MATH-MATHEMATICS

A student may not receive credit for a lower-division mathematics course if it serves as a prerequisite to a lower-division math course that the student had previously passed with a grade of C- or better.

Students without adequate placement to enroll in MATH 1134, MATH 1215 or MATH 130G can gain admission to the course by earning a C- or better in CCDM 114 N at an NMSU Community College campus, or in A S 103.

Students wishing to enroll in MATH 1220G, MATH 1430G, MATH 1511G, MATH 1521G, or MATH 1350G must satisfy one of the following:

1. have passed the stated prerequisite course or an equivalent transfer course with a C- or better
2. have placed into the course with an adequate ACT Math score or through the Mathematics Placement Examination (MPE), the results of which will be made available to the student’s advisor. The MPE is given daily in Walden Hall when school is in session and during new student orientation programs.

MATH 1130G. Survey of Mathematics
3 Credits (3)
This course will develop students’ ability to work with and interpret numerical data, to apply logical and symbolic analysis to a variety of problems, and/or to model phenomena with mathematical or logical reasoning. Topics include financial mathematics used in everyday life situations, statistics, and optional topics from a wide array of authentic contexts. Prerequisite(s): adequate scoring on the Mathematics Placement Exam, or any ACT/SAT and GPA combination that is considered equivalent, or a C- or better in CCDM 113 N or CCDM 114 N or A S 103 or higher

MATH 1134. Fundamentals of Elementary Mathematics I
3 Credits (3)
Numbers and the four operations of arithmetic. Understanding and comparing multiple representations of numbers and operations, in particular how these representations build from whole numbers to integers to fractions and decimals. Applying properties of numbers and operations in contextual situations. Reasoning, communicating, and problem solving with numbers and operations. Applications to ratio, and connections with algebra. Taught primarily through student activities and investigations. Restricted to: EDUC,PAR,E ED,ECED majors. Prerequisite(s): adequate scoring on the Mathematics Placement Exam, or any ACT/SAT and GPA combination that is considered equivalent, or a C- or better in CCDM 113 N or CCDM 114 N or A S 103 or higher

MATH 1215. Intermediate Algebra
3 Credits (3)
A study of linear and quadratic functions, and an introduction to polynomial, absolute value, rational, radical, exponential, and logarithmic functions. A development of strategies for solving single-variable equations and contextual problems. Prerequisite(s): adequate scoring on the Mathematics Placement Exam, or any ACT/SAT and GPA combination that is considered equivalent, or a C- or better in CCDM 113 N or CCDM 114 N or A S 103 or higher

MATH 1217. General Supplemental Instruction I
1 Credit (2P)

MATH 1220G. College Algebra
3 Credits (3)
The study of equations, functions and graphs, reviewing linear and quadratic functions, and concentrating on polynomial, rational, exponential and logarithmic functions. Emphasizes algebraic problem solving skills and graphical representation of functions. Prerequisite(s): adequate scoring on the Mathematics Placement Exam, or any ACT/SAT and GPA combination that is considered equivalent, or a C- or better in MATH 1215 or higher

MATH 1221. General Supplemental Instruction II
1 Credit (1+2P)
Collaborative workshop for students enrolled in College Algebra. Graded: S/U Grading (S/U, Audit). Corequisite(s): MATH 1220G.

MATH 1250G. Trigonometry & Pre-Calculus
4 Credits (3+2P)
Trigonometry & Pre-Calculus includes the study of functions in general with emphasis on the elementary functions: algebraic, exponential, logarithmic, trigonometric and inverse trigonometric functions. Topics include rates of change, limits, systems of equations, conic sections, sequences and series, trigonometric equations and identities, complex number, vectors, and applications. Prerequisite(s): adequate scoring on the Mathematics Placement Exam, or any ACT/SAT and GPA combination that is considered equivalent, or a C- or better in MATH 1220G or higher

