

Maple Getting Started Guide

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Maple Getting Started Guide

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Preface

Maple Software

Maple™ software is a powerful system that you can use to solve mathematical problems from simple to complex. You can also create professional quality documents, presentations, and custom interactive computational tools in the Maple environment.

You can access the power of the Maple computational engine through a variety of interfaces.

Interface	Description
Standard (default)	A full-featured graphical user interface that helps you create electronic documents to show all your calculations, assumptions, and any margin of error in your results. You can also hide the computations to allow your reader to focus on the problem setup and final results. The advanced formatting features lets you create the customized document you need. Because the documents are <i>live</i> , you can edit the parameters and, with the click of a button, compute the new results. The Standard interface has two modes: <i>Document</i> mode and <i>Worksheet</i> mode.
Classic	A basic worksheet environment for older computers with limited memory. The Classic interface does not offer all of the graphical user interface features that are available in the Standard interface. The Classic interface has only one mode, <i>Worksheet</i> mode.
Command-line version	A command-line interface for solving very large complex problems or batch processing with scripts. No graphical user interface features are available.
Maplet™ Applications	Graphical user interfaces containing windows, textbox regions, and other visual interfaces, which gives you point-and-click access to the power of Maple. You can perform calculations and plot functions without using the worksheet.


Interface	Description
Maplesoft™ Graphing Calculator	A graphical calculator interface to the Maple computational engine. Using it, you can perform simple computations and create customizable, zoomable graphs. This is available on Microsoft® Windows® only.

This manual describes how to use the Standard interface. As mentioned, the Standard interface offers two modes: *Document* mode and *Worksheet* mode. Using either mode, you can create high quality interactive mathematical documents. Each mode offers the same features and functionality, the only difference is the default input region of each mode.

Document Mode vs. Worksheet Mode

Before you can begin using Maple, you need to decide if you want to interact in an interface that hides all commands used to perform calculations by default (Document mode) or to show all commands by default (Worksheet mode). Regardless of which mode you are working in, you have the opportunity to show or hide your calculations, i.e. you can hide commands in Worksheet mode by adding a Document Block from the **Format** menu, **Format** → **Create Document Block** or you can show commands in Document mode by adding a Maple prompt from the **Insert** menu, **Insert** → **Execution Group** → **Before / After Cursor**.

Document Mode

Document mode uses *Document Blocks* as the default input region to hide Maple syntax. The Document Block region is indicated by two triangles located in the vertical Markers column along the left pane of the Maple Document, . If the Markers column is not visible, select **View** → **Markers**. This allows you to focus on the problem instead of the commands used to solve the problem. For example, when using context menus on Maple input in Document mode (invoked by right-clicking or **Control**-clicking for Macintosh), input and output are connected using an arrow or equal sign

with self-documenting text indicating the calculation that had taken place. The command used to solve this expression is hidden.



A screenshot of the Maple interface showing a mathematical expression $x^2 + 7x + 10$ followed by a right-pointing arrow with the word "solve" written above it. To the right of the arrow are the solutions $\{x = -2\}, \{x = -5\}$.

When starting Standard Maple, the default mode is Document mode.

Worksheet Mode

Worksheet mode uses a Maple prompt as the default input region. The Maple input prompt is a red greater than symbol where the black square bracket indicates the full execution region, $\left[\right]$. When using content menus on Maple input in Worksheet mode, all commands are displayed.



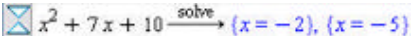




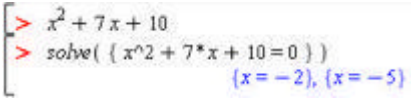


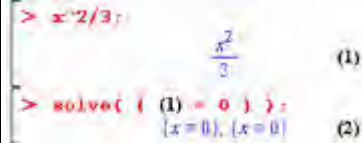


A screenshot of the Maple Worksheet mode interface. It shows a red prompt character $>$ followed by the expression $x^2 + 7x + 10$. Below this, another red prompt character $>$ is followed by the command $\text{solve}(\{x^2 + 7*x + 10 = 0\})$. The output of the command is $\{x = -2\}, \{x = -5\}$.

To work in Worksheet mode, select **File** → **New** → **Worksheet Mode**.

Math Mode vs. Text Mode

Within each interface mode, you have the choice of entering input using *Math mode* or *Text mode*. Math mode allows you to enter input as 2-D Math regardless if you are working in Document mode or Worksheet mode. Text mode is quite different depending on where you are working. Toggling modes is done using the **Text** and **Math** buttons on the toolbar.

Entry mode → Interface mode ↓	Math mode (default setting)	Text mode
Document (default setting)	<ul style="list-style-type: none"> Input is made at a Document Block with slanted cursor,  Input is entered using 2-D Math,  Commands are hidden when using context menus,  	<ul style="list-style-type: none"> Input is made at a Document Block with vertical cursor,  Input is entered as regular text, 
Worksheet	<ul style="list-style-type: none"> Input is made at an input prompt with a slanted cursor,  Input is entered using 2-D Math,  Commands display when using context menus,  	<p>(Default setting for earlier versions of Maple)</p> <ul style="list-style-type: none"> Input is made at an input prompt with a vertical cursor,  Input is entered using 1-D Math and requires a semi-colon or colon to end your input,  Commands display when using context menus on the expression output, 

For more information, see *Document Mode vs. Worksheet Mode* (page 53).

Invoking Context Menus, Command Completion, and Copy & Drag

This manual will frequently refer to context menus and command completion when entering expressions. We will also discuss dragging input into another region by copying the input using a keystroke while dragging. By not using this keystroke, the input is deleted from the input region. The keyboard keys used to invoke these features differ based on the operating system you're using.

Context Menus

- **Right-click**, Windows and UNIX[®]
- **Control-click**, Macintosh[®]

That is, place the mouse over input or output region and press the right button on the mouse or press and hold the **Control** key and click the mouse key for Macintosh.

Command Completion

- **Ctrl + Space** or **Esc**, Windows
- **Command + Shift + Space** or **Esc**, Macintosh
- **Ctrl + Shift + Space** or **Esc**, UNIX

Begin entering a command in a Maple document. Press and hold the **Ctrl** key and then press the **Space** bar for Windows. Press and hold the **Command** key, press and hold the **Shift** key, and then press the **Space** bar for Macintosh. Alternatively, press the **Esc** key. The steps for Macintosh are the same for UNIX with the exception of pressing the **Ctrl** key instead of the **Command** key.

Copy & Drag

- **Ctrl** + drag, Windows and UNIX
- **Command** + drag, Macintosh

That is, highlight the region you want to copy. Press and hold the **Ctrl** key while you drag the input to the new region using the mouse. The steps are the same for Macintosh with the expression of pressing the **Command** key.

This manual will only refer to the keyboard keys needed for a Windows operating system. When working through the examples, use the keyboard keys needed for your operating system. For more information on Context Menus and Copy & Drag, see *Context Menus and Copy & Drag (page 12)*. For more information on Command Completion, see *Command Completion (page 46)*.

In This Manual

This manual provides an introduction to the following Maple features:

- Ease-of-use when entering and solving problems
- Point-and-click interaction with various interfaces to help you solve problems quickly
- Maple commands and standard math notation
- Clickable Calculus
- The help system
- Accessing resources

The *Getting Started Guide* was created using the Standard interface to Maple. An interactive version of this manual is available in the Standard interface. From the **Help** menu, select **Manuals, Dictionary, and more** → **Manuals** → **Getting Started Guide**. For a complete list of manuals, study guides, toolboxes, and other resources, visit the Maplesoft Web site at <http://www.maplesoft.com>

Audience

The information in this manual is intended for first-time Maple users.

Conventions

This manual uses the following typographical conventions.

- **bold** font - Maple command, package name, option name, dialog, menu, and text field
- *italics* - new or important concept
- **Note** - additional information relevant to the section
- **Important** - information that must be read and followed

Customer Feedback

Maplesoft welcomes your feedback. For suggestions and comments related to this and other manuals, contact doc@maplesoft.com.

1 Introduction to Maple

Don't worry about your difficulties in Mathematics. I can assure you mine are still greater.

~Albert Einstein

Mathematics touches us every day—from the simple chore of calculating the total cost of our purchases to the complex calculations used to construct the bridges we travel.

To harness the power of mathematics, Maplesoft provides a tool in an accessible and complete form. That tool is Maple.

In this chapter:

Working in Maple	Describes the capabilities of the Maple Environment.
Starting the Standard Document Interface	Explains what happens the first time you start Maple and shows how to begin a Document.
Entering 2-D Math	Illustrates how to enter an expression in 2-D Math.
Shortcuts for Entering Mathematical Expressions	Provides a table of the common keystrokes when entering 2-D Math.
Palettes	Illustrates how to enter a problem using Maple palettes.
Toolbar Icons	Illustrates how to enter text and math on the same line.
Context Menus and Copy & Drag	Illustrates how to take advantage of Maple's context menus and copy & drag functionality to solve a problem.
Saving a Maple Document	Explains how to save a Maple document and indicates the file extension used for Maple documents.

1.1 Working in Maple

With Maple you can create powerful interactive documents. The Maple environment lets you start solving problems right away by entering expressions in 2-D Math and solving these expressions using point-and-click interfaces. You can combine text and math in the same line, add tables to organize the content of your work, or insert images, sketch regions, and spreadsheets. You can visualize and animate problems in two and three dimensions, format text for academic papers, or books, and insert hyperlinks to other Maple files, Web sites, or email addresses. You can embed and program graphical user interface components, as well as devise custom solutions using the Maple programming language.

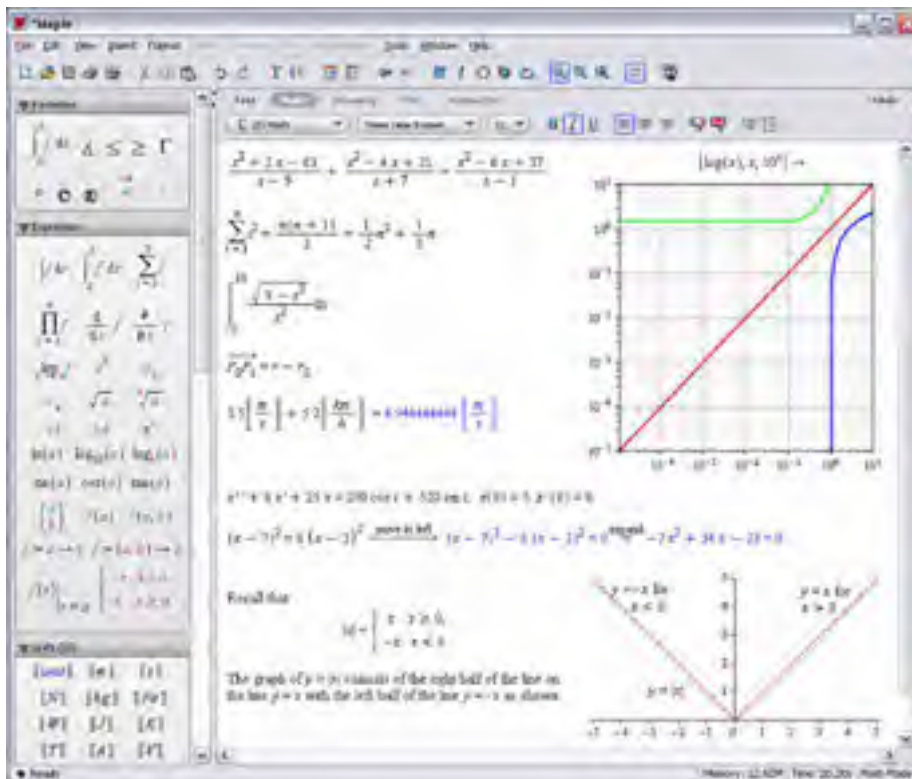


Figure 1.1: The Maple Environment

1.2 Starting the Standard Document Interface

To start Maple on:

Windows	From the Start menu, select All Programs → Maple 12 → Maple 12 . Alternatively: Double-click the Maple desktop icon.
Macintosh	1. From the Finder, select Applications and Maple 12 . 2. Double-click Maple 12 .
UNIX	Enter the full path, for example, /usr/local/maple/bin/xmaple Alternatively: 1. Add the Maple directory (for example, /usr/local/maple/bin) to your command search path. 2. Enter xmaple .

The first Maple session opens with a **Startup** dialog explaining the difference between *Document Mode* and *Worksheet Mode*. Using either mode, you can create high quality interactive mathematical documents. Each mode offers the same features and functionality, the only difference is the input region of each mode.

Document Mode - The default input region is a *Document Block*. Document Blocks hide Maple syntax allowing you to focus on the problem instead of the commands used to solve the problem.

Worksheet Mode - The default input region is a Maple input prompt where all commands are displayed.

Regardless of which mode you are working in, you have the opportunity to show or hide your calculations.

This guide discusses features common to Document mode. Instructions for using Worksheet mode are provided in the section, *Document Mode vs. Worksheet Mode* (page 53).

The Startup dialog also contains links to items, such as various document options, help resources including updates and other introductory help pages, and application resources on the Maplesoft Web site. Subsequent sessions display **Tip of the Day** information.

To start a Maple session in Document Mode:

1. In the **Startup** dialog, select **Blank Document**. A blank document displays.

or

1. Close the **Startup** dialog.

2. From the **File** menu, select **New**, and then **Document Mode**. A blank document displays.

In subsequent sessions, Maple starts in Document mode. Every time you open a document, Maple displays a **Quick Help** pop-up list of important shortcut keys. To invoke **Quick Help** at any time, press the **F1** key.

1.3 Entering 2-D Math

In Maple, the default behaviour to enter mathematical expressions is in 2-D Math. This results in mathematical expressions that are equivalent to the quality of math found in textbooks. Entering 2-D Math in Maple is done using common key strokes or palette items. For more information on palettes, see *Palettes (page 8)*. An example of entering an expression using common key strokes is presented in the following section. An example of entering an expression using palette items is presented in *Example 2 - Enter an Expression Using Palettes (page 8)*.

Example 1 - Enter and Evaluate an Expression Using Keystrokes

Review the following example:

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

In this example, we will enter $\frac{(x^2+y^2)}{2}$ and evaluate the expression.

