of their desired minor to receive written communication of the requirements for that discipline. The requirements for a student (i.e., a non-Mathematics major) who desires to minor in Mathematics are the completion of MATH 260, MATH 261, MATH 360, and any two additional mathematics or statistics courses at the 300-level or above. Minor request forms can be obtained online under the link to the Registrar's Office.

Secondary Education Concentration

IDST 200 (3 credits), **EDUC 201** (2 credits), **EDUC 202** (2 credits), **EDUC 424** (2 credits), **EDUC 315** (3 credits), **EDUC 427** (3 credits), **SPED 325** or (3 credits). To earn a concentration in Secondary Education, students must satisfy all of the following: (i) be accepted into the VSU Professional Teacher Education Program, (ii) complete the 18 credit hours of the minor, and (iii) pass the mandated professional examinations of the Virginia Department of Education. Upon graduation from the Virginia State University Mathematics program, all students who satisfy the requirements for successful completion of a concentration in Secondary Education will also receive the Commonwealth of Virginia certification and teaching endorsement in Secondary Education.

Free Electives (15 credit hours)**

Math/Stat/Actuarial: Choose any 15 credit hours from any discipline(s) or from the list of the restricted elective below.

Math Secondary Education: **EDUC 201** (2 credits), **EDUC 202** (2 credits), **EDUC 424** (2 credits), **EDUC 402** (9 credits).

Restricted Electives (12 credit hours)

MATH 285, MATH 292, MATH 294, MATH 295, Math 299 (for Secondary Education concentration only), **MATH 317, MATH 321, MATH 335, MATH 340, MATH 341, MATH 348, MATH 355, MATH 380** (for Actuarial concentration only), **MATH 392, MATH 401, MATH 415, MATH 417, MATH 426, MATH 429, MATH 430, MATH 432, MATH 445, MATH 452, MATH 470, MAED 475, MAED 473, MATH 475, MATH 490, MATH 493, STAT 380, STAT 382, STAT 385, STAT 410, STAT 480, STAT 481, STAT 482, STAT 484, STAT 490**, and any 300 or 400 level courses from any of the following: **CSCI** electives, **MANE** electives, **CPEG** electives, **ELET** electives, **ENGR** electives.

Double Major in Mathematics

Students who wish to double major in mathematics will have to complete the following credits hours in which some will be cross-listed for both majors.

- All core courses in mathematics (36 credits)
- General Education (GE) requirements (33-37 credits)
- All core courses in the second major (36-42 credits)
- Restricted electives from the above list (minimum of 12 credits).

ECON 100. Basic Economics. (3 Credits)

It is designed to cover basic microeconomics and macroeconomics for those not planning further course work in the field. Basic microeconomic and macroeconomic theories are used to explain the economic system, the institutions that make up the system and their functions.

ECON 210. Principles Of Microeconomics. (3 Credits)

It analyzes the price system and its functions in a market economy of distributing goods and services and allocating resources. Concepts include the examination of markets as they range from highly competitive to monopolistic.

ECON 211. Principles Of Macroeconomics. (3 Credits)

It analyzes national and international economic problems, such as inflation, unemployment, productivity, economic growth, and the balance of trade. Particular attention is given to the role of government policy as it seeks to improve economic performance in these areas. Prerequisite: ECON 210 Principles of Microeconomics or Permission of the instructor.

ECON 310. Microeconomics. (3 Credits)

It provides a foundation for understanding the basic organization and operation of the economy. The subject is developed from three aspects: demand analysis, theory of the firm, and market interaction. Prerequisite: ECON 210 Principles of Microeconomics.

ECON 313. Managerial Economics. (3 Credits)

It focuses on the application of economic method to planning and decision making within the firm with respect to profit maximization, market structure, and forecasting. Prerequisite: ECON 210 Principles of Microeconomics.

ECON 320. Macroeconomics. (3 Credits)

It examines the determinants of aggregate income and output, interest rates, prices, employment and the balance of payments, and the use of monetary and fiscal policies. Prerequisite: ECON 211 Principles of Macroeconomic.

ECON 321. Financial Markets & Institutions. (3 Credits)

It presents an analysis of financial instruments, markets, and institutions. Topics include the commercial banking system and the money expansion process, the Federal Reserve System, monetary theory and policy; and international finance. Prerequisite: ECON 211 Principles of Macroeconomics.

ECON 330. Econometrics. (3 Credits)

Microeconomics and macroeconomics theories are presented in an analytical and researchable format. Econometric theories and procedures are introduced with an emphasis on application through explaining and predicting various economic phenomena using econometric software. Prerequisite: ISDS 260 Business Statistics or equivalent.

ECON 340. Labor Economics. (3 Credits)

Presents theories of the demand for labor, the supply of labor, unemployment, and wage determination. Related topics include investment in human capital, labor mobility, and unions and collective bargaining as they affect employment and earnings. Prerequisite: ECON 211 Principles of Macroeconomics.

