

Maple Quick Start

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Introduction

In this introductory course, you will become familiar with and comfortable in the Maple 10 environment. You will learn how to use context menus, task assistants, and palettes to perform powerful analyses and create high-impact graphics with only a minimal knowledge of commands. You will also learn how to create technical reports that capture the knowledge behind an analysis directly in the Maple document. This course will give you the tools you need to get started quickly, and a solid foundation upon which to build your future Maple explorations.

To try this material on your own, start with an *empty* Maple document. Perform the steps found in the left column of each table below. The results of each step are displayed in the right column for your reference.

Note for non-Windows users: The keystrokes given in this document are for Windows. There will be differences for other platforms. If you are using a different platform, see **Help > Quick Help** for the list of the most common keystrokes.

Talking to Maple

In this section, you will learn the basics of asking Maple a question and getting a result.

Steps	Results
<p>Using [ENTER]</p> <p>When you launch Maple you start with a blank document, with menus and toolbars at the top, palettes on the side. At the cursor, you can start typing math. Press [ENTER] to see the result.</p> <p>Example: Type "1+2 [ENTER]". Notice that the result appears on the next line.</p>	$1 + 2 = 3$
<p>Using [Ctrl] [=]</p> <p>In the example above, we obtained a result by pressing [ENTER] after our input.</p> <p>You can also get Maple to return the result on the same line as your question by typing [Ctrl] [=] (hold down the control key, then press the = key).</p> <p>Example: Type "x+5-2" then [Ctrl] [=].</p>	

$$x + 5 - 2 = x + 3$$

Context Menus

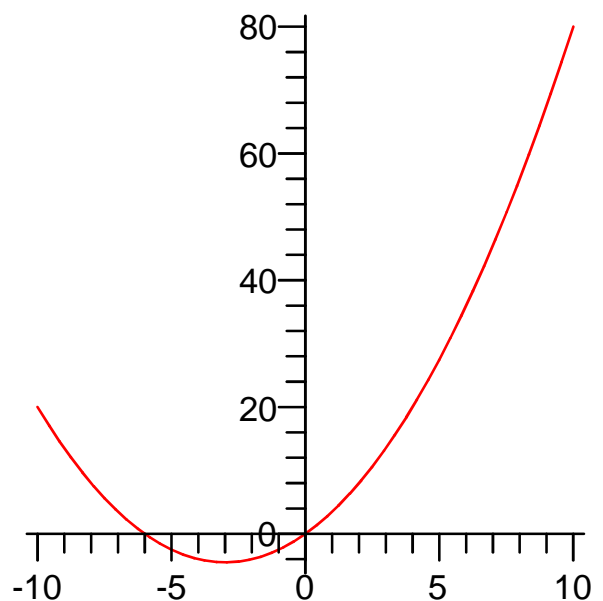
You can use Maple's context menus to perform a wide variety of mathematical and other operations.

Example: Place your cursor on the last result, and right-click. The context menu offers several operations to choose from according to the expression that you are using. To integrate this expression, select **Integrate**, then **x**.

Example: To plot the result of the integration, right-click on the result, and then select **Plots > 2-D Plot**.

$$x + 5 - 2 = x + 3 \rightarrow \frac{1}{2} x^2 + 3 x$$


$$x + 5 - 2 = x + 3 \rightarrow \frac{1}{2} x^2 + 3 x \rightarrow$$



Changing the Problem

Mathematics in a Maple document are *live*. You can go back, make changes, and re-execute the problem to obtain a new result.

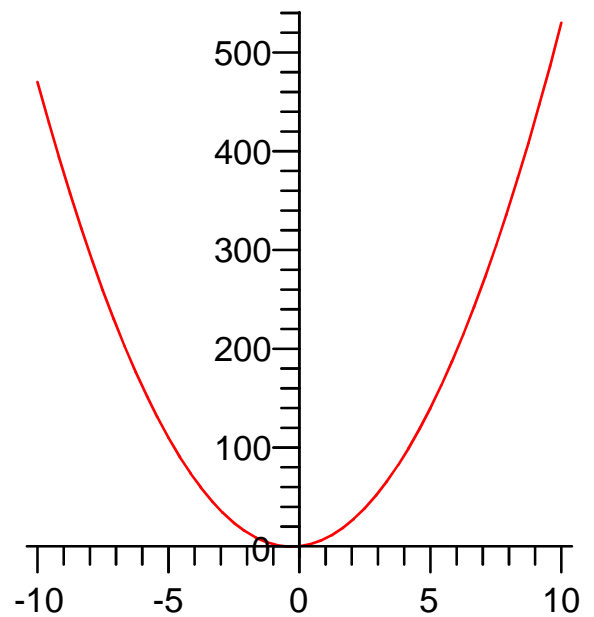
Example: Go back to your original calculation of " $1 + 2$ ", change the number "1" to a "3" and press [ENTER]. Note the change in output.

Example: In the context menu example, above, change the "x" to "10 x". Highlight the entire line, including the plot, then click the execute button, , found at the top of the Maple worksheet. All selected calculations are updated.

$$3 + 2$$

$$5$$

$$10x + 5 - 2 = 10x + 3 \rightarrow 5x^2 + 3x \rightarrow$$



Tip: Clicking on the "execute all" button, , recalculates the entire document.

▼ Entering Math

There are a number of methods to enter math into Maple. You can enter math using a combination of palettes, keyboard shortcuts, context menus and commands. Most operations can be entered in more than one way, so you can pick the method you are most comfortable with.

Steps	Result
<p>Exact Answers and Numeric Approximations</p> <p>Maple calculates exact answers (i.e. fractions remain as fractions).</p> <p>Example: On a new line, enter $\frac{1}{2} + \frac{1}{3}$. Note that the / automatically moves you to the denominator. The right-arrow will take you out. Press [Ctrl] [=] to see the result on the same line.</p> <p>Maple also calculates numeric approximations.</p> <p>Example: Right-click the above result and select Approximate from the context menu. Select accuracy of 5 digits.</p> <p>If your problem uses decimal approximations already, Maple will return the answer in the same format.</p> <p>Example: Try the example on the right.</p>	$\frac{1}{2} + \frac{1}{3} = \frac{5}{6}$ $\frac{1}{2} + \frac{1}{3} = \frac{5}{6} \rightarrow 0.83333$ $0.5 x + \frac{1}{3} x = 0.8333333333 x$
<p>Palettes</p> <p>Maple has over 1000 palette symbols within the 20 palette menus. You can also use Maple's expression</p>	

palette to input data. The expression palette contains fill-in-the-blank templates for common operations.

