

Product Specifications

MATHEMATICS

Maple includes over 4,000 computational functions to deliver the richest set of computation tools for any area in mathematics, science, or engineering.

MAJOR TOPICS INCLUDE:

Algebra*

- Exact symbolic arithmetic with real and complex numbers
- Factor, expand, combine, and simplify algebraic expressions
- Sequences and series

Calculus

- Compute derivatives, integrals, and limits
- Continuity testing
- Asymptotic expansion, and directional and multidirectional limits

Differential Equations*

- Exact and numerical solutions of ODEs and ODE systems*
- Exact and numerical solutions of PDEs and PDE systems*
- Exact and numerical solutions of Boundary Value Problems for PDEs
- Numerical solutions for Differential Algebraic ODE initial value problems (DAEs)*
- Differential elimination for ODE and PDE systems
- Structural analysis and order-reduction of ODEs and PDEs*
- Interactive Maple™ Assistant for numeric and symbolic solutions of ODEs and ODE systems

Dynamic Systems**

- Commands for creating, analyzing, simulating, and plotting linear time-invariant systems, which are essential steps in control systems development
 - Model representations: transfer function, differential/difference equation, state space, and zero/pole/gain models
 - Plotting tools: time and frequency domain responses, root-locus and root-contour plots, and plots of zeros and poles of a linear system
- #### Linear Algebra*
- Over 100 commands for constructing, solving, programming, and querying topics in linear algebra
 - Symbolic and numeric computations
 - Eigenvalues and eigenvectors, both classical and generalized
 - Sophisticated algorithms for modular linear algebra
 - Many matrix factorizations and system solvers
 - State-of-the-art numerical methods for dense and sparse systems with a high degree of user control

Solvers*

- Solve equations and systems of algebraic equations symbolically and numerically for closed form and approximate solutions*
- Inequalities and systems of inequalities*
- ODEs*, PDEs*, and DAEs*
- Numerous specialized solvers including routines for equations over the integers, equations over the integers mod m , recurrence equations, differential equations, series solutions, and q -difference equations*

Statistics*

- Wide range of common statistical tasks, such as quantitative and graphical data analysis, simulation, and curve fitting
- Over 35 continuous and discrete probability distributions and tools for creating custom distributions
- Interactive data analysis assistant
- Statistical plots including box plots, bar charts, histograms, probability plots, and scatter plots
- Tools for fitting linear and nonlinear models to data points and performing regression analysis
- Statistical Process Control (SPC) package with 11 different statistical control charts for process control variables and attributes

Vector Calculus

- Directional derivatives, gradients, Hessian matrices, and Laplacians of a function
- Curl and divergence of a vector field
- Jacobian and Wronskian matrices of a list of functions
- Cross products and dot products of vectors and differential operators

OTHER TOPICS INCLUDE:

Abstract Algebra*

- Groups, polynomial ideals, greatest common divisors, finite rings and fields

Algebraic Curves

- Holomorphic differentials and genus of an algebraic curve
- Normal forms for elliptic and hyperelliptic curves

Combinatorial Functions

- Permutations and combinations
- Construction of random combinations, partitions, and permutations
- Stirling numbers of the first and second kind, polynomials, and Fibonacci numbers

Combinatorial Structures

- Computation and solution of a system of generating function equations associated with an attribute grammar
- Generation of random combinatorial objects and counting the objects of a given size

Complex Arithmetic and Functions

- Complex numbers, fractions, constants, and variables

Curve Fitting*

- B -spline basis functions, polynomial interpolation, least-squares approximation, rational interpolation, and splines

Differential Algebra

- Manipulation and reduction of differential equations
- Development of the solutions into formal power series

Differential Forms

- Create, manipulate, and compute with differential forms

Differential Geometry*

- Vector fields, differential forms and transformations; tensor analysis; calculus on jet spaces; Lie algebras and Lie groups, and transformation groups
- Complete course in Differential Geometry and its applications

Discrete and Integral Transforms

- Laplace, Fourier, Fourier sine, Fourier cosine, Fast Fourier, Hankel, Hilbert, Mellin, Wavelet**, Z transforms, and their inverses

Euclidean Geometry

- Close to 300 commands for constructing, computing, plotting, and translating 2-D and 3-D objects