Action	Result in Document
To enter the expression:	
1. Enter (x.	(x)
2. Press Shift + 6 (the ^ or caret key). The cursor moves to the superscript position.	$(x^)$
3. Enter 2.	(x^2)
4. Press the right arrow key. The cursor moves right and out of the superscript position.	(x^2)
5. Enter the + symbol.	(x^2+)
6. Enter y.	(x^2+y)
7. Press Shift + 6 to move to the superscript position.	$(x^2+y^)$
8. Enter 2 and press the right arrow key.	(x^2+y^2)
9. Enter) to close the parenthesis.	(x^2+y^2)
10. Enter the / symbol. The cursor moves to the denominator.	$\frac{(x^2+y^2)}{}$

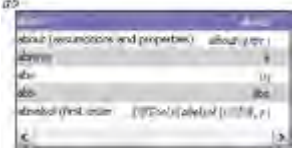
Action	Result in Document
11. Enter 2.	$\frac{(x^2 + y^2)}{2}$
12. Press the right arrow key to move right and out of the denominator position.	$\frac{(x^2 + y^2)}{2}$
To evaluate the expression and display the result inline: 13. Press Ctrl += (Command += for Macintosh).	$\frac{(x^2 + y^2)}{2} = \frac{x^2}{2} + \frac{y^2}{2}$

To execute 2-D Math, you can use any of the following methods.

- Pressing **Ctrl** += (**Command** +=, for Macintosh). That is, *press and hold* the **Ctrl** (or **Command**) key, and then press the equal sign (=) key. This evaluates and displays results inline.
- Pressing the **Enter** key. This evaluates and displays results on the next line and centered.
- Right-click (**Control**-click for Macintosh) the input to invoke a context menu item. From the context menu, select **Evaluate and Display Inline**. See *Context Menus and Copy & Drag (page 12)* for more details.
- Using the context-menu item **Evaluate**.

1.4 Shortcuts for Entering Mathematical Expressions

Table 1.1: Common Keystrokes for Entering Symbols and Formats

Symbol/Formats	Key	Example
implicit multiplication	Space key	$(x^2 - 7xy + 3y^2)xy$
explicit multiplication ¹	* (asterisk)	2*3
fraction ²	/ (forward slash)	$\frac{1}{4}$
exponent (superscript) ²	^ (Shift + 6 or caret key)	x^2
subscript ²	_ (Shift + underscore)	x_{it}
navigating expressions	Arrow keys	
command / symbol completion ³	<ul style="list-style-type: none"> • Ctrl + Space, Windows • Esc, Macintosh • Ctrl + Shift + Space, UNIX 	
square root	<i>sqrt</i> then command completion	$\sqrt{\frac{2}{3}}$
exponential function ²	<i>exp</i> then command completion	e^2
enter / exit 2-D Math	Math and Text icons in the toolbar	$\frac{1}{4}$ versus 1/4
¹ required for products of numbers ² use right arrow key to leave denominator, superscript, or subscript region ³ for more information, see <i>Command Completion</i> (page 46).		

1.5 Palettes

Palettes are collections of related items that you can insert into a document by clicking or drag-and-dropping. The Maple environment provides access to over 20 palettes containing items such as symbols (∞) , layouts

(A^b) , mathematical operations $\left(\int_a^b f dx\right)$, and much more. For more in-

formation on the available palettes, see *Palettes* (page 37).

By default, palettes are displayed in the left pane of the Maple environment when you launch Maple. If the palettes are not displayed,

1. From the **View** menu, select **Palettes**.
2. Select **Expand Docks**.
3. Right-click (**Control**-click, for Macintosh) the palette dock. From the context menu, select **Show All Palettes**.






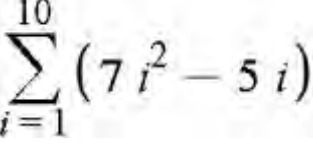
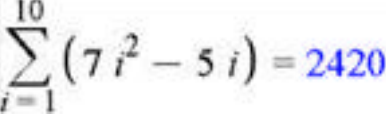
Alternatively, from the main menu, select **View** → **Palettes** → **Arrange Palettes** to display specific palettes.

Example 2 - Enter an Expression Using Palettes

Review the following example:

$$\sum_{i=1}^{10} (7i^2 - 5i) = 2420$$

In this example, we will enter $\sum_{i=0}^{10} (7i^2 - 5i)$ and evaluate the expression.

Action	Result in Document
1. In the Expression palette, click the summation template  . Maple inserts the summation symbol with the range placeholder highlighted.	
2. Enter i and then press Tab . The left endpoint placeholder is selected. Notice that the color of the range placeholder has changed. Each placeholder must have an assigned value before you execute the expression, i.e. all placeholders will display in black font. The Tab key advances you through the placeholders of an inserted palette item.	
3. Enter 1 and then press Tab . The right endpoint placeholder is selected.	
4. Enter 10 and then press Tab . The expression placeholder is selected.	
5. Enter $(7i^2 - 5i)$.	
6. Press Ctrl + = (Command + = for Macintosh) to evaluate the summation.	

1.6 Toolbar Icons

Using Maple, you can enter math and text on the same line with the **Text** and **Math** icons on the toolbar. See Figure 1.2. When the **Text** icon is selected, you can enter text and format it using the available tools. If you then select the **Math** icon, you change the mode to allow entry of 2-D Math. The same formatting options are available when the **Math** icon is selected.

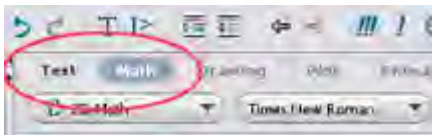



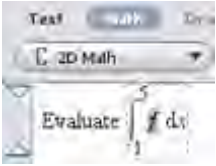
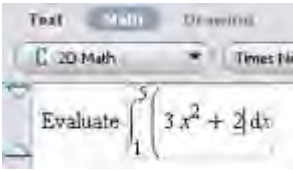
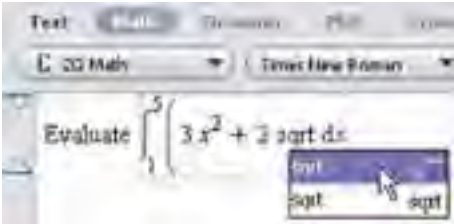

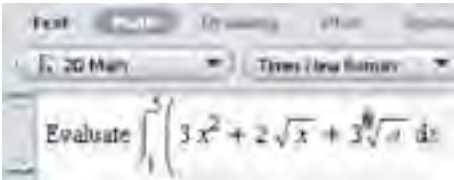
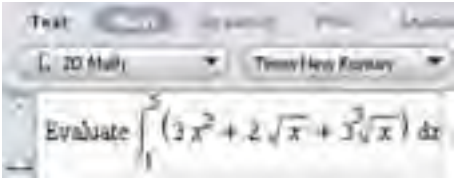
Figure 1.2: Icons for Text and Math Entry Mode

Example 3 - Enter Text and 2-D Math in the Same Line Using Toolbar Icons

Review the following example:

Evaluate $\int_1^5 (3x^2 + 2\sqrt{x} + 3\sqrt[3]{x}) dx$

Action	Result in Document
<p>To enter this sentence:</p> <p>1. Select the Text icon and enter Evaluate.</p>	
<p>2. Select the Math icon.</p> <p>3. From the Expression palette, select the definite integration template, . The expression is displayed with the first placeholder highlighted.</p>	

Action	Result in Document
<p>4. With the first placeholder highlighted, enter 1.</p> <p>5. Press Tab and enter 5.</p> <p>6. Press Tab to highlight the integrand region.</p>	
<p>7. Enter (3x^2 and press the right arrow to leave the superscript position.</p> <p>8. Enter + 2.</p>	
<p>9. Press the Space bar for implicit multiplication. Enter sqrt and press Ctrl + Space to show the command completion options. Maple displays a pop-up list of exact matches. Select the square root symbol, \sqrt{x}. Maple inserts the symbol with the x placeholder selected. You can also select the square root symbol from the Expression palette.</p>	
<p>10. Enter x.</p> <p>11. Press the right arrow to leave the square root region</p> <p>12. Enter +3.</p> <p>13. Press the Space bar.</p> <p>14. Select the n-th root symbol from the Expression palette .</p>	
<p>15. Enter 3.</p> <p>16. Press the Tab key and enter x).</p> <p>17. Press the Tab key and enter x for the integration variable.</p>	

1.7 Context Menus and Copy & Drag

Context Menus

Maple dynamically generates a context menu of applicable options when you right-click an object, expression, or region. The actions available in the context menu depend on the selected input region. For example, you can manipulate and graph expressions, enhance plots, format text, manage palettes, structure tables, and more. When using context menus to perform an action on an expression, the input and output are connected with a self-documenting arrow or equal sign indicating the action that had taken place. For more information, see *Context Menus (page 32)*.

Copy & Drag

To save time entering information, Maple has the ability to drag input into a new input region. This is done by highlighting the input and dragging it with your mouse into a new input region. Dragging the highlighted region will cut or delete the original input. To prevent this, press and hold the **Ctrl** key and then the drag the input. This makes a copy of the highlighted region.

Example 4 - Solve and Plot an Equation Using Context Menus and Copy & Drag

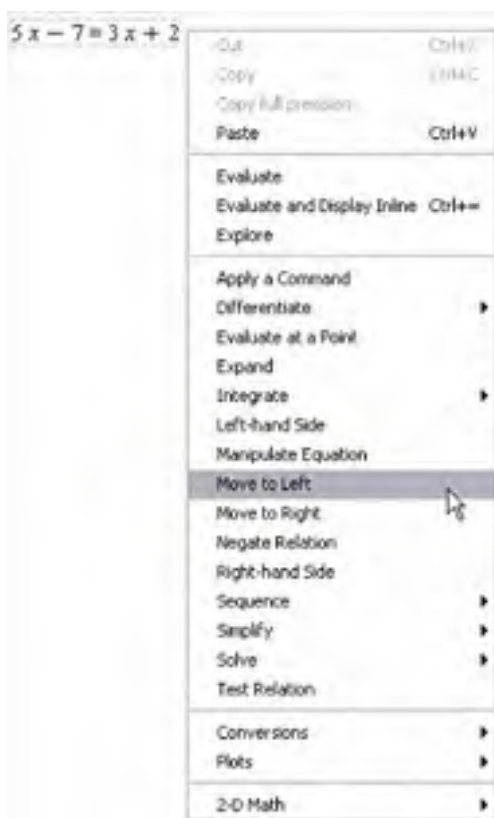
Review the following example:

$$5x - 7 = 3x + 2$$

In this example, we will enter the equation and then solve and plot the equation using context menus and Maple's copy & drag feature. This example will only refer to the keystrokes needed on a Windows operating system to invoke the context menus and the copy & drag feature. For your operating system, refer to section *Invoking Context Menus, Command Completion, and Copy & Drag (page xiii)* for the equivalent keystrokes.

To solve the equation:

1. Enter the equation.
2. Right-click the equation and select **Move to Left**.

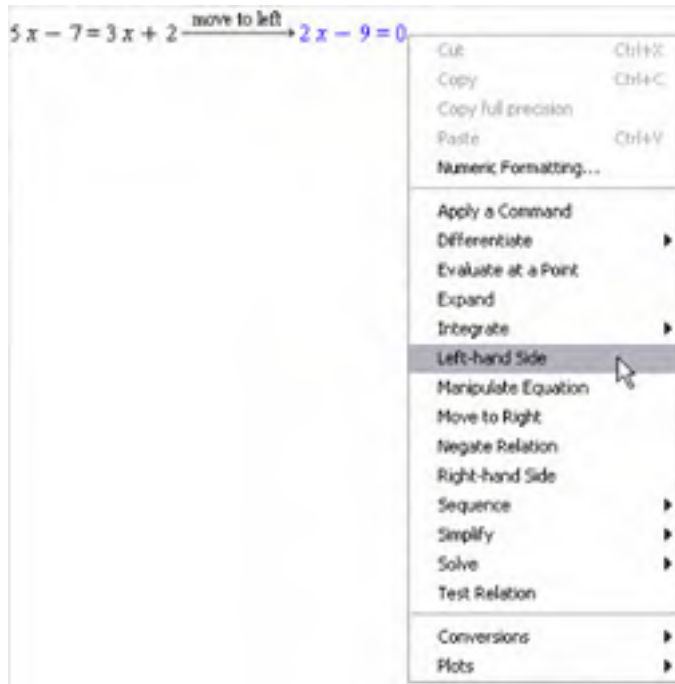
Input:**Result:**

$$5x - 7 = 3x + 2 \xrightarrow{\text{move to left}} 2x - 9 = 0$$

A brief description, "move to left" is placed above the arrow connecting the input and output.

3. Right-click the output from the previous action, $2x - 9 = 0$ and select **Left-hand Side**.

Input:



The screenshot shows the Maple interface. At the top, the equation $5x - 7 = 3x + 2$ is followed by a right-pointing arrow labeled "move to left" and the resulting equation $2x - 9 = 0$. A right-click context menu is open over the $2x - 9 = 0$ equation. The menu items are: Cut (Ctrl+X), Copy (Ctrl+C), Copy full precision, Paste (Ctrl+V), Numeric Formatting..., Apply a Command, Differentiate (with a right-pointing arrow), Evaluate at a Point, Expand, Integrate (with a right-pointing arrow), **Left-hand Side** (highlighted by a mouse cursor), Manipulate Equation, Move to Right, Negate Relation, Right-hand Side, Sequence (with a right-pointing arrow), Simplify (with a right-pointing arrow), Solve (with a right-pointing arrow), Test Relation, Conversions (with a right-pointing arrow), and Plots (with a right-pointing arrow).

Result:

$$5x - 7 = 3x + 2 \xrightarrow{\text{move to left}} 2x - 9 = 0 \xrightarrow{\text{left hand side}} 2x - 9$$

4. Right-click the new output, $2x - 9$ and select **Solve** → **Isolate Expression for** → **x**.

Input:

$5x - 7 = 3x + 2$ $\xrightarrow{\text{move to left}}$ $2x - 9 = 0$ $\xrightarrow{\text{left hand side}}$ $2x - 9$

The context menu includes the following options:

- Cut (Ctrl+X)
- Copy (Ctrl+C)
- Copy full precision
- Paste (Ctrl+V)
- Numeric Formatting...
- Apply a Command
- Approximate
- Assign to a Name
- Coefficients
- Collect
- Differentiate
- Evaluate at a Point
- Factor
- Integrate
- Limit
- Sequence
- Series
- Simplify
- Isolate Expression for (selected)
- Numerically Solve
- Numerically Solve from point
- Obtain Solutions for
- Solve
- Solve for Variable
- x (selected in sub-menu)
- Complex Maps
- Constructions
- Conversions
- Integer Functions
- Integral Transforms
- Language Conversions
- Optimization
- Plots
- Sorts
- Units

Result:

$5x - 7 = 3x + 2$ $\xrightarrow{\text{move to left}}$ $2x - 9 = 0$ $\xrightarrow{\text{left hand side}}$ $2x - 9$ $\xrightarrow{\text{isolate for x}}$ $x = \frac{9}{2}$

Now that we have solved the equation, we can plot it. To do this, we will copy the expression $2x - 9$ to a new Document Block and use context menus once again.