Example: Use the Expression Palette, find the integral of $4 \cdot t^6 + \sin(t)dt$. Open the expression palette (click on "Expression" on the left-hand side of your Maple document) and click the indefinite integral button. An indefinite integral template will appear in your worksheet. Fill in the place-holders (use [TAB] to move to the next placeholder). When done, press [ENTER] to evaluate.

Note: Use ^ to create a superscript, and right-arrow to get out again.

Example: Use the expression palette to find the limit of a function.

$$\int 4 \cdot t^6 + \sin(t)dt$$

$$\frac{4}{7} t^7 - \cos(t)$$

$$\lim_{x \rightarrow 0} \frac{\sin(x^2)}{x} = 0$$

Symbol Recognition

You can use the **symbol recognition palette** to find the symbol you want.

Example: Enter $\frac{100}{3}$, then use the context menu to approximate the result to 5 digits. Open the symbol recognition palette, sketch the "approximation" symbol, and press the **Recognize** button. Drag the new symbol to your worksheet to replace the arrow.

$$\frac{100}{3} \rightarrow 33.333$$

$$\frac{100}{3} \approx 33.333$$

Symbol Completion

The symbol completion mechanism provides an alternative to palettes for entering symbols.

Type the first few characters of the symbol name, and press [Ctrl] [Space]. Choose the symbol you want from the list.

Example: Try entering $\pi^2 + \sqrt{x}$

To enter π , type pi [Ctrl] [Space].

For \sqrt{x} , enter sqrt [Ctrl] [Space].

$$\pi^2 + \sqrt{x}$$

$$\pi^2 + \sqrt{x}$$

Case-Sensitivity

Maple is case-sensitive.

Example: Enter " $x + x$ ".

Example: Enter " $y + Y$ ".

Compare the results.

$$x + x = 2x$$

$$y + Y = y + Y$$

Implicit Multiplication

Maple understands implicit multiplication.

Example: Type " $3x$ " for "3 times x".

$$3x + 5x = 8x$$

To multiply two variables, use a space.
 "x y" means "x times y", but "xy" means the variable whose name is "xy".
Example: Type "x [space]y + xy".
 If you choose to **Differentiate** using the context menu, you will see that x, y, and xy are treated as three separate variables due to the way they were entered.

You should be careful using implicit multiplication in Maple to avoid confusion with function calls. To us, $f(x + 1)$ looks like a function call, and $x(x + 1)$ looks like implied multiplication. Maple understands both of these as function calls.

Example: Enter $\frac{x(x + 2)}{x}$ using no space, a space, and an explicit multiplication sign. Ask Maple to calculate each result so you can see the differences.

When multiplying with brackets you can use a space to achieve implicit multiplication, but it is usually safest to explicitly use the multiplication symbol.

$$x\ y + xy = xy + xy$$

$$f(x + 1) = f(x + 1)$$

$$\frac{x(x + 2)}{x} = \frac{x(x + 2)}{x}$$

$$\frac{x\ (x + 2)}{x} = x + 2$$

$$\frac{x \cdot (x + 2)}{x} = x + 2$$

Mathematical Notation

Maple understands familiar mathematical notation.

For example, Maple understands that $y'' + y' + y = 0$ is a differential equation in $y(x)$.

Example: Enter the equation listed above (using the single quote key for the prime notation). To verify that it is in fact a differential equation, select **Solve DE** from the context menu.

$$y'' + y' + y = 0 \rightarrow$$

$$y(x) = _C1 e^{\left(-\frac{1}{2}x\right)} \sin\left(\frac{1}{2}\sqrt{3}x\right) + _C2 e^{\left(-\frac{1}{2}x\right)} \cos\left(\frac{1}{2}\sqrt{3}x\right)$$

Label References

Maple uses label references.

Whenever you use [ENTER] to get a response, the result is automatically given a label reference. To refer to a previous result in a computation, use [Ctrl] [L] and enter the label reference number.

Example: Multiply the result $\pi^2 + \sqrt{x}$ (from above) by x, using labels.

$$\pi^2 + \sqrt{x} \cdot x$$

$$(\pi^2 + \sqrt{x})x$$

Maple Commands

You can always enter Maple commands by typing them directly. Examples of Maple commands will be found throughout this course.

Example: A common command is the **assignment statement**, := (colon equals).

Note: Anything you want Maple to evaluate (e.g.,

$$value1 := 5x$$

$$value2 := 4x$$


$$value1 + value2$$

assignment statements), must be entered in Math mode. Anything entered in Text mode will be non-executable.	$9x$
---	------

Tip: Find the list of keyboard shortcuts for your platform. Click **Help** > **Quick Help** menu, and select **Math Editor Shortcuts**.



Combining Text and Math



In Maple you can combine math and text in the same paragraph to help formulate mathematical sentences.

Steps	Result
Example: Start by entering a simple computation.	$\int x^3 + x^2 + 3 \, dx = \frac{1}{4} x^4 + \frac{1}{3} x^3 + 3 x$
Go back to the start of your computation (place the cursor to the left of your expression), press [F5] to change from math input to text input, and start typing text.	The integral $\int x^3 + x^2 + 3 \, dx = \frac{1}{4} x^4 + \frac{1}{3} x^3 + 3 x$
You can also input text in place of the equals sign (=). Click on the equals sign and replace it with some additional text.	The integral $\int x^3 + x^2 + 3 \, dx$ is equal to $\frac{1}{4} x^4 + \frac{1}{3} x^3 + 3 x$
Place your cursor at the end of the output, press [F5], and complete the rest of the sentence.	The integral $\int x^3 + x^2 + x + 3 \, dx$ is equal to $\frac{1}{4} x^4 + \frac{1}{3} x^3 + \frac{1}{2} x^2 + 3 x$, as you can plainly see.
Modify some of the terms in the problem, highlight the entire sentence and press the  button to re-execute the computation.	The integral $\int x^3 + 5x^2 + x + 3 \, dx$ is equal to $\frac{1}{4} x^4 + \frac{5}{3} x^3 + \frac{1}{2} x^2 + 3 x$, as you can plainly see.

Tip: Pressing [F5] allows you to easily toggle between math input and text input.

Tip: To check what mode you are in, look at the top left of the toolbar.

In text mode it will look like  .

In math mode it will look like  .

You can also use these buttons to change modes as an alternative to pressing F5.

Tip: Another visual cue is the cursor. When in text mode, the cursor appears as a vertical bar. In math mode, the cursor is slanted and italic.