Financial Mathematics

- Annuities and growing annuities, cash flows, perpetuities and growing perpetuities, and level coupons
- Amortization, Black-Scholes option pricing, effective rate, future value, present value, and yield to maturity

Gaussian Integers

- Chinese remainder, GCD, and LCM of Gaussian integers
- Gaussian integer factorization
- Extended Euclidean algorithm for Gaussian integers

Generating Functions

- Tools for determining and manipulating generating functions, including ordinary and exponential generating functions
- Tools for determining a probable generating function from initial terms

Graph Theory

- Directed graphs, undirected graphs, and edge weights
- More than 150 functions and 35 pre-defined special graphs
- Visualization of graphs in two and three dimensions

Groebner Bases and Polynomial Ideals

- Groebner bases over commutative and non-commutative domains
- Incorporates the FGB library, the world's fastest Groebner bases engine
- Ideal membership and containment
- Radical, prime and primary decompositions
- Hilbert series, polynomials and dimensions

Group Theory

- 34 commands, including calculating the elements of a permutation group, order computations, and finding a permutation of a group

Lie Symmetries

- Lie group symmetry methods for differential forms, ODEs, and PDEs

Linear Functional Systems of Equations

- Transformations of a matrix recurrence system into an equivalent system with nonsingular leading and trailing matrices
- Rational and formal power series solutions of a linear functional system of equations with polynomial coefficients

Linear Operators

- Numerous commands to manipulate d'Alembertian terms
- Conversions among Ore polynomial structures, linear ODEs, linear recurrence equations, and factored OrePoly structures

Linear Programming

- Solve linear programs using symbolic and numeric methods, including simplex

Linear Recurrence Equations

- Polynomial, rational, and hypergeometric solutions of linear recurrence equations
- Solutions of divide and conquer recurrence equations

Logic

- Simplification and normal forms for Boolean expressions

Numerical Approximations

- Arbitrary precision numerical computations
- Chebyshev-Pade and minimax rational approximation
- Conversion of rational functions to continued-fraction form and Polynomials to Horner form

Number Theory*

- Primality testing
- Computation of the n th Fermat number and the n th Mersenne prime
- Computation of the n th convergent, denominator, and numerator of simple and regular continued fractions

Optimization

- Numeric methods for the solution of optimization problems
- Interactive Optimization assistant for defining, solving and visualizing problems
- Solvers for linear, quadratic, and nonlinear programs, including constrained and unconstrained problems
- Solvers for linear and nonlinear least-squares problems
- Solvers for integer linear programs

Orthogonal Polynomials

- Commands to generate the n th Chebyshev, Gegenbauer, Hermite, Laguerre, Legendre, and Jacobi polynomials

p-adic Numbers

- Commands for p -adic evaluation, expansion, and functions
- Computation of the order and the leading coefficient of a p -adic expansion of a rational function

Physics*

- Includes anticommutative and noncommutative variables and functions, spacetime tensors, algebraic vectors, and standard objects used in mathematical physics computations, including Pauli and Dirac matrices and the Kronecker delta
- Permits the use of standard notational abbreviations by allowing you to define a framework of notational conventions and spacetime properties

Polynomials*

- Factor, expand, manipulate, and compute properties of polynomials

Q-Difference Equations

- Solve linear q -difference equations with polynomial coefficients

Rational Normal Forms

- Computation of polynomial and rational normal forms, canonical forms of rational functions, and minimal representations of hypergeometric terms

Real Domain Computations

- Restrict calculations to the domain of real numbers

Series Expansions

- Compute Taylor, Puiseux and asymptotic series expansions

Scientific Constants

- Support for over 70 scientific constants including the Newtonian constant of gravitation, magnetic flux quantum, and conductance quantum
- Properties of all elements and isotopes of the Periodic Table
- Tools for building custom scientific constants

Scientific Error Analysis

- Representation and construction of numerical quantities that have a central value and associated error

Special Functions

- Over 100 special functions
- Includes Airy Ai and Bi wave functions, Bessel, Chebyshev, Ei, Si, Ci, Li, error function, Gamma, Zeta, Heun, Legendre, Jacobi functions

Statistical Process Control

- Supports 11 different control charts for process control variables and attributes, including EWMA, S, MA and X-bar charts
- Visualize both numeric and non-numeric quality characteristics

Symbolic-Numeric Algorithms for Polynomials

- Algebraic manipulation of numeric polynomials

Tensors

- Routines that deal with tensors, their operations, and their use in General Relativity, both in the natural basis and in a moving frame