5. From the **Format** menu, select **Create Document Block**.

6. To copy the expression $2x - 9$, highlight only this expression from the previous result. Press and hold the **Ctrl** key and drag the expression to the new document block region.

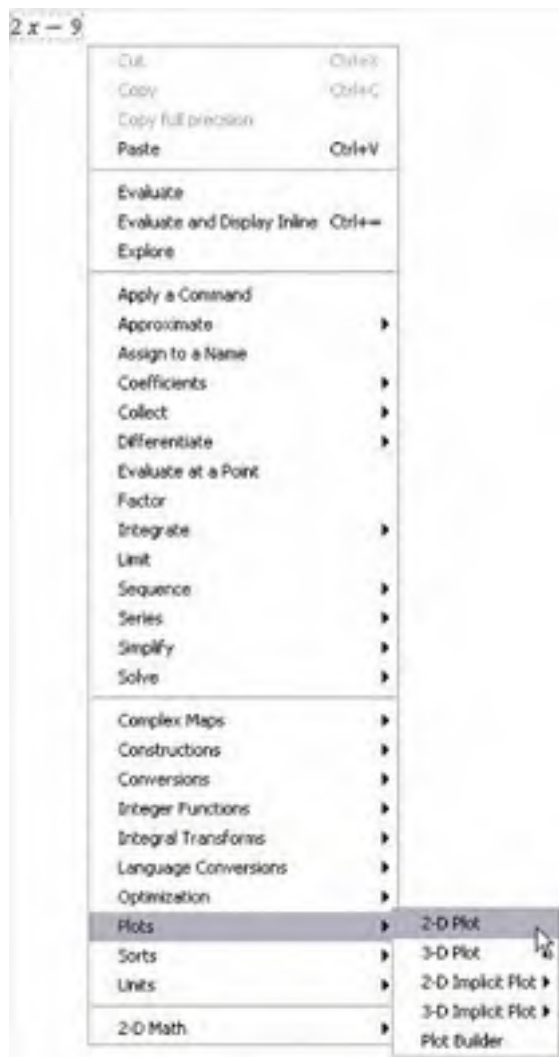
Result:

The result shows four sequential steps of copying the expression $2x - 9$ from a Maple worksheet:

- Initial state: The expression $2x - 9$ is highlighted in the sequence $5x - 7 = 3x + 2 \xrightarrow{\text{move to left}} 2x - 9 = 0 \xrightarrow{\text{left hand side}} 2x - 9 \xrightarrow{\text{isolate for x}} x = \frac{9}{2}$.
- Mouse cursor moves to the highlighted $2x - 9$.
- Mouse cursor is positioned over the $2x - 9$ expression, ready to be dragged.
- The expression $2x - 9$ is being dragged from the original location to a new document block region, indicated by a dashed box around the expression in the new block.

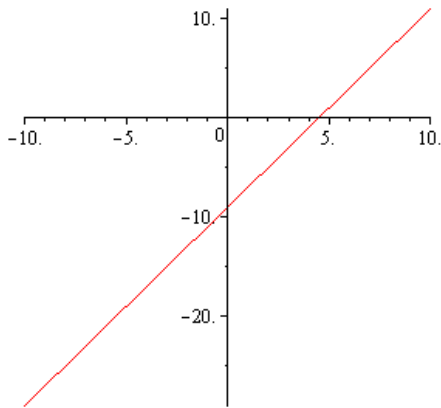
To plot the expression:

7. Right-click the expression and select **Plots** → **2-D Plot**.

Input:

Result:

$2x - 9 \rightarrow$



1.8 Saving a Maple Document

To save these examples you created, from the **File** menu, select **Save**. Maple documents are saved as **.mw** files.

2 Point-and-Click Interaction

Maple contains many built-in features that allow you to solve problems quickly without having to know any commands.

In this chapter:

Assistants	Interactive tools that help you accomplish many specialized tasks, such as solving ODEs and ODE systems, creating plots and matrices, calculating optimization problems, performing unit conversions, and more.
Tutors	Interactive tools that aid in the learning of precalculus, calculus, multivariate calculus, vector calculus, differential equations, and linear algebra concepts.
Context Menus	Context menus to manipulate expressions, plot regions, text regions, and objects easily.
Task Templates	Templates to help you learn how to perform mathematical computations, construct Maple objects, and create a detailed Maple document.
Palettes	A collection of templates representing items such as predefined symbols, expressions, operators, and matrices.

2.1 Assistants

Maple offers a set of assistants in the form of graphical user interfaces to perform many tasks without you needing to use any syntax. An example of an assistant is shown in Figure 2.1.

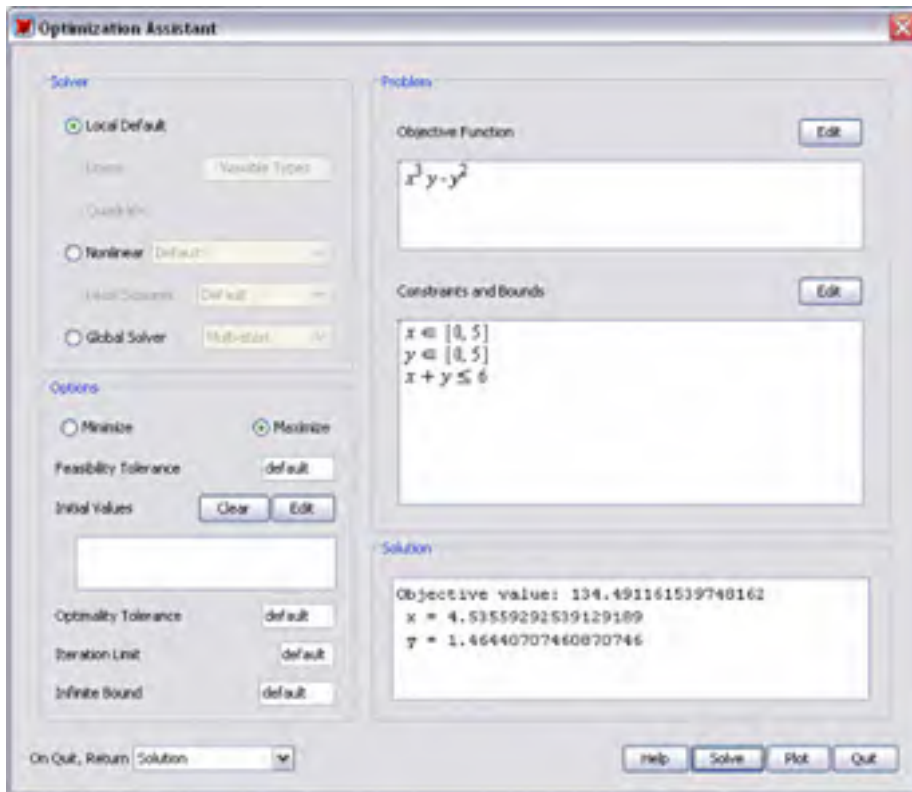


Figure 2.2: Optimization Assistant

Using the **Tools** → **Assistants** menu, you can access tools to help you accomplish these various tasks. See Figure 2.2. In some cases, you can launch the assistants by entering an expression and selecting the assistants from the context menu that displays.

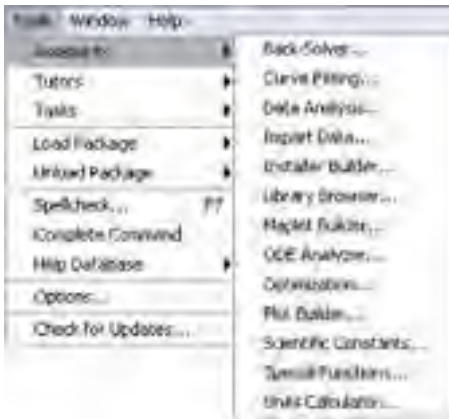


Figure 2.2: Accessing the Assistants from the Tools Menu

Plot Builder

The **Plot Builder** is a point-and-click interface to the Maple plotting functionality. The interface displays plot types based on the expression you specify. The available plot types include plots, interactive plots, animations, or interactive animations. Depending on the plot type you enter, you can create:

- 2-D / 3-D plot
- 2-D polar plot
- 2-D / 3-D conformal plot of a complex-valued function
- 2-D / 3-D complex plot
- 2-D density plot
- 2-D gradient vector-field plot
- 2-D implicit plot

Using the **Plot Builder**, you can:

- (1) Specify the plotting domain before you display the graph
- (2) Specify the endpoints of the graph as symbolic, for example, Pi , $\text{sqrt}(2)$
- (3) Apply plot options using drop-down menus.

The output from the **Plot Builder** is a plot of the expression or the command used to generate the plot. Figure 2.3 - 2.5 shows three of the main dialogs in the Plot Builder.



Figure 2.3: Specify Expressions



Figure 2.4: Select Plot Type



Figure 2.3: Specify Expressions dialog allows you to add, edit, or remove expressions and variables.

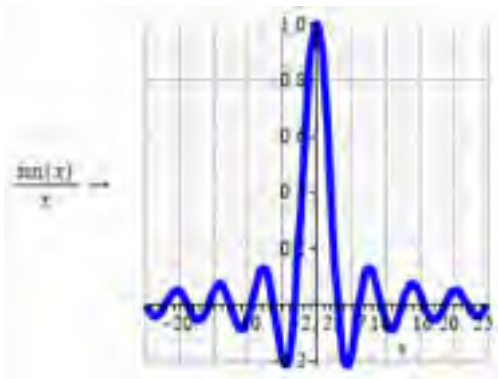
Figure 2.4: Select Plot Type dialog allows you to select the plot type and corresponding plot, and edit the ranges.

Figure 2.5: Plot Options dialog allows you to apply plot options.

Figure 2.5: Plot Options

Example 1- Plot an Expression Using the Interactive Plot Builder

Review the following example:



In this example, we will use the Plot Builder to plot the expression

$$\frac{\sin(x)}{x}$$

and apply the following plot options:

- change the default x -axis range
- change the thickness of the line
- change the color of the line
- apply gridlines
-

Launch the Plot Builder and add the expression:

1. From the **Tools** menu, select **Assistant** → **Plot Builder**. The **Specify Expressions** dialog displays. See Figure 2.3.
2. In the **Expressions** region, click **Add**.
3. In the **Add/Edit Expression** dialog, enter **sin(x)/x** and click **Accept**. **Select a plot type and change the default x-axis range:**
4. Click **OK** and the **Select Plot Type** dialog displays. See Figure 2.4. Alternatively, you could have entered the expression and used the context menus to launch the Plot Builder by selecting **Plots** → **Plot Builder**. See Figure 2.6. This will launch the Plot Builder and automatically insert the expression.

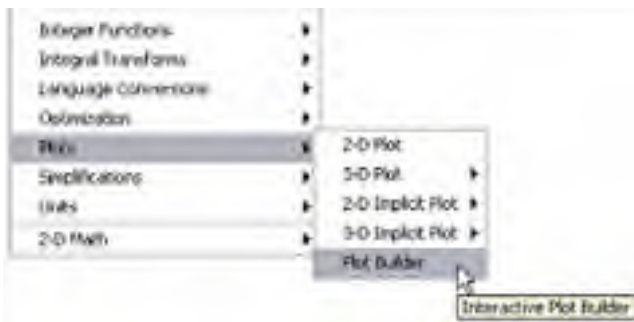


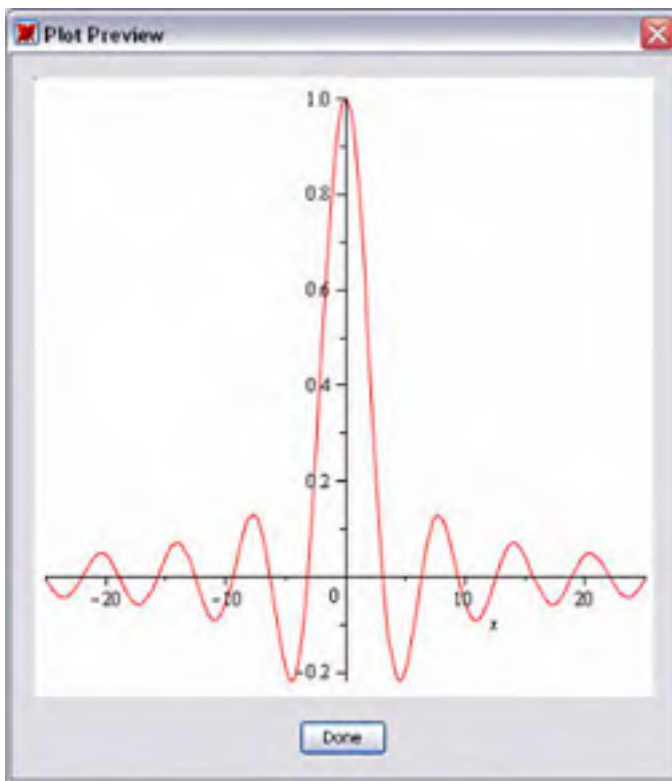
Figure 2.6: Using Context Menus to launch the Plot Builder

5. From the **Select Plot Type** dialog, you can edit or add functions, select a plot type, change the x -axis range, or even preview the plot with the current default settings. With 2-D Plot selected, change the x -axis range to span from **-25** to **25**.

Change the plot options:

6. To edit the plot options, click **Options**. The **2-D Plot (plot)** dialog displays. Refer to *2-D Plot Options Available in the Plot Builder (page 27)* for more information on each plot option available in this dialog.

7. Before we change any options, click **Preview** to display the plot with the current default options. Use this feature after applying each plot option described in the following steps to see how the curve has changed.