Expressions, Functions and Procedures

Maple handles Functions, Expressions, and Procedures differently.

Steps	Result
Expressions f is an <i>expression</i> in x defined to the right. f is not a <i>function</i> . Example: See the example on the right for what happens when you try to evaluate $f(3)$. Example: To find the value of f at a given value of x , you	$f := x^2$ $f(3) = x(3)^2$ x^2

<p>need to evaluate f at that point. You can do this with</p> <p>a) context menus</p> <p>b) or the eval command</p>	f x^2 $\rightarrow 9$ when $x=3$ $eval(f, x=3);$ 9
<p>Functions</p> <p>F is a <i>function</i> in x defined to the right. Note the difference to how f was defined above (to create the arrow, type the "dash" key followed by the "greater than" key: \rightarrow). F is the function that maps x to x^2.</p> <p>To find the value of F at a particular value, call the function F with an argument.</p> <p>Example: Try to evaluate F at 3, and F at y.</p>	$F := x \rightarrow x^2$ $x \rightarrow x^2$ $F(3) = 9$ $F(y) = y^2$
<p>Multi-Parameter Functions</p> <p>G is a 2 parameter function defined to the right.</p> <p>You can evaluate G at specified points.</p> <p>Example: Try evaluating G at (1,2) and at (1, y).</p> <p>Note: this can be extended for use with multi-paramater functions.</p>	$G := (a, b) \rightarrow a^2 - b^3$ $(a, b) \rightarrow a^2 - b^3$ $G(1, 2) = -7$ $G(1, y) = 1 - y^3$
<p>Procedures</p> <p>A function is a special form of the more general <i>procedure</i>.</p> <p>Example: See the example on the right for a very basic procedure.</p> <p>Procedures can include conditional statements, iteration, type checking, local variables, error-handling and other features of standard languages. For an introduction to Maple programming, see Chapter 8 of the User Manual.</p> <p>Tip: Use [Shift] [ENTER] to continue a command on the next line.</p>	$procG := proc(a, b)$ $a^2 + b^2$ $end proc$ $proc(a, b) a^2 + b^2 end proc$ $procG(1, 2)$ 5

▼ Solving Equations

Maple can solve equations and inequalities for their unknowns.

Steps	Result

Defining Equations

When defining an equation in Maple, you should use the = sign for equality.

Example: Solve the equation " $a \cdot x^2 + b \cdot x + c = 0$ " for x using the context menu **Solve for a Variable**.

$$a \cdot x^2 + b \cdot x + c = 0 \rightarrow \left[\left[x = -\frac{1}{2} \frac{b - \sqrt{b^2 - 4ac}}{a} \right], \left[x = -\frac{1}{2} \frac{b + \sqrt{b^2 - 4ac}}{a} \right] \right]$$

Solving for Exact Solutions

Note that your solution is displayed with an exact solution by default.

Example: Solve the equation " $2 \cdot x^2 + 6 \cdot x - 3 = 0$ " for x using **Solve** from the context menu.

$$2 \cdot x^2 + 6 \cdot x - 3 = 0 \rightarrow \left\{ x = -\frac{3}{2} + \frac{1}{2} \sqrt{15} \right\}, \left\{ x = -\frac{3}{2} - \frac{1}{2} \sqrt{15} \right\}$$

Solving for Numeric Solutions

If you desire a numeric solution, you must specify it directly.

Example: Using the example above, solve the equation using the context menu, this time select **Solve Numerically**.

$$2 \cdot x^2 + 6 \cdot x - 3 = 0 \rightarrow \{x = -3.436491673\}, \{x = 0.4364916731\}$$

Solving with Maple Commands

Note that the equivalent Maple commands are **solve** and **fsolve** (floating-point **solve**).

$$\text{solve}(2 \cdot x^2 + 6 \cdot x - 3 = 0, x) \\ -\frac{3}{2} + \frac{1}{2} \sqrt{15}, -\frac{3}{2} - \frac{1}{2} \sqrt{15} \\ \text{fsolve}(2 \cdot x^2 + 6 \cdot x - 3, x) \\ -3.436491673, 0.4364916731$$

Assigning Equations to Variables

Note that you can assign equations to names. Remember to use "colon equals" for assigning.

Example: Assign the variable name "eqn" to the equation " $y = mx + b$ ". Then apply the command "rhs" to your variable name.

$$\text{eqn} := y = m \cdot x + b \\ y = mx + b \\ \text{rhs}(\text{eqn}) \\ mx + b$$

Units

Maple provides the most comprehensive package in the software industry for managing units and dimensions. Over 500 standard units are recognized by the Maple Units package.

Steps	Result
Assigning Units	

Use the **Units** palettes to define values with units. **Units (SI)** is the metric palette, **Units (FPS)** is the imperial palette (foot pound second).

Example:

Enter "Length:= 250.00"

", click on the Units palette, and select "m".

Repeat for Mass and Time.

Type "Force:= Length*Mass/Time^2" and press [Enter].

To simplify the units in this expression, select **Units > Simplify** from the context menu of the result.

$$\begin{aligned}
 \text{Length} &:= 250.00 \text{ [m]} && 250.00 \text{ [m]} \\
 \text{Mass} &:= 500.00 \text{ [lb]} && 500.00 \text{ [lb]} \\
 \text{Time} &:= 25 \text{ [s]} && 25 \text{ [s]} \\
 \text{Force} &:= \frac{\text{Length} \cdot \text{Mass}}{\text{Time}^2} \\
 &&& \frac{200.0000000 \text{ [m]} \text{ [lb]}}{\text{[s]}^2} \\
 &&& \rightarrow 90.71847400 \text{ [N]}
 \end{aligned}$$

Units Package

If the **Units** package is loaded, simplifications are automatic. (More information on Maple packages can be found in the Worksheet Mode section, below.)

Example:

Type "with(Units[Standard]) : " and press [ENTER] to load the Units package.

Then enter the above equation for Force and press [ENTER].

Note that the unit simplification is done automatically.

$$\begin{aligned}
 &\text{with(Units[Standard]) :} \\
 \text{Force} &:= \frac{\text{Length} \cdot \text{Mass}}{\text{Time}^2} \\
 &&& 90.71847400 \text{ [N]}
 \end{aligned}$$

Changing Units

You can use the context menu to replace one unit with another.

Example: Right-click on the value assigned to Length. Select **Units > Replace Units**. Change the meters to centimeters in the length.

$$\begin{aligned}
 \text{Length} &:= 250.00 \text{ [m]} && 250.00 \text{ [m]} \\
 &&& \rightarrow 25000.00 \text{ [cm]}
 \end{aligned}$$

Converting Units

You can also use the context menu to convert units from one system to another.