MATH 1350G. Introduction to Statistics
3 Credits (3)
This course discusses the fundamentals of descriptive and inferential statistics. Students will gain introductions to topics such as descriptive statistics, probability and basic probability models used in statistics, sampling and statistical inference, and techniques for the visual presentation of numerical data. These concepts will be illustrated by examples from a variety of fields. Prerequisite(s): adequate scoring on the Mathematics Placement Exam, or any ACT/SAT and GPA combination that is considered equivalent, or a C- or better in MATH 1215 or higher

MATH 1430G. Applications of Calculus I
3 Credits (2+2P)
An algebraic and graphical study of derivatives and integrals, with an emphasis on applications to business, social science, economics and the sciences. Prerequisite(s): adequate scoring on the Mathematics Placement Exam, or any ACT/SAT and GPA combination that is considered equivalent, or a C- or better in MATH 1220G or higher

MATH 1435. Applications of Calculus I
3 Credits (3)
Intuitive differential calculus with applications to engineering. Prerequisite(s): C- or better in MATH 1250G.

MATH 1440. Applications of Calculus II
3 Credits (3)
Topics in this second course of Applications of Calculus include functions of several variables, techniques of integration, an introduction to basic differential equations, and other applications. Prerequisites: C or better in MATH 1430G or in MATH 1521G, or in MATH 1521H.

MATH 1511G. Calculus and Analytic Geometry I
4 Credits (4)
Limits and continuity, theory and computation of derivatives, applications of derivatives, extreme values, critical points, derivative tests, l'Hopital's Rule. Prerequisite(s): adequate scoring on the Mathematics Placement Exam, or any ACT/SAT and GPA combination that is considered equivalent, or a C- or better in MATH 1250G or higher
MATH 1521G. Calculus and Analytic Geometry II
4 Credits (4)
Riemann sums, the definite integral, antiderivatives, fundamental theorems, techniques of integration, applications of integrals, improper integrals, Taylor polynomials, sequences and series, power series and Taylor series.
Prerequisite(s): C or better in MATH 1511G.

MATH 1521H. Calculus and Analytic Geometry II Honors
4 Credits (3+1P)
A more advanced treatment of the material of MATH 1521G with additional topics. Consent of Instructor required. Restricted to Las Cruces campus only. Consent of Department.

MATH 1531. Introduction to Higher Mathematics
3 Credits (3)
Logic; sets, relations, and functions; introduction to mathematical proofs.
Prerequisite(s): C- or better in MATH 1521G or MATH 1521H.

MATH 1996. Topics in Mathematics
1-3 Credits
Topics to be announced in the Schedule of Classes. Maximum of 3 credits per semester. Total credit not to exceed 6 credits. Community Colleges only.
Prerequisite: consent of instructor.

MATH 2134G. Fundamentals of Elementary Math II
3 Credits (3)
Geometry and measurement. Multiple approaches to solving problems and understanding concepts in geometry. Analyzing and constructing two- and three-dimensional shapes. Measurable attributes, including angle, length, area, and volume. Understanding and applying units and unit conversions. Transformations, congruence, and symmetry. Scale factor and similarity. Coordinate geometry and connections with algebra. Reasoning and communicating about geometric concepts. Taught primarily through student activities and investigations.
Prerequisite(s): C or better in MATH 1134.

MATH 2234. Fundamentals of Elementary Mathematics III
3 Credits (3)
Probability, statistics, ratios, and proportional relationships. Experimental and theoretical probability. Collecting, analyzing, and displaying data, including measurement data. Multiple approaches to solving problems involving proportional relationships, with connections to number and operation, geometry and measurement, and algebra. Understanding data in professional contexts of teaching. Taught primarily through student activities and investigations.
Prerequisite(s): C or better in MATH 2134G.