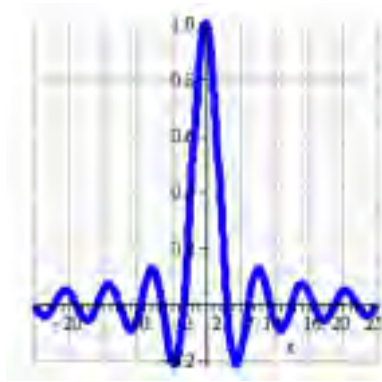


8. Click **Done** to return to the **2-D Plot (plot)** dialog.
7. To change the thickness of the line, from the **Line** region, select **thick** from the right drop-down menu.
10. To change the color of the expression, from the **Color** region, select **Blue** from the drop down menu. Notice that the color swatch below the drop-down menu now shows blue.
11. To alter the axes settings, in the **Axes** region, click **Advanced Settings**.
12. In the x -axis row, select **50** from the **Gridlines** drop-down menu. In the **Major Gridlines** drop-down menu, select **5**. In the second row, select **10** from the **Gridlines** drop-down menu and select **5** from the **Major Gridlines** drop-down menu.



13. Click **Apply** to apply this setting and return to the **2-D Plot (plot)** dialog.
14. To close the Plot Builder and return the plot to the document, in the **2-D Plot (plot)** dialog, click **Plot**.

$$\frac{\sin(x)}{x} \rightarrow$$



2-D Plot Options Available in the Plot Builder

Table 2.1: 2-D Plot Options Available in the Plot Builder

Plot option	Description
expression(s)	Using the Plot Builder, you can plot multiple expressions in the same plot region. To apply different options for each line, you would select an expression from the drop-down menu and apply the line style settings. You would do this for each line. In the previous example, only one expression is available.
x -axis	To edit the x -axis range, you need to click the Back button to return to the Select Plot Type dialog. In the 2-D Plot options dialog, you can change the x -axis label and orientation of the label by altering the default entries for the x -axis row.
y -axis	To edit the y -axis range, enter a range, label, and orientation in the row beginning with Range from .
Style	Specifies the line style, one of line or point. The default setting is line .
Line	Line style and size options available when Style is set to line .
Symbol	Symbol style and size options available when Style is set to point .

Plot option	Description
Color	Select a color from the drop down menu or click Custom to select a color from the color dialog.
Axes	Select from the axes styles available, edit the style of the axes labels or apply advanced axis options such as gridlines by clicking Advanced Settings .
View	Constrained or non-constrained view. The default setting is non-constrained .
Title	Adds a title to the plot and allows you to alter the font style.
Caption	Adds a legend to the plot and allows you to alter the font style.
Resolution	Sets the horizontal display resolution of the device in pixels. The default is 200 .
Adaptive Plotting	When plotting a function over an interval, the interval is sampled at a number of points, controlled by sample and numpoints. Adaptive plotting, where necessary, subdivides these intervals to attempt to get a better representation of the function.
Find Discontinuities	Determines the discontinuities of the input and then breaks the horizontal axis into appropriate intervals where the expression is either continuous or contains only removable discontinuities.
Number of Points	Specifies the minimum number of points to be generated. The default is 50 .
Fill to x-axis	Fills the region between the curve and the x -axis.
Coordinate System	Select from the coordinate systems available.

Descriptions of Assistants

The remaining Assistants are described below. Some of the Assistants are interfaces to package commands. For more information on package commands, see *Package Commands* (page 45).

- **Back-Solver** - an interface that allows you to take a mathematical formula, involving multiple parameters, enter values for all but one of the

parameters and solve for the remaining value. You can also plot the behaviour of the formula as one of the parameters change.

- **Curve Fitting** - an interface to commands in the **CurveFitting** package. Data points can be entered as independent and dependent values, and interpolated with polynomials, rational functions, or splines.
- **Data Analysis** - an interface to the data analysis commands in the **Statistics** package.
- **Import Data** - an interface to read data from an external file into Maple.
- **Installer Builder** - an interface to the **InstallerBuilder** package in which you can create installers for your Maple toolboxes. For information on toolboxes, go to <http://www.maplesoft.com/developers/index.aspx>.
- **Library Browser** - an interface to manipulate the libraries in a specified directory.
- **Maplet Builder** - an interface to the **Maplets** package. The **Maplets** package contains commands for creating and displaying Maplet applications (point-and-click interfaces). Using the Maplet Builder, you can define the layout of a Maplet, drag-and-drop elements (visual and functional components of Maplets), set actions associated with elements, and directly run a Maplet application. The Maplet Builder is available in the Standard interface only.
- **ODE Analyzer** - an interface to obtain numeric or symbolic solutions to a single ODE or a system of ODEs and plot a solution of the result.
- **Optimization** - an interface to the solver commands in the **Optimization** package. The **Optimization** package is a collection of commands for numerically solving optimization problems, which involves finding the minimum or maximum of an objective function possibly subject to constraints.
- **Plot Builder** - an interface for creating two and three-dimensional plots, animations, and interactive plots.
- **Scientific Constants** - an interface to over 20 000 values of physical constants and properties of chemical elements. All of these constants

come with the corresponding unit and, if applicable, with the uncertainty or error, that is, how precisely the value of this constant is known.

- **Special Functions** - an interface to the properties of over 200 special functions, including the Hypergeometric, Bessel, Mathieu, Heun and Legendre families of functions.
- **Units Calculator** - an interface to convert between 500 units of measurement.

2.2 Tutors

Maple provides over 40 interactive tutors to aid in the learning of

- Precalculus
- Calculus
- Multivariate Calculus
- Vector Calculus
- Differential Equations
- Linear Algebra

These tutors are easily accessible by selecting **Tools** → **Tutors**. See Figure 2.7.

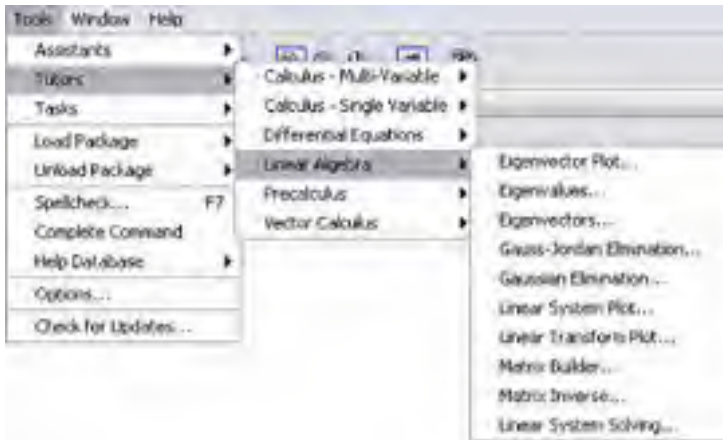


Figure 2.7: Accessing Tutors from the Tools Menu

Some of the tutors are also accessed through the **Student** package. The Differential Equations tutor, **DE Plots**, is accessible through the **DEtools** package. For a definition of the term *package*, see *Package Commands* (page 45).

The **Student** package is a collection of subpackages designed to assist with the teaching and learning of standard undergraduate mathematics. The subpackages contain many commands for displaying functions, computations, and theorems in various ways, and support for stepping through important computations.

- The **visualization** commands are tools that create plots and animations showing the geometric interpretation of important concepts.
- The **computation** commands help you to study the techniques of computation while solving problems. For example, using the **Calculus1** package, you can differentiate a function one step at a time by specifying the needed differentiation rule applied at each step. At any time during a single-step computation, you can request a hint about the next step, which you can then apply to the problem, or you can proceed directly to the final answer.

- The **interactive** commands help you explore concepts and solve problems using a point-and-click interface. These commands launch tutors that provide a graphical interface to visualization and computation commands described above. See Figure 2.8 for an example of one of the interactive commands.

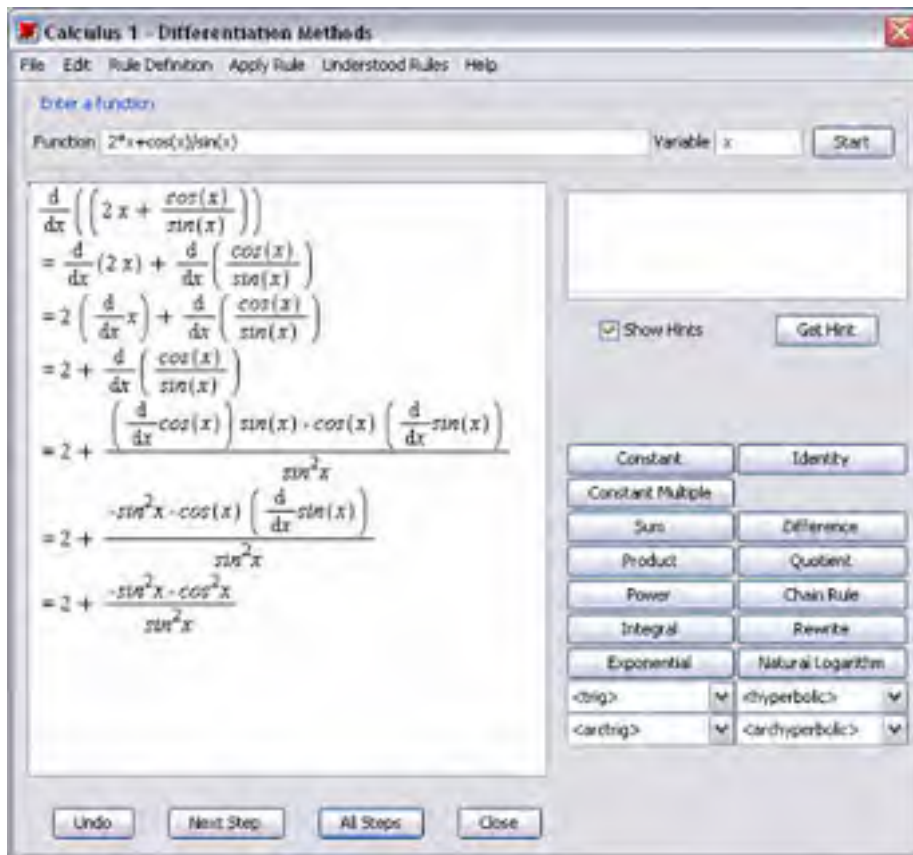


Figure 2.8: Calculus - Single Variable → Differentiation Methods Tutor

2.3 Context Menu

A context menu is a dynamically generated menu of actions that are applicable for the region upon which it is invoked. Context menus allow you to

perform calculations and manipulations on expressions without using Maple syntax. To display a context menu, right-click an object, expression, or region. Context menus are available for many input regions including:

- **expressions** to perform calculations, manipulations, or plotting
- **plot regions** to apply plot options and manipulate the plot
- **tables** to modify the table properties
- **palette regions** to add or remove palettes and palette regions
- **text regions** to add annotations and format text
- **spreadsheets** to manipulate the spreadsheet

When performing calculations or manipulations on an expression, a self-documenting arrow or equal sign connects the input and output indicating the action that took place. See Figure 2.9 and 2.10 for two examples of context menus.



Figure 2.9: Right-click the expression to see a menu of applicable options.

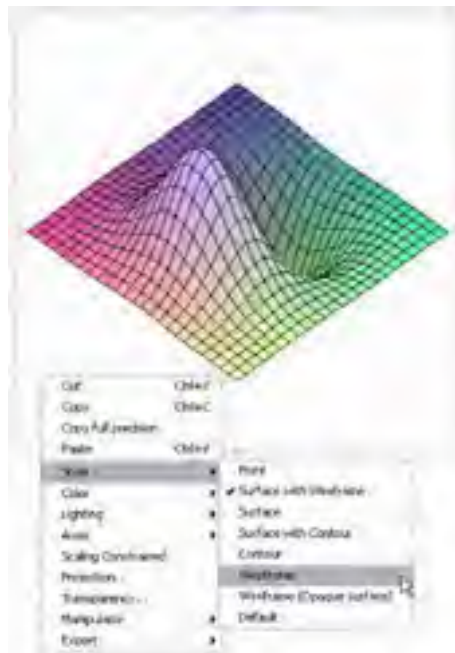


Figure 2.10: Right-click the plot to see a menu of plot options.

2.4 Task Templates

Task templates help you perform specific tasks in Maple, such as:

- performing a mathematical computation such as solving an equation symbolically or numerically, or determining the Taylor approximation of a function of one variable
- constructing a Maple object such as a function
- creating a document such as an application

Each task contains a description along with a collection of content that you can directly insert into your document. Content consists of 2-D mathematics,

commands, embedded components (for example, buttons) and plots. You need to specify the parameters of your problem and then run the document. See Figure 2.11 for an example of a Task Template.



Figure 2.11 Browse Tasks Dialog

Previewing Tasks

To preview Maple tasks,

- From the **Tools** menu, select **Tasks**, and then **Browse**. The **Browse Tasks** dialog opens and displays the list of tasks.

The tasks are sorted by subject to help you quickly find the desired task. In the **Browse Tasks** dialog, you can view tasks without inserting them into your document.

Inserting a Task into the Document

To insert a task into your document,

1. Select the **Insert into New Worksheet** check box to insert the task into a new document.
2. Click **Insert Default Content** or **Insert Minimal Content**.
 - Default content includes the task title and description.
 - Minimal content inserts only the major components (commands and buttons).

Note: You can view the history of previously inserted tasks. From the **Tools** menu, select **Tasks**. Previously selected task names are displayed below the **Browse** menu item.

Before inserting a task, Maple checks whether the task variables have assigned values in your document. If any task variable is assigned, the **Task Variables** dialog opens to allow you to modify the names. Maple uses the edited variable names for all variable instances in the inserted task.

By default, the **Task Variables** dialog is displayed only if there is a naming conflict. You can set it to display every time you insert a task.

To specify that the Task Variables dialog be displayed every time you insert a task:

1. From the **Tools** menu, select **Options**.
2. Click the **Display** tab.
3. In the **Show task variables on insert** drop-down list, select **Always**.
4. Click **Apply to Session**, or **Apply Globally**, as necessary.

Updating Parameters and Running the Commands



In inserted Task Templates, parameters are marked as placeholders or specified using sliders or other embedded components. Update the parameter values as required.

Note: To navigate between placeholders in the document, press the **Tab** key.

After updating any parameters, execute the commands or click the buttons.