Example: Right-click on the value assigned to Mass. Select **Units > Convert > System > SI** to convert the mass from pounds to kilograms.

$$\begin{aligned}
 \text{Mass} &:= 500.00 \text{ [lb]} && 500.00 \text{ [lb]} \\
 &&& \rightarrow 226.7961850 \text{ [kg]}
 \end{aligned}$$

Using Tolerances

You can use the **Tolerances** package to calculate values with tolerances. This presents answers with the plus/minus notation.

$$\begin{aligned}
 &\text{with(Tolerances) :} \\
 \text{Length} &:= 250.00 \pm 1.0 \text{ [m]} \\
 &&& (250. \pm 1.00) \text{ [m]} \\
 \text{Mass} &:= 500.00 \pm .5 \text{ [lb]}
 \end{aligned}$$

Example.

Type "with(Tolerances) :" and press [ENTER] to load the package.

After each of the unit amounts, type "pm[Ctrl] [Space]" to create the \pm sign and input the tolerance amount.

Now recalculate the answer for Force given the specified tolerance levels.

$$(500. \pm 0.500) \llbracket lb \rrbracket$$

$$Time := 25 \pm 3 \llbracket s \rrbracket$$

$$(25. \pm 3.) \llbracket s \rrbracket$$

$$Force := \frac{Length \cdot Mass}{Time^2}$$

$$(94.8 \pm 22.9) \llbracket N \rrbracket$$

Tip: For an overview of the unit facilities, see [units](#).

Data Structures: Lists, Sets, Sequences, Vectors and Matrices

Maple provides a variety of basic data structures, including lists, sets, sequences and matrices, arrays and tables. Different Maple commands return their results inside different data structures, as appropriate to the problem. It is important to become familiar with the basic structures and how they differ, so you can manipulate them properly and choose the most appropriate structure for your problem. This section covers the basics of the most common data structures.

Steps	Result
Lists Lists are ordered elements. Use square brackets when entering data in lists. Example: Input the list [a,b,c,a] and assign it to the variable name <i>mylist</i> . Use square brackets to access a particular element. Example: Retrieve the 3rd item in <i>mylist</i> .	$mylist := [a, b, c, a]$ $[a, b, c, a]$ $mylist[3]$ c
Sets Sets contain elements but remove repeated elements and do not respect order. Use curly braces for defining sets. Example: Input a set and assign it to the variable name <i>myset</i> . Standard set operations work as expected. Example: Using the symbol recognition palette to find the set intersection sign, find the intersection of <i>myset</i> and $\{x^2, x^3\}$. Square bracket notation <i>can</i> be used to extract elements of a set, but should only be used in an interactive session where you can see <i>myset</i> . You cannot use this notation programmatically, as the order of elements in a set may change from session to session. Other commands are available to extract elements from sets, such as remove and select . You can always convert a set to a list, if guaranteed order is needed.	$myset := \{x^2, x \cdot y, x \cdot y^2, y, x^2, x^2\}$ $\{y, x y, x y^2, x^2\}$ $myset \cap \{x^2, x^3\}$ $\{x^2\}$ The following notation is unreliable: $myset[1]$ x^2
Sequences A sequence is any collection of objects separated by commas. The seq command creates sequences.	$myseq := seq(t^2, i = 1..10)$

<p>Example: Enter a sequence which has the value of i^2 for $i=1..10$.</p> <p>Square bracket index notation can also be used for sequences.</p> <p>Example: Retrieve the 3rd item from the sequence defined above.</p>	$1, 4, 9, 16, 25, 36, 49, 64, 81, 100$ $\text{myseq}[3]$ 9
<p>Vectors</p> <p>A vector is NOT the same thing as a list, though they look similar. A vector is a special datatype.</p> <p>Example: Create a vector from the Matrix palette, setting one of the dimensions to one.</p> <p>Example: Define a vector by using the Vector command.</p> <p>Square bracket index notation can also be used for vectors.</p> <p>Example: Retrieve the 3rd item from the sequence defined above.</p>	$\text{myvector} := \begin{bmatrix} 8 & 69 & 99 & 29 \end{bmatrix}$ $\text{Vector}[\text{column}](\begin{bmatrix} 1, 2, 3 \end{bmatrix})$ $\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ $\text{myvector}[3]$ 99
<p>Matrices</p> <p>A matrix is a rectangular array of elements, set out in rows and columns.</p> <p>Example: Use the Matrix palette to create a matrix. You can fill in the values yourself, or select Random from the Type drop-down box of the Matrix palette.</p> <p>You can also use the Matrix() command, to create matrices.</p> <p>Example: See the example on the right.</p> <p>Use indexing to access individual elements.</p> <p>Example: Use indexing to retrieve the value from the 1st row, 3rd column of <i>mymatrix</i> and assign it to a variable name.</p> <p>Example: Use indexing to retrieve the 1st and 2nd values from the 1st row, of <i>mymatrix</i>.</p>	$\text{mymatrix} := \begin{bmatrix} -32 & -4 & 8 & 99 \\ -74 & 27 & 69 & 29 \end{bmatrix}$ $\text{Matrix}\left(\begin{bmatrix} 1, 2, 3 \\ 4, 5, 6 \end{bmatrix}\right);$ $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$ $\text{element} := \text{mymatrix}[1, 3]$ 8 $\text{mymatrix}[1, 1..2]$ $\begin{bmatrix} -32 & -4 \end{bmatrix}$
<p>The map command</p> <p>The map command applies a function to every element in a list, set, vector matrix, etc. See examples to the right.</p>	$\text{map}(x \rightarrow x^2, \text{mymatrix})$ $\begin{bmatrix} 1024 & 16 & 64 & 9801 \\ 5476 & 729 & 4761 & 841 \end{bmatrix}$ $\text{map}(j \rightarrow j^2, \text{mylist});$

$$[a^2, b^2, c^2, a^2]$$

Working with Matrices

Maple can perform a number of operations with matrices.