MATH 2350G. Statistical Methods
3 Credits (3)
Exploratory data analysis. Introduction to probability, random variables and probability distributions. Concepts of Central Limit Theorem and Sampling Distributions such as sample mean and sample proportion. Estimation and hypothesis testing single population parameter for means and proportions and difference of two population parameters for means and proportions. Analysis categorical data for goodness of fit. Fitting simple linear regression model and inference for regression parameters. Analysis of variance for several population means. Techniques in data analysis using statistical packages. Prerequisite(s): adequate scoring on the Mathematics Placement Exam, or any ACT/SAT and GPA combination that is considered equivalent, or a C- or better in MATH 1215 or higher.
MATH 377. Introduction to Numerical Methods
3 Credits (3)
Basic numerical methods for interpolation, approximation, locating zeros of functions, integration, and solution of linear equations. Computer-oriented methods will be emphasized.
Prerequisite(s): grade of C or better in MATH 1521G or MATH 1521H and some programming experience.

MATH 391. Vector Analysis
3 Credits (3)
Calculus of vector valued functions, Green's and Stokes' theorems and applications.
Prerequisite: grade of C or better in MATH 2530G.

MATH 392. Introduction to Ordinary Differential Equations
3 Credits (3)
Introduction to differential equations and dynamical systems with emphasis on modeling and applications. Basic analytic, qualitative and numerical methods. Equilibria and bifurcations. Linear systems with matrix methods, real and complex solutions.
Prerequisite: C or better in MATH 1521G or MATH 1521H or B or better in MATH 1440.

MATH 400. Undergraduate Research
1-3 Credits
May be repeated for a maximum of 6 credits. Graded S/U.
Prerequisite: consent of faculty member.

MATH 401. Special Topics
1-3 Credits (1-3)
Specific subjects to be announced in the Schedule of Classes. May be used to fulfill a course requirement for the mathematics major. Consent of Instructor required.

MATH 411V. Great Theorems: The Art of Mathematics
3 Credits (3)
Adopts the view of mathematics as art, using original sources displaying the creation of mathematical masterpieces from antiquity to the modern era. Original sources are supplemented by cultural, biographical, and mathematical history placing mathematics in a broad human context.
Prerequisite: Grades of B or better in MATH 1521G or MATH 1521H and any upper division MATH course, with overall GPA of 3.2 or better, or consent of instructor.

MATH 450. Introduction to Topology
3 Credits (3)
Topological spaces: general spaces and specific examples such as metric spaces, Hausdorff spaces and/or normed vector spaces; separation axioms; continuity, compactness, connectedness; related theorems. Crosslisted with: MATH 520.
Prerequisite(s): MATH 332.

MATH 451. Introduction to Differential Geometry
3 Credits (3)
Applies calculus to curves and surfaces in three dimensional Euclidean space.
Prerequisite(s): C- or better in each of MATH 2415 and MATH 391, or consent of instructor.

MATH 452. Foundations of Geometry
3 Credits (3)
Topics in projective, axiomatic Euclidean or non-Euclidean geometries. Restricted to: Main campus only.
Prerequisite(s): C or better in MATH 331 or MATH 332.

MATH 454. Logic and Set Theory
3 Credits (3)
Prerequisite(s): C- or better in MATH 331 or MATH 332, or consent of instructor.

MATH 455. Elementary Number Theory
3 Credits (3)
Covers primes, congruences and related topics.
Prerequisite: grade of C or better in MATH 331 or consent of instructor.

MATH 456. Abstract Algebra I: Groups and Rings
3 Credits (3)
Group theory, including cyclic groups, homomorphisms, cosets, quotient groups and Lagrange's theorem. Introduction to rings: ring homomorphisms, ideals, quotient rings, polynomial rings, and principal ideal domains. Crosslisted with: MATH 526.
Prerequisite(s): MATH 331 or consent of instructor.

MATH 459. Survey of Geometry
3 Credits (3)
May include topics in non-Euclidean geometry. For non-math majors. Restricted to: Main campus only.
Prerequisite(s): C- or better in MATH 331 or MATH 332.

MATH 471. Complex Variables
3 Credits (3)
A first course in complex function theory, with emphasis on applications.
Prerequisite(s): C- or better in MATH 391 or C- or better in both MATH 392 and MATH 2530G.

MATH 472. Fourier Series and Boundary Value Problems
3 Credits (3)
Fourier series and methods of solution of the boundary value problems of applied mathematics.
Prerequisite(s): C- or better in MATH 392.