2.5 Palettes

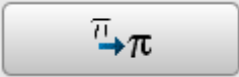
The Maple document environment provides access to over 20 palettes. Palettes are collections of related items that you can insert by clicking or drag-and-dropping into a document. Palettes contain:

- Symbols such as π , ∞ , and ∇
- Layouts such as an item with a superscript  and subscript 
- Mathematical operations such as a definite integral with placeholders for the integrand, variable of integration, and endpoints of the interval

of integration 

You can create a **Favorites** palette of the expressions and entities you use often by right-clicking (**Control**-click for Macintosh) the palette template you want to add and selecting **Add To Favourites Palette** from the context menu.

The **Handwriting** palette provides another way to find and insert desired symbols easily. Draw the symbol with your mouse in the space provided

and then click . Maple matches your input against symbols available in the system. See Figure 2.12.

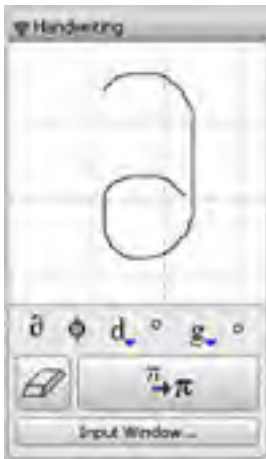


Figure 2.12: Handwriting Palette

By default, palettes display in palette docks at the right and left sides of the Maple window. To view and manage palettes and palette docks, see Table 2.2.

Table 2.2: Managing Palettes

To view palette docks:

From the **View** menu, select **Palettes**, and then **Expand Docks**.

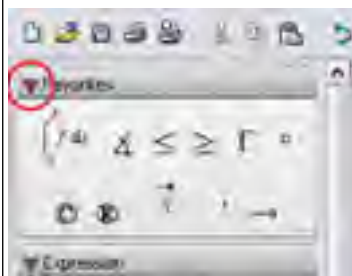


To add a palette:

1. Right-click the palette dock. Maple displays a context menu near the palette.
2. From the context menu, select **Show Palette** and then select the palette.

**To expand a palette in a palette dock:**

Click the triangle at the left of the palette title.



To move a palette in a palette dock:

Move the palette by clicking the title and dragging the palette to the new location.

**To expand/collapse the palette docks:**

Select the appropriate triangle at the top right or top left side of the palette region.

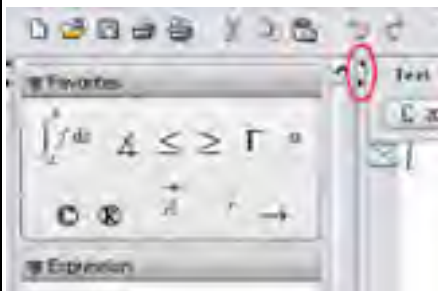












Table 2.3: Palette Categories

Palette Category	Palette Description
<p data-bbox="244 303 467 331">Expression Palettes</p> 	<p data-bbox="526 303 1188 331">Expression - a palette for constructing expressions such as in-</p> <p data-bbox="526 338 696 419">tegrals .</p> <p data-bbox="526 426 1188 525">Matrix - a palette allowing you to enter the number of rows and columns required, designate type, such as zero-filled, and designate shape, such as diagonal.</p> <p data-bbox="526 532 1188 596">Layout - a palette that allows you to add math content that has specific layout, such as expressions with one or more super-</p> <p data-bbox="526 603 817 649">scripts and subscripts .</p> <p data-bbox="526 656 1188 832">Components - a palette that allows you to embed graphical interface components such as a button into your document or worksheet. Components can be programmed to perform an action when selected such as executing a command when clicking a button .</p> <p data-bbox="526 839 1188 903">Handwriting - a palette that provides an easy way to find a desired symbol.</p> <p data-bbox="526 910 1188 991">Units (SI) - a palette that inserts a unit from the International System of Units (SI), or any general unit .</p> <p data-bbox="526 998 1188 1079">Units (FPS) - a palette that inserts a unit from the Foot-Pound-Second System (FPS), or any general unit .</p> <p data-bbox="526 1086 1188 1167">Accents - a palette that allows you to insert decorated names such as an  with an arrow over it to denote a vector .</p> <p data-bbox="526 1174 1188 1238">Favorites - an empty palette where you can add templates that you use most often from other palettes.</p>

Palette Category	Palette Description
<p data-bbox="149 248 420 284">Mathematical Palettes</p> 	<p data-bbox="428 248 1091 275">Palettes for constructing expressions</p> <p data-bbox="428 292 1091 328">Common Symbols, Relational \geq, Relational Round \gtrsim, Operators \div, Large Operators \int, Negated \neq, Fenced \ll, Arrows \nrightarrow, Constants and Symbols ∞. Punctuation - a palette of punctuation symbols such as the registered trademark symbols ® for inserting into text regions Miscellaneous - a palette of miscellaneous math and other symbols outside the above categories \square.</p>
<p data-bbox="149 839 420 874">Alphabetical Palettes</p> 	<p data-bbox="428 839 1091 963">Greek, Script \mathcal{A}, Fraktur \mathfrak{H}, Open Face \mathbb{C}, Cyrillic \mathcal{K}, Diacritical Marks ˆ, Roman Extended Upper Case \mathbb{A}, Roman Extended Lower Case \mathbb{a}.</p>

3 Commands

Even though Maple comes with many features to solve problems and manipulate results without entering any commands, you may find that you prefer greater control and flexibility by using the set of commands and programming language that Maple offers.

In this chapter:

The Maple Library	Explains the structure of the commands in the Maple system and provides resources for learning Maple commands.
Entering Commands	Provides examples of entering top-level commands and package commands, and explains the benefits of using equation labels and command completion.
Accessing Help with Commands and Packages	Explains one of the main resources available when learning Maple commands.
Viewing Maple Code in Document Mode	Explains how to view the Maple code hidden in Document blocks.
Document Mode versus Worksheet Mode	Explains the Worksheet mode and how it differs from Document mode.
Math Mode versus Text Mode	Compares Math mode and Text mode forms of entering information in Maple.
Maple Toolbar Options	Describes the Maple toolbar options.
Top Packages and Commands	Provides a list of the top packages and commands in Maple.

3.1 The Maple Library

Commands are contained in the Maple library, which is divided into two groups: the *main library* and *packages*.

- The main library contains the most frequently used Maple commands.
- Packages contain related commands for performing tasks from disciplines such as Student Calculus, Statistics, or General Relativity Theory. For example, the **Optimization** package contains commands for numerically solving optimization problems.

3.2 Entering Commands

If you want to interact with Maple using commands, simply enter the command using 2-D math. You will notice that commands and variable names display in italics. Maple commands are constructed in a format similar to *command(arguments)* based on the command you are using.

To factor an expression, enter:

```
factor( $x^2 + 2x + 1$ )
```

```
(x + 1)2
```

To differentiate an expression, enter:

```
diff(sin(x), x)
```

```
cos(x)
```

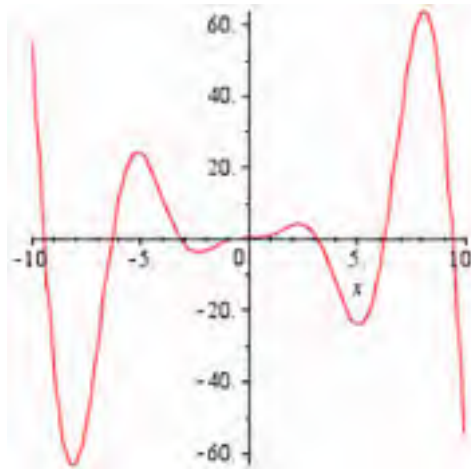
To integrate an expression in the range $[0, 2\pi]$, enter:

```
int(2x + cos(x), x = 0 .. 2π)
```

$4\pi^2$

To plot an expression, enter:

```
plot(sin(x) x^2, x = -10 .. 10)
```



For a list of the top commands in Maple, see *Top Commands and Packages* (page 61).

Package Commands

There are two ways to access commands within a package, using the long form of the package command or the short form.

Long Form of Accessing Package Commands

The long form specifies both the package and command names using the syntax `package[command](arguments)`.

```
LinearAlgebra[RandomMatrix](2)
```

```
[ 44 -31 ]  
[ 92  67 ]
```

Short Form of Accessing Package Commands

The short form loads all of the commands in the package using the **with** command, *with(package)*. If you are using a number of commands in a package, loading the entire package is recommended. Using the **with** command, a list of all commands in the package displays. To suppress the display of all command names, end the *with(package)* command with a colon. Alternatively, you can load packages through **Tools** → **Load Package**.

```
with(Optimization)
```

```
[ImportMPS, Interactive, LPSolve, LSSolve, Maximize, Minimize, NLPsolve,  
QPSolve]
```

After loading a package, you can use the short-form names, that is, the command names, without the package name.

```
LSSolve([x - 2, x - 6, x - 9])
```

```
[12.3333333333333322, [x = 5.66666666666666696]]
```

For a list of the top packages in Maple, see *Top Commands and Packages* (page 61).

Command Completion

To help with syntax and reduce the amount of typing when entering Maple commands, you can use *command completion*. Command completion displays a list of all Maple packages, commands, and functions that match the entered text.

To use command completion:

1. Begin entering a command or package name.
2. Select **Tools** → **Complete Command** or use short cut keys:
 - **Ctrl + Space** or **Esc**, Windows
 - **Command + Shift + Space** or **Esc**, Macintosh
 - **Ctrl + Shift + Space** or **Esc**, UNIX

If there is a unique completion, it is inserted. Otherwise, a list of matches is displayed.

3. Select the correct completion from the list.

**Equation Labels**

Equation labels help to save time entering expressions by referencing Maple output. The label is associated with all output within an execution group. See Figure 3.1 and 3.2. You cannot apply equation labels to the following:

- Error, warning, and information messages
- Tables, images, plots, sketches, or spreadsheets

By default, equation labels are displayed. If equation labels are not displayed,

1. From the **Tools** menu, select **Options**, and click the **Display** tab. Ensure that the **Show equation labels** check box is selected.
2. From the **Format** menu, select **Labels**. Ensure that **Execution Group** is selected.



Figure 3.1: Inserting an Equation Label

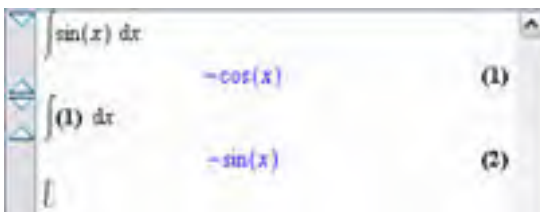


Figure 3.2: Equation Label

To apply equation labels:

1. Enter an expression and press **Enter**. Note that the equation label is displayed to the right of the answer in the document.
2. In a new execution group, enter another expression that will reference the output of the previous execution group.
3. From the **Insert** menu, select **Label**. Alternatively, press **Ctrl+L** (**Command+L**, for Macintosh) to open the **Insert Label** dialog. Enter the label number in the **Insert Label** dialog and click **OK**. The item is now a label.
4. Press **Enter** to obtain the result.

To change the format of equation labels:

- Select **Format** → **Labels** → **Label Display**. In the **Format Labels** dialog, select one of the numbering schemes.
- Optionally, enter an appropriate numbering prefix.



Figure 3.3: Format Labels Dialog: Adding a Prefix

The **Label Reference** menu item allows you to switch between the label name and its reference content. Place the cursor on the referenced equation label and select **Format** → **Labels** → **Label Reference**.

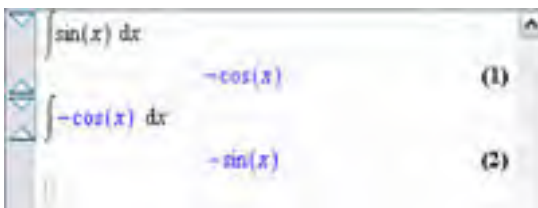



Figure 3.4: Label Reference

3.3 Accessing Help with Commands and Packages

Most command names in Maple are quite intuitive, but if you are unable to determine the command or proper syntax you need, you can search the Maple help system. The Maple help system is complete with help pages for every command available, along with tours, examples, and a mathematical dictionary. Each help page contains the correct syntax for a command: calling sequences, parameters, and description of use. See Figure 3.5. Examples and links to related subjects are provided at the bottom of each help page.

To launch the Help browser:

1. You can launch the Maple help browser in three ways:
 - From the **Help** menu in your worksheet, select **Maple Help**
 - Click  in the toolbar
 - In the document or worksheet, enter **?topicname**. For example, enter **?LinearAlgebra** and then press **Enter**.

To search the help system:

2. In the left pane, enter a search string in the text region provided.
3. By default, a topic search is performed. To perform a text search, select the **Text** radio button. For more information on topic searches, see *Using the Help Navigator* (page 67).
4. Enter the term and click **Search**.
5. The left pane is populated with matches to your search term in the **Search Results** tab. With text searches, the help page with the highest number of instances that term appears in the help page displays first followed by the second highest and so forth.

For more information on the Maple Help system, see *The Maple Help System* (page 65).

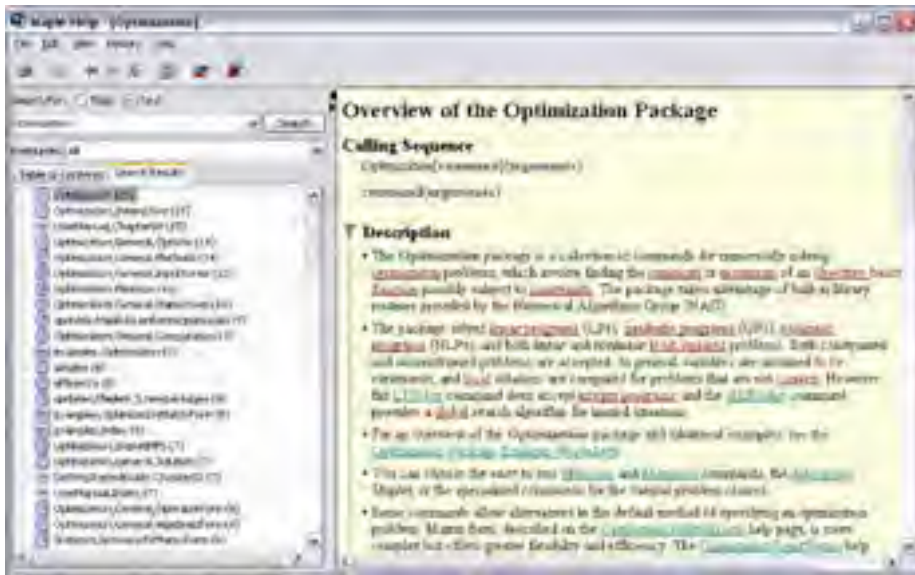


Figure 3.5: Search Results for Optimization

3.4 Viewing Maple Code in Document Mode

In Document mode, content is created as a series of document blocks. Document blocks allow you to hide the syntax used to perform calculations, which in turn lets you focus on the concept presented instead of the command used to manipulate or solve the problem. Document blocks are typically collapsed to hide the Maple code, but these regions can also be expanded to reveal this code.

