

# MATH - MATHEMATICS (MATH)

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## **MATH 0012 Developmental Math II (3 Credits)**

Topics covered: review of arithmetic skills, simplifying algebraic expressions, exponents, equations, polynomials, graphing, factoring, square roots, algebraic fractions and elementary word problems. Successful completion of this class will satisfy the Developmental Math requirements. Prerequisite: MATH 0011 or appropriate placement.

## **MATH 0015 College Algebra Coreq Lab (3 Credits)**

A 3-credit lab linked with specified sections of MATH 1014 required for students whose placement indicated the need for additional mathematics skills mastery. Topics covered: review of arithmetic skills, simplifying algebraic expressions, exponents, equations, polynomials, graphing, factoring, radical expressions, algebraic fractions and elementary word problems.

## **MATH 1014 College Algebra (3 Credits)**

The real number system, algebraic manipulations, solving equations and inequalities, exponents and radicals, functions and graphing. Prerequisite: MATH 0012 or appropriate placement.

## **MATH 1015 Pre Calc Math Alg and Trig (4 Credits)**

The real number system, functions, polynomial functions and equations, exponential and logarithmic functions, trigonometric functions (graphs, applications, identities and equations), analytic geometry. Prerequisite: MATH 1014 or appropriate placement.

## **MATH 1061 Math for Elem Educators II (3 Credits)**

## **MATH 1101 Stat Concepts and Methods (3 Credits)**

Nature of statistics. Descriptive statistics, graphical methods, measures of central tendency and variability. Probability, correlation and regression, sampling distributions. Inferential statistics, estimation and hypothesis testing, tests of independence and nonparametric statistics. Use of computer statistical packages. Prerequisite: MATH 0012 or appropriate placement.

## **MATH 1102 Mathematical Perspective (3 Credits)**

Introduction to traditional and contemporary mathematical ideas in logic, number theory, geometry, probability and statistics. Historical and cultural development of these topics, as well as connections to other disciplines and various problem-solving strategies are included. Prerequisite: MATH 0012 or appropriate placement.

## **MATH 1151 Math for Elem Educators I (3 Credits)**

## **MATH 1161 Math for Elem Educators II (3 Credits)**

## **MATH 1203 Stats Models for Soc Science (3 Credits)**

Applications of statistics in the social sciences. Analysis and interpretation of statistical models. Sampling techniques, common flaws and errors in sampling and in using statistics. Descriptive statistics, levels of measurement, measures of central tendency and dispersion. Contingency tables and measures of association for categorical variables. Correlation and linear regression. Probability and frequency distributions. Parametric and nonparametric inferential statistics. Confidence intervals and hypothesis testing. Prerequisite: MATH 0012 or appropriate placement.

## **MATH 1205 Finite Math w Calculus for Bus (3 Credits)**

For students in the School of Business. Functions and linear models, systems of linear equations, linear programming, sets and counting, probability, random variables and statistics, quadratic functions, introduction to the derivative, marginal analysis, maximum and minimum problems, the mathematics of finance. Specific and real-world applications to problems illustrate each topic. Prerequisite: MATH 0012 or appropriate placement.

## **MATH 1311 Calculus for Business- Econ II (3 Credits)**

Implicit differentiation, related rates, differential equations, improper integrals and probability density functions, partial derivatives and applications and multiple integrals. Introduction to matrix theory, solution of systems of linear equations and linear programming. Prerequisite: MATH 1303.

## **MATH 1401 Calculus I (4 Credits)**

Real numbers, functions, elements of plane analytic geometry, limits, continuity, derivatives, differentiation of algebraic functions, applications of the derivative, antiderivatives, definite integral and Fundamental Theorem of Calculus. Applications using computer software packages. Prerequisite: MATH 1015 or appropriate placement.

## **MATH 1411 Calculus II (4 Credits)**

Applications of integration. Differentiation of trigonometric and exponential functions and their inverses. Techniques of integration. Improper integrals, indeterminate forms, polar coordinates and vectors. Applications using computer software packages. Prerequisite: MATH 1401.

## **MATH 1501 Calculus I - Math - Phys Sci (4 Credits)**

Real numbers, proof by induction, functions, definition by recursion, limits, continuity, derivatives and applications, definite integral, Fundamental Theorem of Calculus and inverse functions. Applications using computer software packages. Emphasis on theory. Prerequisite: MATH 1015 or appropriate placement.

## **MATH 1511 Calculus II - Math - Phys Sci (4 Credits)**

Applications of integration, polar coordinates, techniques of integration, infinite series, conics, two-dimensional vectors and differential equations. Applications using computer software packages. Emphasis on theory. Prerequisite: MATH 1401 or 1501.