Steps	Result
Creating a Matrix <i>Example:</i> Use the Matrix palette to create a random 3x3 matrix. Tab between the placeholders and fill in the values.	$\begin{bmatrix} 1 & 2 & 4 \\ 3 & 4 & 2 \\ 4 & 5 & 3 \end{bmatrix}$
Matrix Calculations with the Context Menu Use the context menu to perform matrix calculations. <i>Example:</i> Select Standard Operations > Inverse to find the inverse. Select Standard Operations > Determinant to find the determinant.	$\begin{bmatrix} 1 & 2 & 4 \\ 3 & 4 & 2 \\ 4 & 5 & 3 \end{bmatrix} \rightarrow \begin{bmatrix} \frac{-1}{2} & \frac{-7}{2} & 3 \\ \frac{1}{4} & \frac{13}{4} & \frac{-5}{2} \\ \frac{1}{4} & \frac{-3}{4} & \frac{1}{2} \end{bmatrix} \rightarrow \frac{-1}{4}$
Multiplying Matrices <i>Example:</i> To multiply two matrices by implicit multiplication, place them side-by-side. <i>Example:</i> You can also multiply matrices explicitly by using the period (.) as the matrix multiplication symbol.	$\begin{bmatrix} 44 & -31 \\ 92 & 67 \\ -98 & 57 \\ -77 & 27 \end{bmatrix} \begin{bmatrix} 8 & 99 \\ 69 & 29 \\ -38 & 87 \\ -18 & 33 \end{bmatrix} = \begin{bmatrix} -1787 & 3457 \\ 5359 & 11051 \\ 2698 & -6645 \\ 2440 & -5808 \end{bmatrix}$
Multiplying by a scalar <i>Example:</i> To multiply a matrix by a scalar, use the multiplication symbol.	$b \cdot \begin{bmatrix} -93 & -72 \\ -76 & -2 \end{bmatrix} = \begin{bmatrix} -93 b & -72 b \\ -76 b & -2 b \end{bmatrix}$

Tip: Linear algebra tutors can be found in the **Tools > Tutors > LinearAlgebra** menu, for stepping through problems such as Gaussian Elimination.

Tip: The **LinearAlgebra** package contains many commands for manipulating matrices and vectors and for solving linear algebra problems.

Plotting

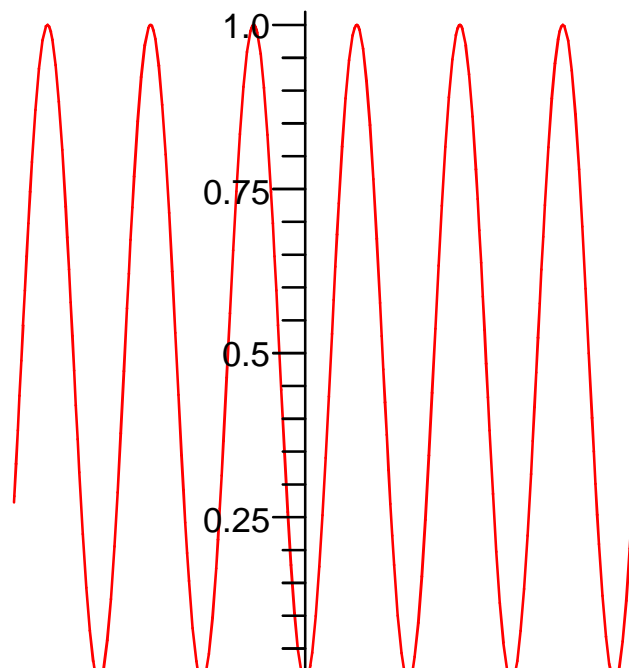
Maple can produce 2-D and 3-D plots of equations and expressions.

Steps	Result
2-D Plots Now we will demonstrate plotting in Maple. The fastest way to plot an expression in Maple is to use the context menu. <i>Example:</i> Enter an expression in x (e.g., $\sin^2(x)$), right-click on the expression, and select Plots > 2-D Plot .	$\sin^2(x) \rightarrow$

Example: Use the point probe to find the coordinates of different points in the graph. Click on the plot, then move the cursor to different locations. The coordinates are displayed in the top left of the plot toolbar.

Example: To pan the plot, right-click on the plot, and select **Manipulator>Pan**. Hold down the left mouse button and use the mouse to move the plot around. To scale the plot, perform the same steps, but select **Manipulator>Scale**.

Tip: You can also change the manipulator tool by clicking on the plot, and then selecting the appropriate tool from the drop-down toolbar button at the top of the Maple window:

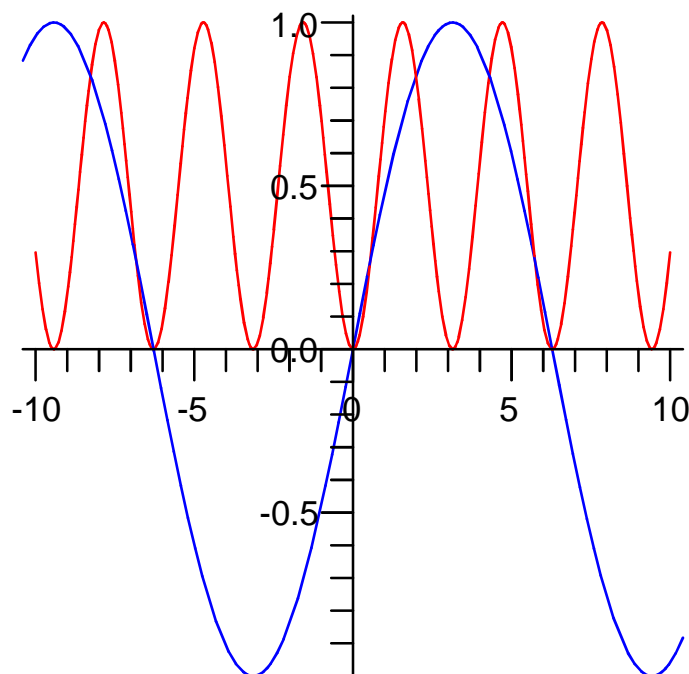


Combining Plots

You can easily add another plot on the same set of axes.

Example: Enter another equation in x (e.g., $\sin\left(\frac{x}{2}\right)$), highlight the new expression with your mouse, hold down the [Ctrl] key and drag it onto the plot.