MATH 473. Calculus of Variations and Optimal Control
3 Credits (3)
Euler's equations, conditions for extrema, direct methods, dynamic programming, and the Pontryagin maximal principle.
Prerequisite(s): C- or better in MATH 392.

MATH 480. Matrix Theory and Applied Linear Algebra
3 Credits (3)
An application driven course, whose topics include rectangular systems, matrix algebra, vector spaces and linear transformations, inner products, and eigenvalues and eigenvectors. Applications may include LU factorization, least squares, data compression, QR factorization, singular value decomposition, and search engines.
Prerequisite(s): C or better in any 300-level course with a MATH prefix.

MATH 481. Advanced Linear Algebra
3 Credits (3)
Rigorous treatment of vector spaces and linear transformations including canonical forms, spectral theory, inner product spaces and related topics.
Prerequisite: grade of C or better in MATH 331.
MATH 491. Introduction to Real Analysis I  
3 Credits (3)  
Rigorous discussion of the topics introduced in calculus. Sequences, series, limits, continuity, differentiation.  
Prerequisite: grade of C or better in MATH 332 or consent of instructor.

MATH 492. Introduction to Real Analysis II  
3 Credits (3)  
Continuation of MATH 491. Integration, metric spaces and selected topics.  
Prerequisite(s): C- or better in MATH 491 or consent of instructor.

MATH 498. Directed Reading  
1-6 Credits  
May be repeated for a maximum of 6 credits. Graded S/U.

MATH 499. Complex Analysis  
3 Credits (3)  
Rigorous treatment of complex differentiation and integration, properties of analytic functions, series and Cauchy's integral representations. Crosslisted with: MATH 529.  
Prerequisite(s): MATH 332.

MATH 501. Introduction to Differential Geometry  
3 Credits (3)  
Same as MATH 451 with additional work for graduate students.

MATH 502. Foundations of Geometry  
3 Credits (3)  
Same as MATH 452 with additional assignments for graduate students.

MATH 505. Elementary Number Theory  
3 Credits (3)  
Same as MATH 455 with additional assignments for graduate students.

MATH 511. Fundamentals of Elementary Mathematics I  
3 Credits (3+1P)  
Topics from real numbers, geometry, measurement, and algorithms, incorporating calculator technology. Intended for K-8 teachers. As part of course students mentor MATH 1134 undergraduates. Does not fulfill degree requirements for M.S. in mathematics.

MATH 512. Fundamentals of Elementary Mathematics II  
3 Credits (3+1P)  
Real numbers, geometry, and statistics, incorporating calculator technology. Intended for K-8 teachers. Students serve as mentors to MATH 2134G undergraduates. Does not fulfill degree requirements for M.S. in mathematics.

MATH 513. Fundamentals of Algebra and Geometry I  
3 Credits (3+1P)  
Algebra and metric geometry, incorporating appropriate calculator technology. Intended for K-8 teachers. Students serve as mentors to MATH 313 undergraduates. Does not fulfill degree requirements for M.S. in mathematics.

MATH 516. Calculus with Hands-on Application  
3 Credits (3)  
This course, primarily for in-service teachers, is taught in an interactive laboratory format. Students design and construct physical objects for which the planning stage requires calculus techniques. All numerical computations are carried out on graphing calculators. Meets simultaneously with Math 316, primarily for prospective teachers. Does not fulfill degree requirements for M.S. in Mathematics.  
Prerequisite(s): MATH 511 and MATH 512 or consent of instructor.

MATH 517. Complex Variables  
3 Credits (3)  
Same as MATH 471 with additional work for graduate students.

MATH 518. Fourier Series and Boundary Value Problems  
3 Credits (3)  
Same as MATH 472 with additional work for graduate students.

MATH 519. Calculus of Variations and Optimal Control  
3 Credits (3)  
Same as MATH 473 with additional work for graduate students.

MATH 520. Introduction to Topology  
3 Credits (3)  
Same as MATH 450 with additional work for graduate students. Crosslisted with: MATH 450.