Document block regions are identified using markers that are located in a vertical bar along the left pane of the document. See Figure 3.6. In addition to document block boundaries, these markers (icons) indicate the presence of hidden attributes in the document such as annotations, bookmarks, and numeric formatting.

To activate markers:

From the **View** menu, select **Markers**. See Figure 3.6.

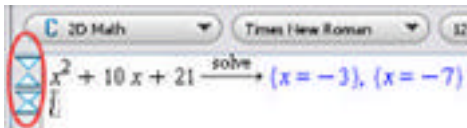


Figure 3.6: Document Block Markers

To view code in Document mode:

1. Place the cursor in a document block to be expanded.
2. From the **View** menu, select **Expand Document Block**.

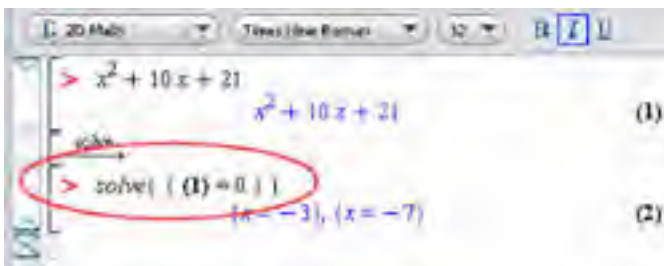



Figure 3.7: Expanded Document Block

With the Document Block expanded, you can see the Maple command that was used to perform this calculation. In Figure 3.7, the *solve* command was used.

You will also notice a red prompt (`>`) before the original expression and the *solve* command. Entering commands outside of a document block region is done at this input region. To insert an input region, click the  button in the toolbar menu.

In Figure 3.7, an equation label was used to refer to the expression. For more information, see *Equation Labels* (page 47).

To collapse a Document Block:




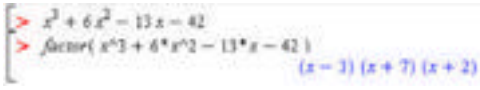
With your cursor inside the document block, select **View** → **Collapse Document Block**.

You can use this process of expanding document blocks to begin learning Maple commands.

3.5 Document Mode vs. Worksheet Mode

Worksheet Mode and Document Mode are identical in the functionality that they both offer; therefore in each mode context menus and palettes are available when entering expressions; tables, spreadsheets, and images can be inserted; and access to the complete Maple library is available. You can even insert a document block while in Worksheet mode or insert a Maple prompt while in Document Mode. The only difference between the two modes is the default input format.

Table 3.1: Worksheet Mode vs. Document Mode

Document Mode	Worksheet Mode
<p>To start a document session: From the File menu, select New, and then Document Mode.</p>	<p>To start a worksheet session: From the File menu, select New, and then Worksheet Mode.</p>
<p>Default input region is a document block.</p> 	<p>Default input region is a Maple input prompt.</p> 
<p>Syntax is hidden when using context menus.</p> 	<p>Syntax is displayed when using context menus.</p> 

Document Mode	Worksheet Mode
<p>Context menus offer an option to evaluate and display an expression inline. All other context menu options are identical when using context menus in Worksheet Mode.</p>	<p>Context menus do not offer an option to evaluate and display an expression inline. All other context menu options are identical when using context menus in Document Mode.</p>
 <p>The screenshot shows a context menu for the expression $x^3 + 6x^2 - 13x - 14$. The menu items are: Cut (Ctrl+X), Copy (Ctrl+C), Copy full expression, Paste (Ctrl+V), Evaluate and Display Inline (Ctrl+I) (circled in red), Explore, Apply a Command, Approximate, Assign to a Name, Coefficients, Collect, Combine, Complete Square, Differentiate, Evaluate at a Point, Factor, Integrate, Limit, Sequence, Series, Simplify, Solve, Complex Maps, Constructions, Conversions, Integer Functions, Integral Transforms, Language Conversions, Optimization, Plots, Sorts, Units, and 2-D Math.</p>	 <p>The screenshot shows a context menu for the expression $x^3 + 6x^2 - 13x - 14$. The menu items are: Cut (Ctrl+X), Copy (Ctrl+C), Copy full expression, Paste (Ctrl+V), Explore, Apply a Command, Approximate, Assign to a Name, Coefficients, Collect, Combine, Complete Square, Differentiate, Evaluate at a Point, Factor, Integrate, Limit, Sequence, Series, Simplify, Solve, Complex Maps, Constructions, Conversions, Integer Functions, Integral Transforms, Language Conversions, Optimization, Plots, Sorts, Units, and 2-D Math.</p>

3.6 Math Mode vs. Text Mode

The default mode of entry in Document or Worksheet mode is Math Mode which displays input in 2-D Math. In earlier releases of Maple, commands and expressions were entered using Maple Input or 1-D Math.

Important: With Maple Input, you must terminate commands with a semi-colon or colon.

> **cos(alpha)^2+sin(alpha)^2;**

$$\cos(\alpha)^2 + \sin(\alpha)^2$$

> **a*int(exp(sqrt(2)*x),x);**

$$\frac{1}{2} a \sqrt{2} e^{\sqrt{2} x}$$

> **limit(f(x),x=infinity);**

$$\lim_{x \rightarrow \infty} f(x)$$

> **sum(a[k]*x^k, k=0..m)=product(b[j]*x^j, j=0..n);**

$$\sum_{k=0}^m a_k x^k = \prod_{j=0}^n (b_j x^j)$$

To enter input using Maple Input mode, insert a Maple prompt by clicking

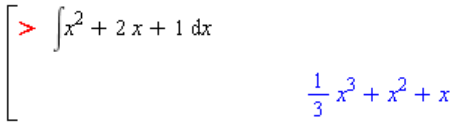
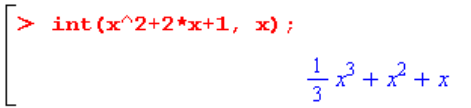



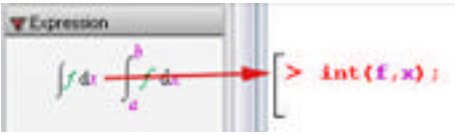


in the toolbar and then click the **Text** button in the toolbar,

Text



Table 3.2: Math Mode vs. Text Mode

Math Mode	Text Mode*
<p><i>Maple's default setting.</i> Executable standard math notation. This is also referred to as 2-D Math Input.</p> 	<p>Executable Maple notation. This is also referred to as 1-D Math Input or Maple Input.</p> 
Access from the Insert → 2-D Math menu.	Access from the Insert → Maple Input menu.
When using 2-D Math, the Math mode icon is highlighted in the toolbar. 	When entering Maple Input or text in a text region, the Text mode icon is highlighted in the toolbar. 
To convert a 2-D Math expression to 1-D Math, right-click the expression (Command-click for Macintosh) and select 2-D Math → Convert To → 1-D Math Input .	To convert a 1-D Math expression to 2-D Math, right-click the expression (Command-click for Macintosh) and select Convert To → 2-D Math Input .
No termination symbol is required.	All input must end with a semi-colon (;) or a colon (:).
<p>If you are a new Maple user, palettes make entering expressions in familiar notation easier than entering foreign syntax and reduces the possibility of introducing typing errors.</p> 	<p>Using palettes while in 1-D Math teaches you the related Maple command syntax.</p> 

* In a Document Block, Text Mode displays regular text.

If you prefer 1-D Math input, you can change the default math input notation.

To change math input notation for a session or globally across all documents:







1. From the **Tools** menu, select **Options**. The **Options Dialog** opens.
2. Click the **Display** tab.
3. In the **Input Display** drop-down list, select **Maple Notation**.
4. Click the **Apply to Session** or **Apply Globally** button.




Important: The new input display becomes the default setting *after* selecting the Enter key.

3.7 Maple Toolbar Options

The Maple toolbar offers several buttons to assist you when interacting with Maple. See Table 3.3.




Table 3.3: Maple Toolbar Options

Basic Usage	Icon	Equivalent Menu Option or Command
Insert Plain Text after the current execution group.		From the Insert menu, select Text .
Insert Maple Input after the current execution group.		From the Insert menu, select Execution Group and then After Cursor .
Enclose the selection in a subsection.		From the Format menu, select Indent .
Remove any section enclosing the selection.		From the Format menu, select Outdent .
Executes all commands in the worksheet or document		From the Edit menu, select Execute and then Worksheet .
Executes a selected area.		From the Edit menu, select Execute and then Selection .

Basic Usage	Icon	Equivalent Menu Option or Command
Causes Maple to clear its internal memory.		Enter <i>restart</i> .
Adjusts the display size of document content. Note: plots, spreadsheets, images, and sketches remain unchanged.		From the View menu, select Zoom Factor and then a zoom size.
Opens the Maple help system.		From the Help menu, select Maple Help .

For 1-D Math and text regions, the Tab icon in the toolbar allows you to set the **Tab** key to move between placeholders or to indent text.

Table 3.4: Tab Icon Description

Tab Icon	Description
	Tab icon off . Allows you to move between placeholders using the Tab key.
	Tab icon on . Allows you to indent in the worksheet using the Tab key.
	The Tab icon is disabled when using 2-D Math (Math mode), and as such, the Tab key allows you to move between placeholders.

Toolbar icons are controlled by the location of the cursor in the document. For example, place the cursor at an input region and the **Text** and **Math** icons are accessible while the others are greyed out. See Table 3.5 for a list of the tools available in each icon.

Table 3.5: Toolbar Icons and their Tools

Toolbar Icon Options	
Text tools	
Math tools	
Drawing tools	
Plot tools	
Animation tools	

Table 3.6: Toolbar Icon Availability

Region	Available Tools
Input region	Text and Math icons
Plot region	Drawing and Plot icons
Animation region	Drawing, Plot, and Animation icons
Canvas and Image regions	Drawing icon

The **Text** and **Math** icons allow you to enter text and math in the same line by choosing the appropriate input style at each stage when entering the sentence.

The derivative of $\sin(x)$ is $\cos(x)$

Using the tools available in these icons, you can customize the input style of the text and 2-D Math. For the **Text** and **Math** icons, the icon that is selected remains in that state until prompted otherwise; therefore if the **Text** icon is selected and you press the **Enter** key, the new input region remains a Text region.

The **Text** and **Math** icons differ while at a Maple input prompt. The Math icon displays input as 2-D Math, whereas the Text icon displays Maple input.

> $\frac{x^2}{2}$

> $x^2/2;$

To access the tools available in the **Plot** and **Drawing** icons, click a plot region. The tools available in these icons allow you to manipulate the plot or draw shapes and enter text on the plot region. By clicking an animation region, you have the same features available for a plot region, in addition to tools for playing the animation in the **Animation** icon.

For the remaining icons, hover the mouse over the icon to display the icon description.

3.8 Top Commands and Packages

After you have reviewed the contents of the first few chapters, you can scan the top Maple commands and packages (topics).

Table 3.7: Top Commands

Command Name	Description
plot and plot3d	Create a two-dimensional and three-dimensional plot of functions.
solve	Solve one or more equations or inequalities for their unknowns.
fsolve	Solve one or more equations using floating-point arithmetic.
eval	Evaluate an expression at a given point.
evalf	Numerically evaluate expressions.
dsolve	Solve ordinary differential equations (ODEs).
int	Compute an indefinite or definite integral.
diff	Compute an ordinary or partial derivative, as the context dictates.
limit	Calculate the limiting value of a function.
sum	For symbolic summation. It is used to compute a closed form for an indefinite or definite sum.
assume/is	Set variable properties and relationships between variables. Similar functionality is provided by the assuming command.
assuming	Compute the value of an expression under assumptions.
simplify	Apply simplification rules to an expression.
expand	Distribute products over sums.
normal	Normalize a rational expression.
convert	Convert an expression to a different type or form.
type	Type-checking command. In many contexts, it is not necessary to know the exact value of an expression; it suffices to know that an expression belongs to a broad class, or group, of expressions that share some common properties. These classes or groups are known as <i>types</i> .

Command Name	Description
series	Generalized series expansion.
map	Apply a procedure to each operand of an expression.

A complete list of top-level commands is available at **Help** → **Manuals, Dictionary, and more** → **List of Commands**.

Table 3.8: Top Packages

Package Name	Description
CodeGeneration	The CodeGeneration package is a collection of commands and subpackages that enable the translation of Maple code to other programming languages, such as C, Fortran, MATLAB [®] , Visual Basic, and Java [™] .
LinearAlgebra	The LinearAlgebra package contains commands to construct and manipulate Matrices and Vectors, and solve linear algebra problems. LinearAlgebra routines operate on three principal data structures: Matrices, Vectors, and scalars.
Optimization	The Optimization package is a collection of commands for numerically solving optimization problems, which involve finding the minimum or maximum of an objective function possibly subject to constraints.
Physics	The Physics package implements computational representations and related operations for most of the objects used in mathematical physics computations.
RealDomain	The RealDomain package provides an environment in which Maple assumes that the basic underlying number system is the field of real numbers instead of the complex number field.
ScientificConstants	The ScientificConstants package provides access to the values of various physical constants, for example, the velocity of light and the atomic weight of sodium. This package provides the units for each of the constant values, allowing for greater understanding of an equation. The package also provides units-matching for error checking of the solution.

Package Name	Description
ScientificErrorAnalysis	The ScientificErrorAnalysis package provides representation and construction of numerical quantities that have a central value and an associated uncertainty (or error), which is a measure of the degree of precision to which the quantity's value is known. Various first-order calculations of error analysis can be performed with these quantities.
Statistics	The Statistics package is a collection of tools for mathematical statistics and data analysis. The package supports a wide range of common statistical tasks such as quantitative and graphical data analysis, simulation, and curve fitting.
Student	<p>The Student package is a collection of subpackages designed to assist with teaching and learning standard undergraduate mathematics. The many commands display functions, computations, and theorems in various ways, including stepping through important computations.</p> <p>The Student package contains the following subpackages:</p> <ul style="list-style-type: none"> • Calculus1 - single-variable calculus • LinearAlgebra - linear algebra • MultivariateCalculus - multivariate calculus • Precalculus - precalculus • VectorCalculus - multivariate vector calculus
Units	The Units package contains commands for unit conversion and provides environments for performing calculations with units. It accepts approximately 300 distinct unit names (for example, meters and grams) and over 550 units with various contexts (for example, standard miles and U.S. survey miles). Maple also contains two Units palettes that allow you to enter the unit for an expression quickly.