## **MATH 1611 Intro to Discrete Mathematics (3 Credits)**

Basic counting rules, permutations, combinations, Pigeonhole principle, inclusion-exclusion, generating functions, recurrence relations, graphs, digraphs, trees and algorithms. Prerequisite: MATH 1015 or appropriate placement

## **MATH 2111 Statistics for Science Majors (4 Credits)**

Oriented toward direct application to research problems in the sciences. Collecting and organizing data, design of experiments, standard distributions, statistical tests and procedures used in hypothesis testing. A discursive treatment of the probability theory necessary to understand statistical tests is included but minimized. Emphasis on statistical inference and developing an awareness of statistical methods in a given situation. Prerequisite: MATH 1401.

## **MATH 2411 Calculus III (4 Credits)**

Elements of solid analytic geometry, parametric equations, vector-valued functions, partial differentiation, multiple integrals, line integrals and surface integrals. Applications using computer software packages. Prerequisite: MATH 1411.

**MATH 2511 Calculus III - Math - Phys Sci (4 Credits)**

Vectors in space, vector-valued functions, partial differentiation, multiple integrals, vector analysis, and line and surface integrals. Applications using computer software packages. Emphasis on theory. Prerequisite: MATH 1511.

**MATH 2711 Intro Probability - Statistics (4 Credits)**

Introduction to statistics. Levels of measurement; central tendency and dispersion; accuracy, precision, error and bias. Probability spaces, random variables, and sampling. Counting: principles, permutations and combinations, combinatorics. Continuous and discrete probability, conditional probability and expectation. Approaches for summarizing and visualizing statistical information. Univariate, bivariate, and multivariate distributions; standard continuous and discrete distributions, including Binomial, Poisson, Exponential, Normal and Chi-Square distributions; introduction to moment generating functions. The Central Limit Theorem. Overview of confidence intervals and hypothesis testing. Independence and association, correlation and regression, and the Chi-Square test. Use of software packages such as Maple, Excel, and/or StatCrunch for statistics. Prerequisite: MATH 1401 or MATH 1501, and MATH 1611. (Note: Students cannot receive credit for both MATH 2711 and MATH 2111.)

**MATH 2810 Linear Algebra - Diff Equation (4 Credits)**

First order and linear second order differential equations, matrices and linear equation systems, eigenvalues and eigenvectors, and linear systems of differential equations. Separable partial differential equations.

**MATH 2813 Linear Algebra (4 Credits)**

Matrix algebra, determinants, solutions of systems of linear equations,  $R_n$ , abstract vector spaces, linear transformations, inner product spaces and eigenvectors. Prerequisites: MATH 2611.

**MATH 2814 Intro Linear Algebra Comp Math (3 Credits)**

Topics essential for computer science selected from traditional linear algebra and Calculus II. The material is presented in a constructive and algorithmic way to increase relevance for computer science students. The students will implement relevant mathematical algorithms in a programming language taught during the freshman or sophomore year. Students will acquire skills that are essential for designing efficient software applications, needed in industrial and scientific applications of computer science.

**MATH 3111 History of Mathematics (3 Credits)**

The development of mathematical ideas in various cultures, civilizations, and eras including Ancient Greece, Medieval China, the Renaissance, Era of Descartes and Fermat, Era of Newton and Leibniz, as well as the logical foundations and the use of the computer in Modern Mathematics. Prerequisite: MATH 2511 and MATH 1611.

**MATH 3204 Logic and the Limits to Know (3 Credits)**

The course presents an overview of topics in and related to logic, including development of formal logic and an axiomatic first-order logic. It explores the history of mathematics and logic in the Catholic Intellectual and wider Western Traditions, as well as the mutual interactions of mathematics, philosophy and religion. It then considers extensions of first-order logic, and provable limits to knowledge: the three unsolvable problems of Euclidean geometry, and examples from Gödel, Turing, Arrow, quantum physics, and others

**MATH 3411 Graph Algorithms (3 Credits)**

This course introduces discrete graphs and their applications, with emphasis on applications. It covers the fundamental structures of and algorithms on discrete graphs, teaching students how to use graph algorithms to extract useful information from graph and network data, how to model complex processes using graph theoretic techniques, and how to investigate and validate resulting models in order to test graph models and make predictions.

**MATH 3512 Intro to Complex Analysis (3 Credits)**

Analytic functions, elementary functions and mappings, integrals, Cauchy's integral theorem and formula, power series, residues and poles. Prerequisite: MATH 2511. 3 credits

**MATH 3514 Differential Equations (3 Credits)**

Existence theorems, graphical methods, phase plane analysis, boundary value problems and selected topics. Prerequisites: MATH 2511, MATH 2813.

**MATH 3515 Analysis (4 Credits)**

Structure of  $R^1$  and  $R^n$ . Sets, equivalence classes, countability; compactness and connectedness; continuity, differentiability and integrability. Theory of series. Pointwise and uniform convergence. Prerequisites: MATH 2411 or 2511; MATH 2813.

**MATH 3611 Intro to Ops Res (3 Credits)**

Construction and use of mathematical models in operations research. Classical techniques for optimization of functions of one and several variables. Linear programming problem and simplex method for their solutions. Applications to practical problems. Prerequisites: MATH 2511, MATH 2813.