Tolerances

- Perform best- and worst-case computations with quantities involving tolerances, using standard notation
- Tolerances understood by arithmetic operators and by many built-in functions, including square roots, exponentials, trigonometric and special functions

Units and Dimensions

- Support for over 500 units and dimensions defined using exact conversions
- Systems of units include Atomic, CGS, Electromagnetic, Electrostatic, FPS, MKS, MTS, and SI
- Over 50 base quantities include acceleration, area, dynamic viscosity, electric resistance, energy, heat transfer, light, magnetic flux, and mass
- Ability to add and remove systems and dimensions

Variational Calculus

- Euler-Lagrange equations and first integrals
- Solve Jacobi differential equation for conjugate points
- Weierstrass excess function

Mathematics Education

Maple includes educational packages and resources to assist students by furthering their understanding of concepts presented in mathematics courses.

Precalculus

- Study lines, polynomials, rational functions, compositions of functions, and more using interactive tutors and visualization routines

Calculus

- Single step through differentiation, integration, and limit problems
- Visualization routines display a function and its derivative, Taylor series approximation, Newton's method, approximating integrals, antiderivatives, surfaces of revolution, and more
- Explore these Calculus 1 concepts using interactive tutors

Linear Algebra

- Single step through Gaussian elimination; Gauss-Jordan elimination; and the computation of the inverse, eigenvalues, and eigenvectors of a matrix using interactive tutors
- Visualization routines display the cross product of two vectors, a system of 2-D or 3-D linear equations, the projection of a vector onto a subspace, and more
- Over 65 routines for computing with matrices and vectors

Multivariate Calculus

- Interactive tutors allow you to work through the standard problems of multivariate calculus in a visually directed manner
- Visualization routines to aid in the understanding of concepts including Taylor approximation, change of variables, center of mass, gradient, Jacobian, and surface area

Vector Calculus*

- Computations, visualizations* and interactive problem solving involving the calculus of functions from \mathbb{R}^2 to \mathbb{R}^n
- Interactive tutors for exploring space curves and vector fields through plots and animations
- Supports 5 predefined coordinate systems

Dictionary

- Over 5,000 definitions of mathematical and engineering terms and concepts incorporated into the Help system
- Includes over 300 figures to clearly explain the concepts

Graphing Calculator

- Traditional graphing calculator interface
- Standalone or over a MapleNet™ installation

Maple T.A.™ Assessment Tools

- Question authoring environment provides templates for creating common question types, such as fill-in-the-blank, Maple-graded, and multiple-choice questions.
- Questions can include algorithmically generated content
- Questions can contain plots, hints, feedback and algorithmically-generated variables.
- Assignments are used inside Maple, printed, or exported to Maple T.A.

Student Portal**

- A guide for hundreds of common tasks from mathematics courses
- Makes use of interactive assistants, context menus, palettes, and task templates

Programming

Flexible programming language, tools, and base routines.

- Advanced programming language*
- Procedural and functional programming
- Operator overloading
- Exception handling
- Debugging, profiling, security, and library management tools*
- User-level routines for multi-threaded programming on multi-core computers*
- Analysis of the code complexity of a Maple procedure and module
- Ability to create new worksheets, programs, packages, modules, and help pages
- Source code of most routines available for viewing
- Assumptions on variables
- Create and manipulate many kinds of objects, including sets, strings, lists, arrays, and libraries*
- Tools for manipulating mathematical objects, including polynomials, integrals and sums*
- Extend existing types
- Generate and manipulate Maple worksheets through its XML representation
- Compiler package for dramatic speed-up of numerical computations*

Custom Interfaces

Maple lets you create custom user interfaces to access built-in and user-written routines.

Interactive Embedded Components*

- Components include buttons, sliders, plots, check boxes, list boxes, toggle buttons, radio button**, dial***, gauges**, and mathematical expression boxes for entering and displaying 2-D math
- Add components to your document using the Components palette
- Easily programmable to accept input, display results and plots, and interact with other elements of the document*

Maplet Application

- Create custom Java™-based graphical user interfaces to access the Maple kernel and libraries, or user-written Maple functions
- Graphical elements include text areas, buttons, equation editors, slider bars, tool tips, plotting windows, and numerous built-in dialogs
- Can be created programmatically or through the point-and-click Maplet Builder
- Perform calculations and display graphs without seeing the Maple code

Context-Sensitive Menus

- Design a context menu or edit an existing menu

Visualization

Maple includes a comprehensive set of visualization tools to make problem exploration easier.