$\sin^2(x) \rightarrow$



$\sin\left(\frac{x}{2}\right)$

3-D Plots

$\sin(x) \cdot y \rightarrow$

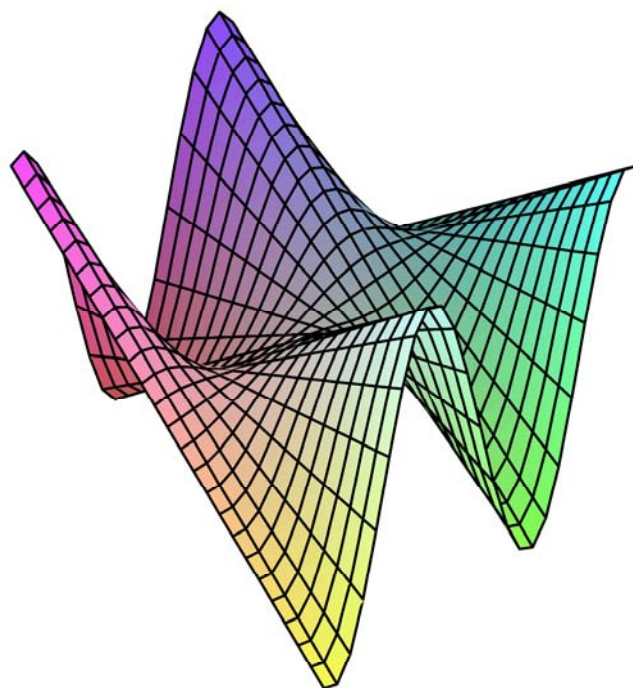
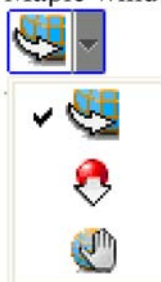
You can also create 3-D plots.

Example: Enter an expression in x and y (e.g.. $\sin(x) \cdot y$) . Right-click on the expression and use **Plots > 3-D Plots > x,y** from the context menu.

Example: Rotate the plot by clicking on the plot, holding down the left mouse button and moving the mouse.

Example: Pan and scale the plot by selecting a different tool from the **Manipulator** list on the context menu. Now when you hold down the mouse button and move the mouse, the new action is performed.

Tip: You can also change the manipulator tool by clicking on the plot, and then selecting the appropriate tool from the drop-down toolbar button at the top of the Maple window:



Plot Options

You can modify the look of your plot in a variety of ways.

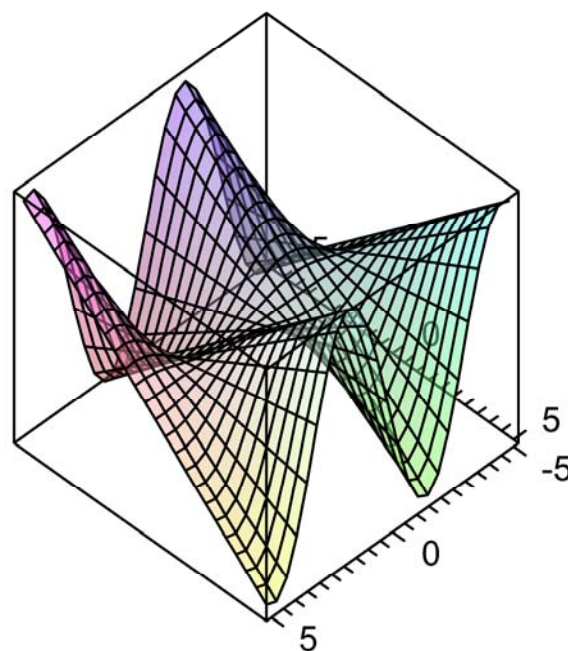
Plot options can be changed by right-clicking on the plot and modifying the options within the context menu. Note that the choices available in the context menu are specific to 3-D plots.

Example: Right-click on the plot to obtain the context menu. Click **Transparency** and modify the plot transparency.

Plot options can also be changed by clicking on the plot, selecting the Plot toolbar at the top of your Maple worksheet, and selecting the relevant options.

Example: Click on the image, from the toolbar select **Plot > Axes > Boxed**.

$\sin(x) \cdot y \rightarrow$



Task Assistants and Tutors

As explored above, context menus are one way to solve problems without using Maple commands. Task assistants provide another method. Tutors are useful for teaching and exploring mathematical concepts. The full list of assistants and tutors can be found on the **Tools** menu.

Steps

Result

Using the Plot Builder Assistant

Plots can easily be created in Maple using the built-in Plot Builder.

Example: Enter the expression you want to plot. From the context menu, select **Plots > Plot Builder**. Using the Plot Builder, you can choose the kind of plot you want, add titles, and set options, all at once. This example shows the use of **plot title**, **normal axes** and style of **patch with contours**.

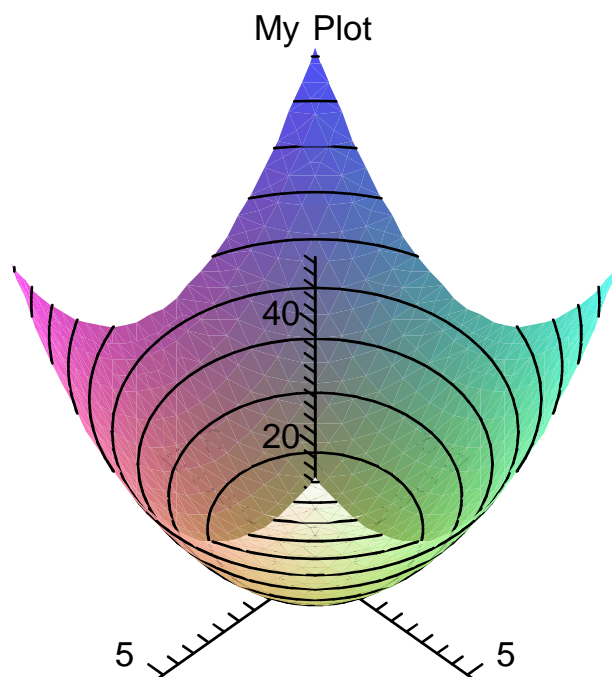
The Plot Builder allows you to create more than just ordinary 2-D and 3-D plots. The example on the right is a contour plot.

Example: Enter the expression $x^2 + y^2$. Select **Plots > Plot Builder** from the context menu. Select **2-D Contour Plot** from the **Select Plot Type** list box, then click **Plot**.