Package Name	Description
VectorCalculus	The VectorCalculus package is a collection of commands that perform multivariate and vector calculus operations. A large set of predefined orthogonal coordinate systems is available. All computations in the package can be performed in any of these coordinate systems. It contains a facility for adding a custom but orthogonal coordinate system and using that new coordinate system for your computations.

A complete list of packages is available in the Maple help system at **Help** → **Manuals, Dictionary, and more** → **List of Packages**.

For detailed information about features you have reviewed in this book, and other advanced features, refer to the *Maple User Manual*.

To access the Maple User Manual:

1. From the **Help** menu, select **Manuals, Dictionary, and more**.
2. Select **Manuals**, and then **User Manual**.

4 The Maple Help System


The Maple program provides a custom help system consisting of almost 5000 reference pages. The help system is a convenient resource for determining the syntax of Maple commands and for learning about Maple features.

In this chapter:

Accessing the Help System	Describes the different ways you can access the Maple help system.
Using the Help Navigator	Explains the types of searches available in Maple help system.
Viewing Help Pages as Worksheets	Explains how to open a help page as a worksheet.
Copying Examples	Explains how to copy examples to a Maple worksheet.

4.1 Accessing the Help System

To access the Maple help system:

- From the **Help** menu, select **Maple Help**
- Click  in the toolbar
- In the document, enter **?topic**, i.e. enter **?LinearAlgebra** and press **Enter**

The Maple help system opens in a separate window with two panes. The left pane contains the Help Navigator where you initiate searches and the right pane displays the final search result, such as a specific help page.

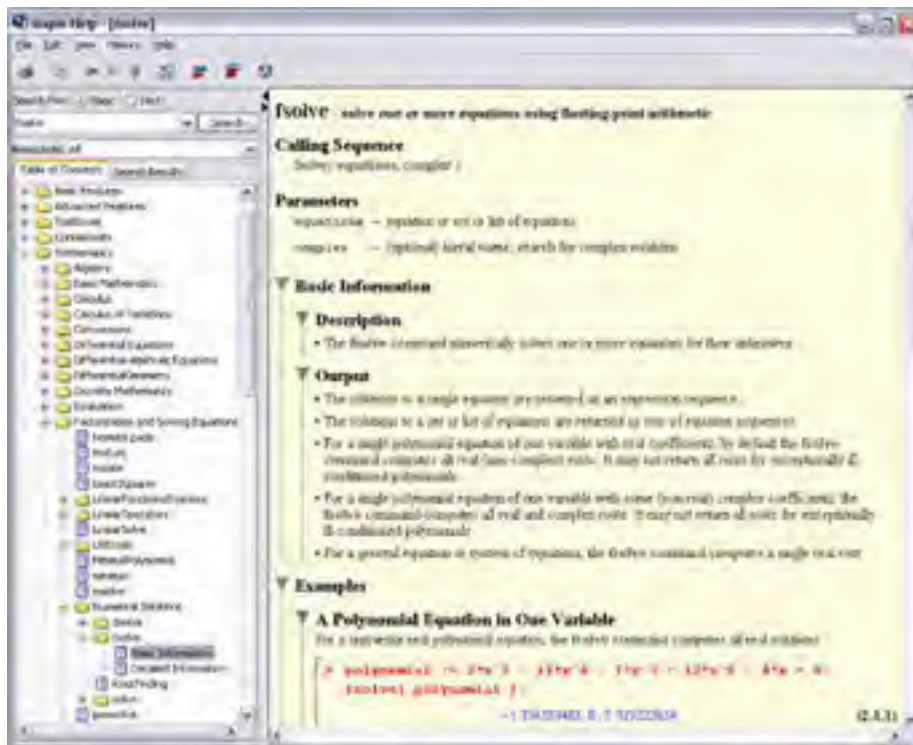


Figure 4.1: Example Help Page

Every help page in Maple lists the command's calling sequence, parameters, a description, and examples of the command at the end of the page. Some help pages also contain hyperlinks to related help pages and hyperlinks to dictionary definitions. Hyperlinks to help pages display in green while hyperlinks to dictionary definitions display in rust.

4.2 Using the Help Navigator




The Help Navigator contains a field for topic or text-based searches.




- **Topic** searches reveal a list of matching topics sorted by exactness of match.
- **Text** searches reveal a list of topics based on keyword frequency.
- You can search all of the help system or specific Resources such as Help Pages, Tasks, definitions in the Math and Engineering Dictionary, Tutorials, and Manuals by selecting the **Resources** drop-down menu.
- Search results are displayed as a list in the **Search Results** tab of the left pane. Click the **Table of Contents** tab to view a structured list of all topics in the help system.

Help System Table of Contents

The **Table of Contents** tab provides a structured list of all topics in the help system.

To display potential matches in the right pane, click a topic preceded by an icon.

	A folder icon in the Table of Contents tab indicates that a topic can be expanded into subtopics.
	Question mark icon indicates a help page and displays the associated help page in the right pane when selected.
	WS icon indicates an example worksheet. Example worksheets open in a new tab in the Maple document.

	D icon indicates a definition and displays the associated dictionary definition in the right pane when selected.
	T icon indicates a Task template and displays the associated Task Template in the right pane when selected.
	M icon indicates a manual. Manuals open in a new tab in the Maple document.


4.3 Viewing Help Pages as Documents

In help pages, examples are not executable.

The Maple help system allows you to open help pages as documents that you can execute.

To open a help page as a document or worksheet:

- With the help page displayed in the right pane of the help system, from the **View** menu, select **Open Page as Worksheet**. A new worksheet window opens.

	Alternatively, in the help system toolbar, click the <i>open current help page in a worksheet window</i> icon.
---	--

4.4 Copying Examples

Instead of opening the entire page as a document, you can copy the **Examples** section only.

To copy examples:

1. With the help page displayed in the right pane of the help system, from the **Edit** menu, select **Copy Examples**.
2. Close or minimize the Help Navigator and return to your document.

3. In your document, place the cursor at the location where the examples are to be pasted.
4. From the **Edit** menu, select **Paste**. The **Examples** section of the help page is now executable content in your document.

5 Using Maple

Maple is a powerful application with many resources to guide you and assist you in solving problems of different types.

In this chapter:

Clickable Math in Maple	Provides steps to solving various problems using some of the different methods available in Maple.
Calculus Examples	Provides two word problems and illustrates the various resources available to solve these problems.

5.1 Clickable Math in Maple

As we have seen, Maple has incorporated several features that eliminate the learning curve for new users. With drag-and-drop functionality, context-sensitive menus, built-in tutors, command completion, and over 20 palettes, using Maple has never been so easy. This chapter is designed to show several of the ways to solve the same problem in Maple. Recall the keyboard keys for the different operating systems mentioned in *Invoking Context Menus*, *Command Completion*, and *Copy & Drag* (page xiii).

Example 1 - Graph a function and its derivatives

On $[-\pi, \pi]$, graph f , f' , and f'' if $f(x) = x \cos(x)$.

Solution by Context Menus

1. Enter the expression $x \cos(x)$.

Make a copy of the expression and calculate the derivative:

2. Insert a new document block region by selecting from the **Format** menu **Create Document Block**.
3. Highlight the original expression. **Ctrl** + drag the expression to the new document block.
4. Right-click the expression and select **Differentiate** \rightarrow **x**.

Make a copy of the derivative and calculate the second derivative:

5. Insert a new document block. Highlight the derivative of the expression. **Ctrl** + drag the expression to a new document block.
6. Right-click the derivative and select **Differentiate** \rightarrow **x**.

Result:

$$\begin{array}{l}
 x \cos(x) \\
 x \cos(x) \xrightarrow{\text{differentiate w.r.t. } x} \cos(x) - x \sin(x) \\
 \cos(x) - x \sin(x) \xrightarrow{\text{differentiate w.r.t. } x} -2 \sin(x) - x \cos(x)
 \end{array}$$




Plot the expression:

7. Insert a new document block. Highlight the original expression. **Ctrl** + drag the expression to the new document block.
8. Right-click the expression and select **Plots** → **Plot Builder**.
9. In the **Interactive Plot Builder : Select Plot Type** dialog, change the **x Axis** range to **-Pi .. Pi**.




Enhance the plot using context menus:**Add the first and second derivative to the plot**

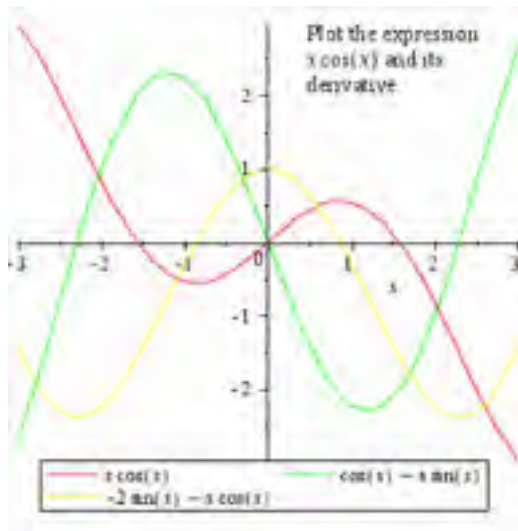
10. Highlight the derivative of the expression. **Ctrl** + drag the expression on to the plot region. Do the same for the second derivative. Note: You can also drag a curve off of the plot region by placing the mouse over the curve, selecting it with the mouse, and dragging it off of the plot region. A new plot region with this curve displays.

Add a legend:

11. Right-click in the plot region and select **Legend** → **Show Legend**.
12. In the legend, double-click **Curve 1**. Notice that the **Text** icon is selected in the toolbar, . Delete the text and select the **Math** icon in the toolbar, . This allows you to enter 2-D Math. Enter the original expression, . Do the same for Curve 2 and Curve 3.

Add a title:

13. To enter a title, click the **Drawing** icon in the toolbar, . If the **Drawing** icon is not accessible, click the plot region. Notice that the **Plot** and **Drawing** icons are now available while the others are grayed out, .
14. Click **T** in the **Drawing** menu, .
15. Click the plot region and a text region appears. Notice that the toolbar has changed once again with the **Text** icon selected. To enter Text and 2-D Math on the same line, you will use the **Text** icon when entering text and the **Math** icon when entering 2-D Math. With the **Text** icon selected, enter **Plot the expression**. Click the **Math** icon and enter the expression. Click the **Text** icon and enter **and its derivatives**.
16. Click the text region and the border becomes highlighted. You can now reshape the text region and move it around the plot region using the mouse.

Result:`x cos(x) →`**Solution by Tutor**

The Student Calculus I package contains a tutor called Derivatives which displays a plot of the expression along with its derivatives. In this section, we will solve the same problem as previously using this tutor.

1. Load the Student Calculus I package by selecting **Tools** → **Load Package** → **Student Calculus 1**. Notice the message inserted in the Document indicating the package that was loaded.

Result:

Loading Student:-Calculus1

2. **Ctrl** + drag the expression for $f(x)$ to a blank document block region.
3. Right-click the expression and select **Tutors** → **Calculus - Single Variable** → **Derivatives**. Note: The **Tutors** menu option would not be available in the context menu had we not loaded the Student Calculus 1 package in step 1.

The **Derivatives** tutor displays a plot of the expression as well as its derivative. The color swatch shown beside the expression is the colour used for the curve in the plot region. This is the same for $f'(x)$ and $f''(x)$. See Figure 5.1.

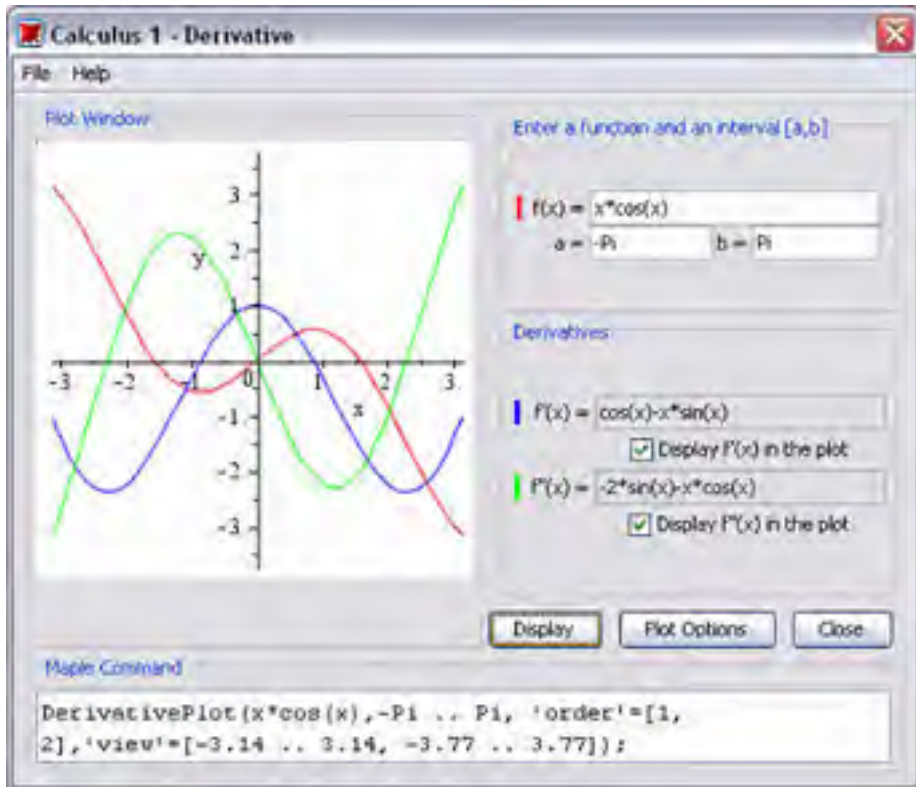


Figure 5.1: Derivative Tutor

4. Select the check box to display $f'(x)$ in the plot. Click **Display** to make this change take effect.

5. You can change the expression, ranges, or plot options from within this tutor. For each change made, click **Display**. When complete, select **Close** to display the resulting plot in the document.