**MATH 3612 Discrete Mathematics (3 Credits)**

Combinatorial methods and discrete structures. Topics may include enumeration techniques, subsets and designs, partitions, generating functions and recurrence relations; codes and graphs. Prerequisites: MATH 1611, MATH 2813 or MATH 2814.

**MATH 3614 Graph Theory (3 Credits)**

Graphs, trees and digraphs. Various properties are discussed and may include connectivity, colorability, planarity, matchings, extremal graph theory, spanning trees, and reliability. Applications to real world problems will be introduced.

**MATH 3626 Applied Matrix Techniques (3 Credits)**

This course introduces fundamental matrices and matrix algorithms used in applied mathematics, and essential theorems and their proofs. It covers matrices used in linear optimization, solving systems of linear differential equations, and modeling of stochastic processes. It also covers implementing matrix algorithms with mathematical software,

**MATH 3711 Statistical Analysis (3 Credits)**

Overall emphases on modeling, on concepts and theory, and on standard statistical tools and approaches. Review of probability spaces, random variables, and sampling. Continuous and discrete probability, moment generating functions, standard distributions. Functions of random variables. The Law of Large Numbers and the Central Limit Theorem. Point estimation, confidence intervals and hypothesis testing. The power of a test. Correlation and regression; the Chi-Square Test. Use of software packages such as Maple, Excel and/or StatCrunch/SPSS for statistics. Prerequisites: Either MATH 2111 or MATH 2711, and either MATH 2813 or MATH 2814.

**MATH 3721 Financial Calculus (3 Credits)**

The course presents an overview of topics in and related to actuarial math, including the time value of money, annuities, and amortization. It looks at financial mathematics in terms of bonds, internal rate of return, and term structure of interest rates. It then considers financial calculus with discrete financial models, market models, risk free assets with a concentration on bonds and money markets, and risky assets. Finally, the course introduces financial engineering including the Black-Scholes Equations using probabilistic methods and applications to options and derivatives.

**MATH 3814 Linear Alg and Matrix Theory (3 Credits)**

Vector spaces and algebras, unitary and orthogonal transformations, characteristic equation of a matrix, the Jordan canonical form. Bilinear, quadratic and Hermitian forms. Spectral theorem. Prerequisite: MATH 2813.

**MATH 3815 Abstract Algebra (4 Credits)**

Introduction to algebraic structures: monoids, groups, rings and fields. Examples are given, and the elementary theory of these structures is described. Prerequisite: MATH 2813.

**MATH 3913 Junior Seminar (3 Credits)**

Seminars and discussions designed to integrate readings of mathematical literature with both oral and written presentations.

**MATH 4092 Topics in Applied Math II (3 Credits)**

Topics chosen from among operations research, optimization, including an introduction to the calculus of variations, combinatorics, discrete mathematics, Fourier analysis, integral equations, partial differential equations. Students acquire some experience.

**MATH 4095 Independent Study-Math (2 Credits)**

Prerequisite: permission of department chair.

**MATH 4097 Independent Study-Math (3 Credits)**

Prerequisite: permission of department chair.

**MATH 4098 Independent Study-Math (3 Credits)**

Prerequisite: permission of department chair.

**MATH 4099 Mathematics Independent Study (1 Credit)**

Independent study on a select topic completed under the supervision of the instructor.

**MATH 4512 Intro to Complex Analysis (3 Credits)**

Analytic functions, elementary functions and mappings, integrals, Cauchy's integral theorem and formula, power series, residues and poles. Prerequisite: MATH 2511.

**MATH 4516 Advanced Topics in Analysis (3 Credits)**

Consequences of continuity, differentiability and integrability in  $\mathbb{R}^n$ ; introduction to metric spaces. Lebesgue integration.

**MATH 4712 Adv Topic in Appl Prob - Stat (3 Credits)**

Advanced topics in probability and statistics or its application, selected by the instructor. Possible topics include, but are not limited to: advanced statistical modeling, stochastic models, applications to actuarial science and reliability, statistical data analysis and visualization, simulation and validation, design of experiments.

**MATH 4722 Adv Topics Financial Calculus (3 Credits)**

The course presents an overview of topics in and related to financial calculus and financial engineering, including portfolio management, hedging strategy, and risk management. It will introduce Brownian Stochastic Processes and Martingales and Continuous Financial Models. It then considers extensions of optimal portfolios and risk management, including swaps and currency forward contracts.

**MATH 4816 Advanced Topics in Algebra (3 Credits)**

Further properties of groups and fields, with a section on the applications of finite fields. Galois theory, the theory of the solution of algebraic equations.

**MATH 4912 Senior Project (3 Credits)**

Individual research project applying skills developed in Junior Seminar (MATH 3912) under the guidance of faculty adviser. Grade is ordinarily based on oral and written presentations. Prerequisites: MATH 3912 and permission of department chair.

**MATH 5011 Mathematics Seminar (3 Credits)**

Special topics and problems in various branches of mathematics. Prerequisite: permission of department chair.