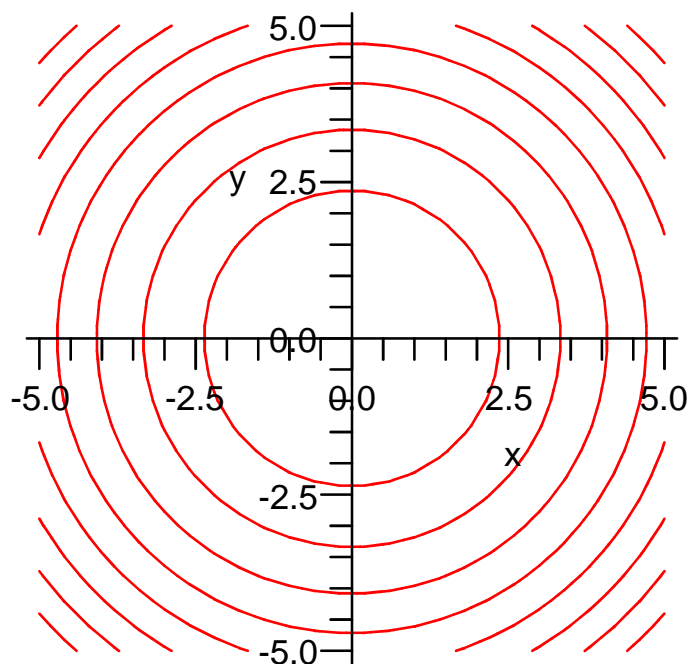
You can also create an animation using the Plot Builder assistant.

Example: Enter the expression on the right, right-click to invoke the context menu.

$$x^2 + y^2 \rightarrow$$



$$x^2 + y^2 \rightarrow$$

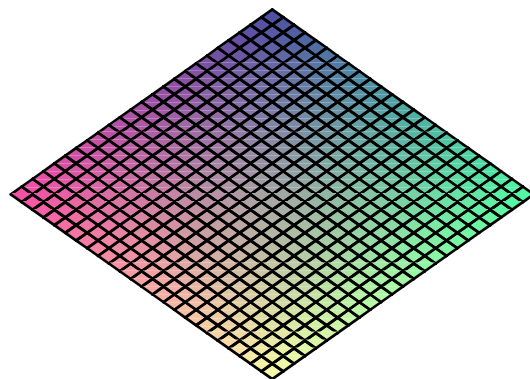


$$\frac{\sin(a \cdot \sqrt{x^2 + y^2})}{\pi^2} \rightarrow$$

Select **Plots** > **Plot Builder** > select **Animation** from the **Select Plot Type** drop-down list, and click the **Plot** button.

Now click on the plot image - some new, plot-specific, buttons will appear at the top left of your worksheet. Click the Play button ">" and watch the animation.

$$a = 0.$$



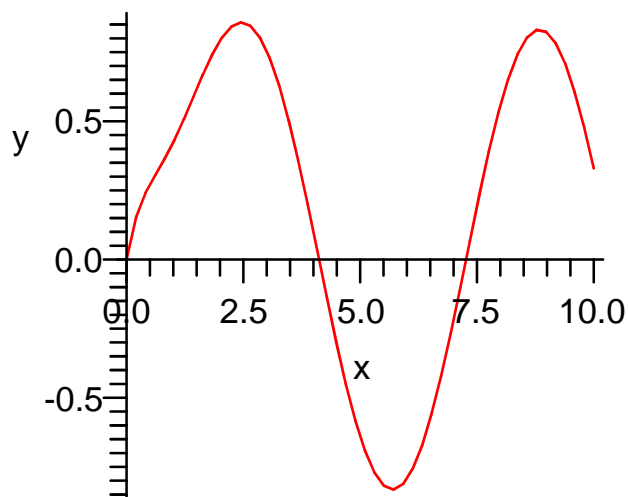
Using the ODE Analyzer Assistant

Another useful Maple assistant is the ODE Analyzer.

Example: Enter the differential equation on the right. Select **Solve DE Interactively** from the context menu of this differential equation.

- Under Conditions, click **Edit** to add initial conditions, such as $y(0)=0$ and $y'(0)=1$
- Select **Solve Numerically**
- Press **Plot**

$$\frac{1}{3}y'' + y' + y = \sin(x) \rightarrow$$



Using Tutors in Maple

Maple provides several tutors which are useful for teaching and exploring mathematical concepts in the subjects of:



- Precalculus
- Calculus - Multi-Variable
- Calculus - Single-Variable
- Vector Calculus
- Linear Algebra


Example: From the menu, select **Tools > Tutors > Calculus - Single Variable > Differentiation Methods**. Enter a function and follow the example through by applying the correct rule at each step and using the "Get Hint" button for help.

Worksheet Mode

Worksheet mode is an alternative to document mode. The key differences between the two modes are:

- Command prompt is displayed.
- Commands used by context menu operations are shown as they are executed.
- Always use [ENTER] to evaluate expressions. All output appears on next line.

Steps	Result
<p>Working in Worksheet Mode</p> <p>Click on the  button to get into Worksheet mode.</p> <p>Example: Using the context menus, differentiate $x^2 + x$. Notice that the diff() command is shown on the next line.</p> <p>You can also have your whole document in Worksheet mode. Select File > New > Worksheet Mode. You will see a red prompt.</p> <p>Example: Enter an assignment statement, $a := 5$, and press [ENTER]. The result is returned, and a new prompt appears.</p>	<pre>[> > x^2 + x x^2 + x > diff(x^2 + x, x) 2 x + 1 > > a := 5 a := 5 ></pre>
<p>1-D versus 2-D Math</p> <p>If you prefer to enter your commands in 1-D math, use [F5] or the  toolbar button to toggle to 1-D "Text" mode. Because you are at a command prompt, Maple knows to evaluate the expression when you press [ENTER].</p> <p>Example: enter the command on the right to differentiate $x^2 + x$ with respect to x.</p> <p>In 1-D, you must end the command with semi-colon (in 2-D, it is not needed). If you forget, Maple will give you a warning.</p> <p>Example: Try it and see.</p>	<pre>[> diff(x^2+x,x) ; 2 x + 1 > diff(x^3-2*x,x) Warning, inserted missing semicolon at end of statement 3 x^2-2 ></pre>
<p>Toggling Between Text and Math in Worksheet Mode</p> <p>To enter non-executable text in worksheet mode, you must create a text region. This region can contain 2-D mathematics notation, but the mathematics will not be executable.</p>	<pre>[Find the derivative of $x^4 + x^2 \cdot \sin(x)$.</pre>

Example: Click the  button on the toolbar to create a text region. Type the text shown on the right. Use [F5] to switch in and out of math mode for the 2-D mathematics.
Right-click on the expression in your text region and find the derivative with respect to x. The diff command and answer are displayed at a new command prompt.

```
> diff(x^4 + x^2 * sin(x), x)
4 x^3 + 2 x sin(x) + x^2 cos(x)
```

Document Mode within a Worksheet

You can create a mini-document mode inside your worksheet. This can be used to start a fresh Document mode section of your document, or it can be used to hide calculations and commands.

Example: In the example above, select (highlight) the text, input, and output entirely, then select **Format > Create Document Block**.