ECON 350. Economic Development. (3 Credits)

Examines and analyzes alternative theories of economic development in less developed countries. Special emphasis is placed on factors such as capital formation, population growth, institutions, policies and planning for development. Prerequisite: ECON 211 Principles of Macroeconomics.

ECON 366. Economics & Minority Groups. (3 Credits)

It examines and analyzes the economic problems and conditions of minority groups, including problems of the effects of numerous programs influencing that development; and strategies for economic and social changes. Prerequisite: One semester of Economics or permission of the instructor.

ECON 411. Industrial Organization & Regulation. (3 Credits)

It examines and analyzes industrial organization and structure in terms of market strategies, pricing, and the determinants of the most efficient firm size. Analysis and investigation of the rationale for government regulation of firms and the resulting economic impact is also covered. Prerequisite: ECON 211 Principles of Macroeconomics.

ECON 423. Public Finance. (3 Credits)

Analyzes the economic effects of public expenditures, revenues, and indebtedness with reference to select tax and budgetary problems. Prerequisite: ECON 211 Principles of Macroeconomics.

ECON 438. Financial Economic Analysis. (3 Credits)

ECON 438 Financial Economic Analysis - 3 semester hours F This course introduces the theory and application of modern financial economic analysis and its application. Time-value of money, types of financial assets and markets, interest rates, risk and return, equity valuations, investment decisions, and portfolio theory are discussed. Prerequisite(s): ECON 321.

ECON 445. Analytical Economics. (3 Credits)

ECON 445 Analytical Economics - 3 semester hours SP Concepts and tools in economic analytics with focus on exploring and visualization of micro and macroeconomics data as well as descriptive and predictive analytics. Prerequisite(s): ECON 330.

ECON 451. International Economics. (3 Credits)

Deals with the study of the theories of causes of trade, directions of trade, and the gains from trade, balance of payments, foreign exchange, and current trade policies and problems including international financial reforms. Prerequisite: ECON 310 Microeconomics, or the approval of the instructor.

ECON 455. Comparative Economic Systems. (3 Credits)

Examines the economic life under alternative systems in the world today. Emphasis is placed on capitalism, socialism, communism and democratic socialism. Prerequisite: ECON 211 Principles of Macroeconomics.

ECON 465. Urban Economics. (3 Credits)

Focuses on the economic functions of cities, metropolitan decentralization, urban growth and development, transportation, housing markets, urban renewal, local government finance, and poverty. Prerequisite: ECON 211 Principles of Macroeconomics.

ECON 470. History Of Economic Thought. (3 Credits)

Surveys the development of economic thought and the advancement of economic analysis, including the physiocrats, classicists, marginalists, socialists, neoclassicists, institutionalists, and contemporary schools. Prerequisite: ECON 211 Principles of Macroeconomics.

ECON 490. Reading In Economics. (3 Credits)

Provides an opportunity for students to select topics not otherwise included in Economics course work. It requires intensive reading supervised by the instructor and reported on by the students. Prerequisite: ECON 211 Principles of Macroeconomics and approval of instructor.

ECON 498. Economics Internship. (3 Credits)

Provides an opportunity for students to observe and be exposed to the application of economic theories and methods to practical work experience in a closely supervised environment. Prerequisite: Junior standing and department approval.

ECON 499. Seminary In Economics. (3 Credits)

This is a capstone course which a student must demonstrate the ability to choose a well-defined research topic or a case review under faculty advising then proceed to search for essential information and correct procedures for analysis, write-up, and presentation. Prerequisite: Senior standing.

Economics Electives

The ECON electives include **ECON 313, ECON 340; ECON 350; ECON 411; ECON 423; ECON 451; ECON 455; ECON 465; ECON 470; ECON 490**, or any other economic courses approved by the department.

Minor in Economics & Finance

The minor program in economics is designed to give students for other programs in the University the opportunity to diversify and complement their education experience in economics. It consists 18 credit hours, including 4 core economics courses (**ECON 210; ECON 211; ECON 310 and ECON 320**) and two electives from Economics electives at 300 and 400 levels. Students must earn a grade of "C" or better in all required by the program courses.

Double Major in Economics

Students enrolled in Double Major Economics program are expecting to complete the following credit hours:

- General Education (GE) courses (33 credits)
- Six core courses and four electives in Economics (30 credits)
- The Economics and Double Major (including economics) students could apply in their senior year for Certificate Program in Project Management, taking at least 9 electives credits that could lead to their Certificate Program in PMJT and later on to their MA Program in economics degree with concentration in Project Management.

Technical electives (12 credits for students interested in double major): INLT 292; INLT 320; INLT 444; INLT 485; MISY 318; PADM 305; PADM 404 and other courses approved by academic faculty adviser.