MATH 524. Logic and Set Theory  
3 Credits (3)  
Same as MATH 454 with additional assignments for graduate students. Crosslisted with: MATH 454.  
Prerequisite(s): consent of instructor.

MATH 525. Advanced Linear Algebra  
3 Credits (3)  
Same as MATH 481 with additional work for graduate students. May be repeated up to 3 credits.

MATH 526. Abstract Algebra I: Groups and Rings  
3 Credits (3)  
Same as MATH 456 with additional work for graduate students. Crosslisted with: MATH 456.  
Prerequisite(s): MATH 525 or consent of instructor.

MATH 527. Introduction to Real Analysis I  
3 Credits (3)  
Same as MATH 491 with additional work for graduate students.

MATH 528. Introduction to Real Analysis II  
3 Credits (3)  
Same as MATH 492 with additional work for graduate students.

MATH 529. Complex Analysis  
3 Credits (3)  
Same as Math 499 with additional work for graduate students. Crosslisted with: MATH 499.  
Prerequisite(s): MATH 528.

MATH 530. Special Topics  
1-3 Credits  
Specific subjects to be announced in the Schedule of Classes. May be for unlimited credit with approval of the department.

MATH 531. Ordinary Differential Equations  
3 Credits (3)  
Linear algebra and linear ordinary differential equations, existence and uniqueness of solution, smooth dependence on initial conditions, flows, introduction to smooth dynamical systems. May be repeated up to 3 credits.  
Prerequisite(s): MATH 527, or consent of instructor.

MATH 532. Nonlinear Dynamics  
3 Credits (3)  
Introduction to nonlinear dynamics and deterministic chaos. Core topics include stability and bifurcations; chaos in one dimensional maps; universality and re-normalization group. Further topics include symbolic dynamics, fractals, sensitive dependence on initial data, self-organization and complexity and cellular automata. Knowledge of differential equations and linear algebra is desired.
MATH 540. Directed Reading
1-6 Credits
May be repeated for a maximum of 6 credits. Consent of instructor required. Graded: S/U.

MATH 541. Topology I
3 Credits (3)
Connectedness and compactness of topological spaces, introduction to the quotient topology, elementary homotopy theory, the fundamental group, the Seifert-van Kampen theorem.
Prerequisite(s): MATH 525 and MATH 528, or consent of instructor.

MATH 542. Topology II
3 Credits (3)
Covering spaces and their classification, singular homology, degree theory, Brouwer’s fixed point theorem, CW-complexes and cellular homology, and other applications.
Prerequisite(s): MATH 541 or consent of instructor.

MATH 551. Mathematical Structures in Logic
3 Credits (3)
Prerequisite(s): MATH 524.

MATH 552. Universal Algebra and Model Theory
3 Credits (3)
Prerequisite(s): MATH 524.

MATH 555. Differentiable Manifolds
3 Credits (3)
Differentiable structures, tangent bundles, vector fields and differential equations. Additional topics may include differential forms, De Rham cohomology, Riemannian geometry, and topics chosen by the instructor. May be repeated for a maximum of 3 credits. Consent of instructor required.
Prerequisite(s): MATH 525 and MATH 528, or consent of instructor.

MATH 569. Geometry with Connections
3 Credits (3)
Connections between Geometry and other K-12 curriculum strands, especially Algebra and Probability / Data Analysis. Apply algebraic modeling and reasoning to a variety of mathematical problem solving situations. Does not fulfill requirements for degrees in mathematics. Consent of instructor required.
Prerequisite(s): Admittance into the MC2-LIFT program.

MATH 564. From Number to Algebra
3 Credits (3)
The progression from Number to Algebra in the K-12 curriculum as a concrete-to-abstract progression. Key concepts considered across the grade levels include the different uses of variables, equivalence in different contexts, patterns, and ratios. Does not fulfill requirements for degrees in mathematics. Consent of instructor required.
Prerequisite(s): MATH 524.