To see inside the document block, place your cursor in the visible text and select **View > Expand Document Block**.

Tip: When working with Document blocks, turn on markers by clicking **View > Markers**. Markers let you see the start and finish of document blocks.

Find the derivative of $x^4 + x^2 \cdot \sin(x)$.

```
4 x^3 + 2 x sin(x) + x^2 cos(x)
```

Entering Maple Commands in Worksheet Mode

Many commands are grouped together in packages. You can type the long name, or enter a **with()** command prior to using a command from that particular package.

Example: Create a Matrix, M , and apply the command `LinearAlgebra[Determinant](M)` to find the determinant of M .

Note: Maple returns an unknown answer when using the command on it's own (without the package name).

You can avoid having to type the long-form of each command by pre-loading the desired package. You can use a colon at the end of the command to suppress output or use a semi-colon to see the commands contained in the package.

Example: Load the LinearAlgebra package first using a colon. Try replacing the colon with a semi-colon after the **with** command to see the difference.

Example: Now calculate the Determinant of M using the short-form of the command.

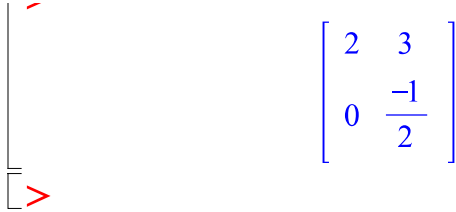
Command completion is very useful when typing out

```
> M := [ [ 2 3 ]
          [ 3 4 ] ]
M := [ [ 2 3 ]
        [ 3 4 ] ]
> LinearAlgebra[Determinant](M);
-1
> Determinant(M);
Determinant([ [ 2 3 ]
               [ 3 4 ] ])
```

```
> with(LinearAlgebra) :
> Determinant(M);
-1
```

```
> GaussianElimination(M);
```

long command names.
Example: Type `Gau`, then press `[Ctrl] [Space]` to see a list of possible completions. Use the arrow key to select the desired command and press `[Enter]`.


$$\begin{bmatrix} 2 & 3 \\ 0 & \frac{-1}{2} \end{bmatrix}$$

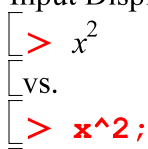
Word Processing Tools

Maple contains numerous word processing tools to help you create professional-looking reports. For your reference, here is a list of some of the more common ones.

Feature	Where to Find It
Built-in title and headings styles	Drop-down list on toolbar
Sections and subsections	Insert > Section, Insert > Subsection
Tables	Insert > Table
Sketch regions	Insert > Sketch
Font control and ability to define new styles	Toolbar buttons, Format > Styles...
Ability to insert images, spreadsheets and other objects	Insert > Image Insert > Object
A spell-checker aware of mathematical terms	Tools > Spellcheck
Hyperlinks and bookmarks	Format > Convert to > Hyperlink Format > Bookmarks...
Page numbers	Format > Page Numbers...
Export to HTML	File > Export

Configuring the Maple Environment

You can customize the Maple environment in many ways. Below is a list of the most common ones. Note that any option set through the **Options** menu can be set just for this session, or globally (every time you start Maple).

Feature	How to Control Feature
Start-up dialog.	Turn it off by clearing the check box on the dialog. Turn it on always by Tools > Options, Interface tab. See it anytime by Help > Startup Dialog...
Quick Help displayed on new documents.	Turn it off by clearing the check box on the quick help. Turn it on again by Tools > Options, Interface tab. See it anytime by pressing <code>[F1]</code> .
Option for new documents to start in Document mode (no prompt, context menu commands hidden) or Worksheet mode (prompts, all commands shown).	Tools > Options, Interface tab. Default format for new worksheets...
Option to enter math in 2-D (default) or 1-D? (Note: Choice only available in worksheet mode. All math must be entered in 2-D in document mode.)	Tools > Options, Display tab Input Display...  <code>> x²</code> vs. <code>> x^2;</code>

You can also control the input type for individual lines, without changing the overall default.	<div> <div>Use context menu on the line above. Selecting Convert to > 2-D Math Input turns the above line into:</div> <div>> x^2;</div> </div>
Number of digits displayed in calculation results. Maple displays 10 digits by default (though it calculates with more).	<div> <div>Tools > Options, Precision tab</div> <div>Round screen display to..</div> <div>For example, show the floating point value of π. The default result is:</div> <div> <div>> $\text{evalf}(\pi)$;</div> <div>3.141592654</div> </div> <div>After setting the screen display to 5, the result is:</div> <div> <div>> $\text{evalf}(\pi)$;</div> <div>3.14159</div> </div> </div>
<p>Palettes can be reordered, and individual palettes can be moved from one dock to the other, or turned off completely.</p> <p>Palette docks can also be expanded and collapsed.</p>	<div> <div>View > Palettes > Arrange Palettes...</div> <div>Use the View > Palettes menu, or the small arrows at the top of the palette to expand and collapse. For the left-hand-side dock, these arrows are in the top-right corner of the palette, to the right of the scroll bar.</div> </div>

Getting Help

Maple has an extensive help system, including help pages, online manuals, an integrated dictionary of mathematical and engineering terms, examples, and tutorials.

Steps	Useful for
Select the Help > Maple Help menu to display the help browser. Enter the topic name (e.g.. "fourier") into the search box.	Search and browse full help system, including help pages, dictionary and manuals.
<p>To get help on a particular topic, use the ? notation. E.g. ? int</p> <p>If topic name already appears in your document, place the cursor on the word and press [F2].</p>	Instant access to the help page when you know the topic name or command name.
Press [F1] for Quick help. Follow links for full explanations.	Instant help on common tasks.
Help > Quick Reference Card (or [Ctrl] [F2])	Succinct overview of important topics.
?examples,index	Example documents illustrating different mathematical and programming commands.
Tools > Task > Browse for task templates.	Fill-in-the-blank templates. Organized by concept, not command name.
Printed manuals are included with the product. The <i>Getting Started Guide</i> and <i>User Manual</i> are also available through the help system. Select Help > Manuals, Dictionary, and more>Manuals to view the manuals.	Conceptual overviews, more in-depth explanations.
Help > Take a Tour of Maple for introductions to topics and example applications.	Quick introduction to a variety of Maple topics in slide-show format.

▼ Example of a Polished Maple Document

We have now covered the basics. Here is an example of how it all fits together.

Tip: You can find more information on using embedded components in Maple documents in the Tips & Techniques section of the Application Center (http://www.maplesoft.com/applications/app_center_view.aspx?AID=1857).