- 2-D and 3-D graphs and animations*
- Over 150 plot types and options, including implicit, contour, complex, polar**, vector field, conformal, density, ODE, PDE, and statistical plots*
- Engineering plots, including time and frequency domain responses and root-locus and root-contour plots**
- Light modeling, legends, axis control, titles, glossiness, gridlines, and transparency*
- Display typeset text and mathematical expressions in plot titles, labels, legends, tickmark labels, and axis labels
- International (non-English) characters in text
- Plot annotations for 2-D plots include arrows, shapes, and drawing tools*
- Scale and pan 2-D and 3-D plots and animations
- Real-time rotation of 3-D plots
- Interactive control of parameters through slider controls
- Wide variety of coordinate systems*

- Layering of graphics and animations of different types
- Standard geometric objects, regular solids, and polyhedra, including ellipses, hyperboloids, polygons, cones, spheres, torii, dodecahedra, icosahedra, and tetrahedra
- Over 40 visualization routines display concepts presented in calculus, precalculus, multivariate calculus, and linear algebra courses
- Plot builder assistant for creating and modifying plots and animations

User Interface

Maple includes many features to automate tasks and interact with Maple without knowledge of Maple commands and syntax.

- Sophisticated 2-D Math editing
- Self-documenting context menus*
- Over 20 palettes for expressions, symbols, matrices, operators, including a handwriting palette and favorites palette*
- Comprehensive word-processing for creating professional reports and presentations*
- Spell-checker containing standard math terms
- Command completion*
- Output automatically labeled for easy referencing
- Tables*, symbolic spreadsheets, code regions**, embedded components such as buttons, sliders and dials*
- Over 40 interactive tutors display concepts presented in precalculus, calculus, multivariate calculus, vector calculus, and linear algebra courses
- Over 250 task templates for fill-in-the-blank problem solving*
- Interactive assistants for many tasks including analyzing ODEs and ODE systems, creating plots and matrices, exploring parameters in expressions, converting units, and back-solving*
- Document blocks to write content with live calculations while hiding computation details
- Help Navigator for searching help pages, tasks, tutors, definitions, and manuals*
- Drawing canvas includes shapes, lines, arrows, text, outline and fill color control, and provides alignment tools, grid controls, and a favorites palette*

Connectivity

Maple adheres to international standards for data communication by enhancing tool interoperability and web connectivity.

- CAD connectivity**
 - Retrieve parameters from a CAD drawing and send new values back to be automatically incorporated in the design.
 - Includes the interactive CAD Link Assistant
- Code Generation*
 - Generate Visual Basic, MATLAB®, Java, C, and Fortran code
 - Override or add to code translations specified in the existing definition or specify an entirely new language definition
- Link to MATLAB
 - MATLAB to Maple code translator for commands and .m files*
 - Call out to MATLAB to compute and retrieve the results of MATLAB expressions.
- Easy import and export of Microsoft® Excel® data files
 - Programmatic and interactive use through the Data Import Assistant and Matrix Browser
 - Supports partial file import
- Link to Microsoft Excel 2000, Excel XP, Excel 2003 and Excel 2007 on Windows*
 - Access the Maple kernel from within Excel
 - Function Wizard steps through the creation of a Maple function
- Database connectivity**
 - Tools to query, update, and create databases from within Maple
- Mathematica® Notebook conversion and command translation tools
- Access Maple algorithms and data structures in compiled C, Java, and Visual Basic programs using OpenMaple™
- External calling to Java, C, and Fortran
- MathML 2.0 presentation and content support
- Import and export of XML documents
- TCP/IP socket connectivity
- Export worksheets to HTML, XML, MathML, LaTeX, and RTF
- Export plots to BMP, DXF, EPS, GIF, HPGL, JPEG, PCX, POV, TEK, and WMF
- Import, manipulate and export data from WAV, JPEG, and TIFF files
- Import data from ASCII, CSV, Matrix Market, MATLAB, and more
- Direct links to the Maple Application Center™, Teacher Resource Center, Student Help Center, and more*

** Enhanced features in Maple 12

** New features in Maple 12



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