MATH 566. Data Analysis with Applications
3 Credits (3)
Statistical concepts and terminology in professional uses of data by teachers, such as standardized test score reports and educational research; visual displays of data; measures of variation and central tendency; consideration of how K-12 topics in Data Analysis are developed from one grade level to the next. Does not fulfill requirements for degrees in mathematics. Consent of instructor required.
Prerequisite(s): Admittance into the MC2-LIFT program.

MATH 567. From Measurement to Geometry
3 Credits (3)
The progression from Measurement to Geometry in the K-12 curriculum as a concrete-to-abstract progression. Important concepts such as angle, length, and area progress from concrete, measurable situations to more abstract problems which require reasoning and proof. Does not fulfill requirements for degrees in mathematics. Consent of instructor required.
Prerequisite(s): Admittance into the MC2-LIFT program.

MATH 568. Using Number Throughout the Curriculum
3 Credits (3)
Understand number concepts more deeply by seeing many examples of those concepts applied in other content strands. Develop mathematical knowledge and understanding to build a repertoire of ways for students to practice and review basic number skills and concepts as part of later, more advanced courses. Does not fulfill requirements for degrees in mathematics. Consent of instructor required.
Prerequisite(s): Admittance into the MC2-LIFT program.

MATH 569. Geometry with Connections
3 Credits (3)
Connections between Geometry and other K-12 curriculum strands, especially Algebra and Probability / Data Analysis. Address key attributes of geometric concepts by considering their connections within and across grade levels. Does not fulfill requirements for degrees in mathematics. Consent of instructor required.
Prerequisite(s): Admittance into the MC2-LIFT program.

MATH 571. Partial Differential Equations I
3 Credits (3)
The basic equations of mathematical physics. Laplace, Heat and Wave Equations. The method of characteristics, introduction to conservation laws, special solutions.
Prerequisite(s): MATH 518 and MATH 528 or consent of instructor.

MATH 572. Partial Differential Equations II
3 Credits (3)
Sobolev spaces theory: basic definitions and properties, embedding theorems, weak solutions of boundary value problems and variational methods for partial differential equations.
Prerequisite(s): MATH 593 or consent of instructor.
MATH 581. Abstract Algebra II: Fields, Rings and Modules
3 Credits (3)
Topics covered include field extensions; algebraic closure; polynomials rings; irreducibility criteria; Noetherian rings; algebraic sets; Nullstellensatz; modules; applications to linear algebra.
Prerequisite(s): MATH 526 or consent of instructor.

MATH 582. Module Theory and Homological Algebra
3 Credits (3)
Introductory concepts of homological algebra, including projective, injective and flat modules; projective and injective resolutions; exactness of functors; homology of chain complexes; derived functors.
Prerequisite(s): MATH 581 or consent of instructor.

MATH 583. Introduction to Commutative Algebra and Algebraic Geometry
3 Credits (3)
Introduction to the basic notions and techniques of modern algebraic geometry, including the necessary commutative algebra foundation. Topics likely to include algebraic and projective varieties, Nullstellensatz, morphisms, rational and regular functions, local properties. Other topics may include Noether normalization, dimension theory, singularities, sheaves, schemes, Grobner bases.
Prerequisite(s): MATH 581 or consent of instructor.

MATH 593. Measure and Integration
3 Credits (3)
Measure spaces, measurable functions, extension and decomposition theorems for measures, integration on measure spaces, absolute continuity, iterated integrals.
Prerequisite: MATH 528 or consent of instructor.

MATH 594. Real Analysis
3 Credits (3)
Differentiation, Lp spaces, Banach spaces, measure and topology, other selected topics.
Prerequisite: MATH 593.

MATH 595. Introduction to Functional Analysis
3 Credits (3)
Banach spaces. The three basic principles: uniform boundedness principle, closed graph/open mapping theorems, Hahn-Banach theorem.
Prerequisite(s): MATH 594, or consent of instructor.

MATH 599. Master's Thesis
1-15 Credits
Thesis.

MATH 600. Doctoral Research
1-15 Credits
Research.

MATH 698. Selected Topics
1-15 Credits
Selected topics.

MATH 700. Doctoral Dissertation
1-15 Credits
Dissertation.