Result:

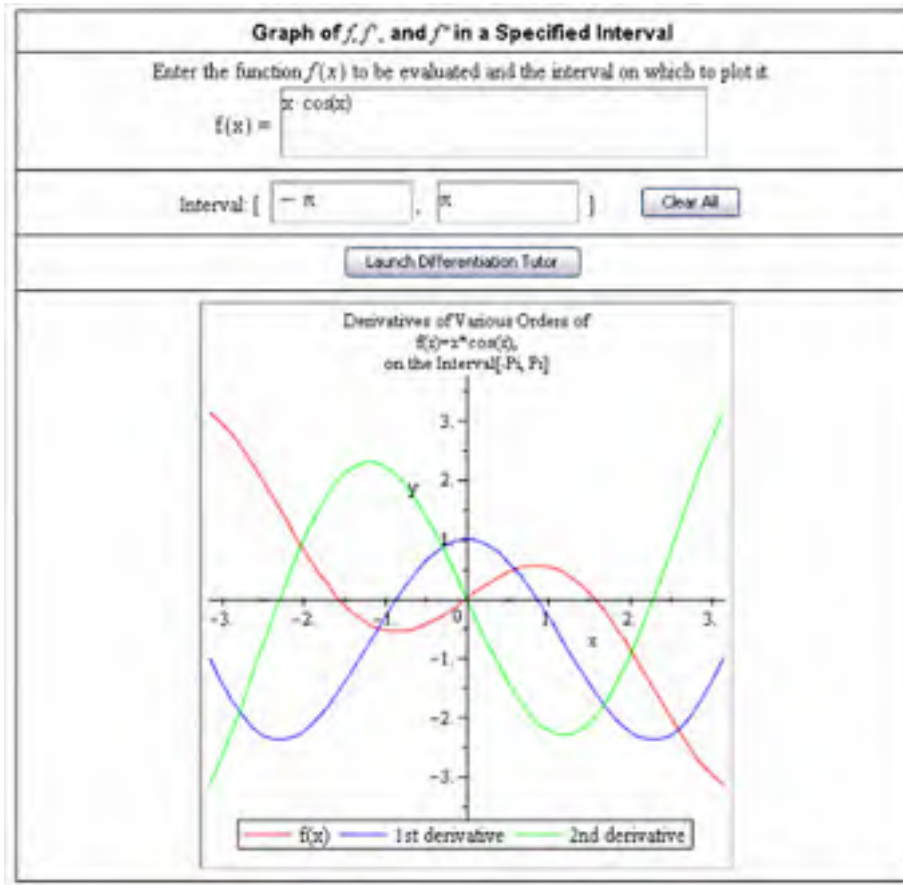


Access the Tutor from a Task Template

Maple also comes with a Task Template to solve this problem without using and commands.

1. Launch the Task Template Browser by selecting **Tools** → **Tasks** → **Browse**.
2. In the table of contents of the Task Template dialog, expand **Calculus** → **Derivatives** → **Graph $f'(x)$ and Its Derivatives**.
3. Click **Insert Minimal Content** at the top of the dialog to insert the task template into the current document.
4. Enter the new expression in the $f(x)$ region.
5. Enter the interval.
6. Click **Launch Differentiation Tutor** to launch the same tutor from the previous example.
7. When complete, click **Close**. A plot of the expression and its derivative(s) will display in the plot region.

Result:



Example 2 - Solve for x in the linear equation

Solve for x in the equation $(x-7)^2 + (x-1)^2 = 4((x-1)^2 + (x-4)^2)$.

Solution through Equation Manipulator

Maple contains a dialog that allows you to single-step through the process on manipulating an expression. This manipulator is available from the context menu.

1. Ctrl + drag the expression to a new document block region.
2. Right-click this equation and select **Manipulate Equation**. The **Manipulate Equation** dialog displays. See Figure 5.2.

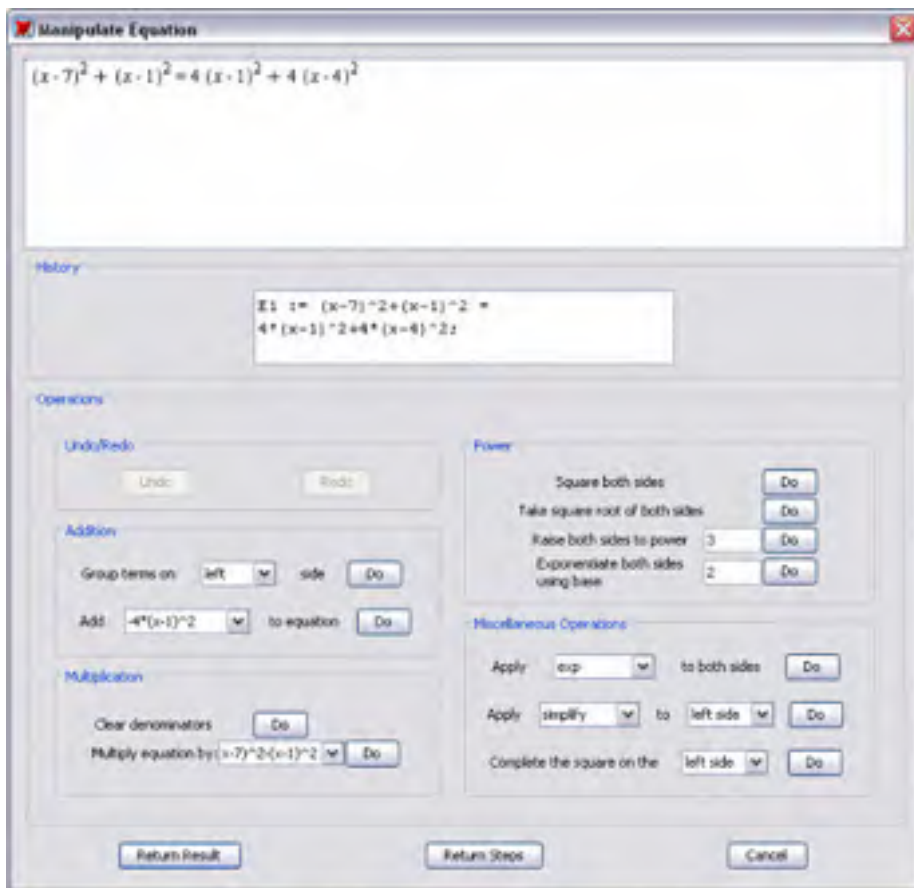


Figure 5.2: Manipulate Expression

Group all of the terms to the left:

4. In the **Addition** region, the **Group terms** row allows us to group terms on a specified side. Accept the default side of **left**, click **Do**.

Expand the left side of the equation:

5. In the **Miscellaneous Operations** region, we can manipulate the equation by applying a command from one of the drop-down menus. Since we want to apply a command on the left side of the equation only, click the drop-down menu in the second row and select **expand**. Since the left side is already selected, click **Do**.

Factor the equation:

6. In the same drop-down menu, select **factor** and click **Do**.

Return all of the steps to the Maple document and close the dialog:

7. Click **Return Steps**.

Result:

$$(x-7)^2 + (x-1)^2 = 4((x-1)^2 + (x-4)^2) \xrightarrow{\text{manipulate equation}}$$

$$(x-7)^2 + (x-1)^2 = 4(x-1)^2 + 4(x-4)^2$$

$$(x-7)^2 - 3(x-1)^2 - 4(x-4)^2 = 0$$

$$-6x^2 + 24x - 18 = 0$$

$$-6(x-1)(x-3) = 0$$

8. **Ctrl**+drag the factored form of the original equation to a new document block region.

9. Right-click and select **Solve** → **Solve For Variable** → **x**.

Result:

$$-6(x-1)(x-3) = 0 \xrightarrow{\text{solve for } x} [[x=1], [x=3]]$$

Instant Solution

To apply an instant solution to this problem, we can use the context menus.

1. **Ctrl** + drag the equation to a new document block region.
2. Right-click the expression and select **Solve** → **Solve for Variable** → **x**.

Result:

$$(x-7)^2 + (x-1)^2 = 4((x-1)^2 + (x-4)^2) \xrightarrow{\text{solve for } x} \{[x=1], [x=3]\}$$

Point-and-click Interactive Solution

By making use of equation labels, we can refer to each successive equation and add, subtract, multiply, and divide as appropriate, one step at a time.

1. **Ctrl** + drag the equation to a blank document block and press the **Enter** key.

To group all terms on the right, we need to subtract $(x-7)^2$ from both sides of the equation:

2. **Ctrl** + **L**. In the dialog that displays, enter the equation label for the previous result.

With the equation label inserted, enter $-(x-7)^2$.

3. Repeat step 2 for $(x-1)^2$.

Result:

$$(x-7)^2 + (x-1)^2 = 4((x-1)^2 + (x-4)^2)$$

$$(x-7)^2 + (x-1)^2 = 4(x-1)^2 + 4(x-4)^2$$

$$(1) - (x-7)^2$$

$$(x-1)^2 = 4(x-1)^2 + 4(x-4)^2 - (x-7)^2$$

$$(2) - (x-1)^2$$

$$0 = 3(x-1)^2 + 4(x-4)^2 - (x-7)^2$$

We now need to use Maple's `expand`, `factor`, and `solve` commands to complete the problem:

4. Using Maple's `expand` command, we will expand the equation using equation labels to refer to the equation.

5. Enter `expand(`.

6. **Ctrl** + **L** and enter the value for the previous result.

7. Enter a closing parenthesis, `)`.

8. Repeat steps 5 → 7 to factor and solve the problem.

Result:

```
expand( (3) )
```

$$0 = 6x^2 - 24x + 18$$

```
factor( (4) )
```

$$0 = 6(x - 1)(x - 3)$$

```
solve( (5) )
```

$$1, 3$$

Graphical Solution

Now that we've seen several methods to solve this problem, let's check our answer by plotting the expression.

We must manipulate the equation to become an expression before we can plot this problem.

1. Copy the equation to a new document block region and press **Enter**
2. Right-click the output and select **Move to Left**. Notice the difference in the alignment of the equation when using context menus on output rather than input.
3. Right-click the output and select **Left-hand Side**.
4. Right-click the output and select **Expand**.

Result:

$$(x-7)^2 + (x-1)^2 = 4((x-1)^2 + (x-4)^2)$$

$$(x-7)^2 + (x-1)^2 - 4(x-1)^2 - 4(x-4)^2$$

move to left

$$(x-7)^2 - 3(x-1)^2 - 4(x-4)^2 = 0$$

left hand side

$$(x-7)^2 - 3(x-1)^2 - 4(x-4)^2$$

expand

$$-6x^2 + 24x - 18$$

Now that the equation has been manipulated into its simplest form, plot the result.

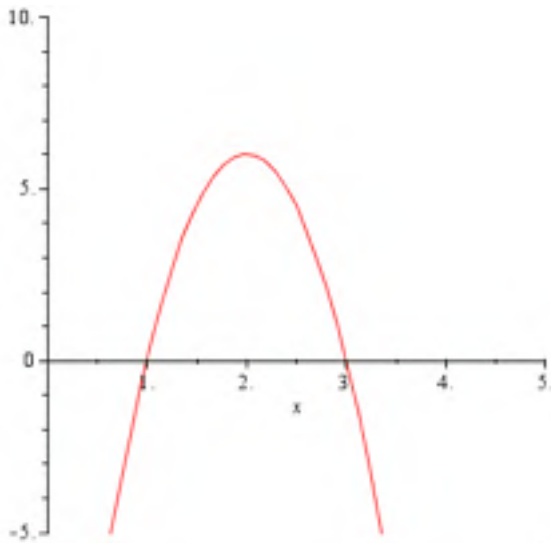
5. **Ctrl** + drag the output to a new document block.

6. Right-click the expression and select **Plots** → **2-D Plot**.

7. Right-click the plot and select **Axes** and then **Properties**. In the **Horizontal** tab of the **Axes Properties** dialog, de-select **Use data extents** and change the **Range min** and **Range max** to **0** and **5** respectively. Click the **Vertical** tab and de-select the **Use data extents**. Change the **Range min** and **Range max** to **-5** and **10** respectively.

Result:

$$-6x^2 + 24x - 18 \rightarrow$$



Example 3 - A Quadratic Trig Equation

For the equation $6 \cos^2(x) - \cos(x) - 2 = 0$, find all solutions in the interval

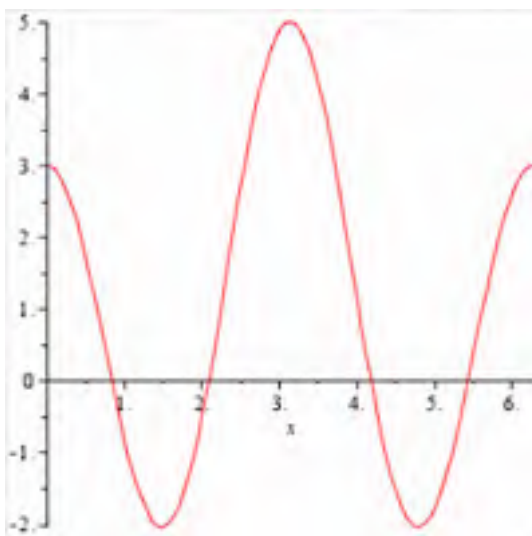
$$[0, 2\pi].$$

Graphical Solution

1. **Ctrl**+drag the equation to a blank document block and press the **Enter** key.
2. Right-click and select **Left-hand Side**.
3. Right-click and select **Plots** → **Plot Builder**.
4. Modify the plot range appropriately. (Use $2*\text{Pi}$ for the right endpoint.)

Result:

$$6\cos^2(x) - \cos(x) - 2 \rightarrow$$



Solution by Task Template

1. **Ctrl** + drag the equation to a blank document block region.
2. From the Format menu, select **Tasks** → **Browse**. Expand the **Algebra** folder and select **Solve Analytically in a Specified Interval**.
3. Click **Insert Minimal Content**.
4. Replace the current expression with the one in this example.
5. Notice Equation Labels are used to reference the result from the calculation.

Result:

Solve Analytically in a Specified Interval	
Enter an expression:	$\begin{aligned} > 6 \cos^2(x) - \cos(x) - 2 = 0 \\ & 6 \cos(x)^2 - \cos(x) - 2 = 0 \end{aligned} \quad (5.11)$
Find the roots in a specified interval:	$\begin{aligned} > \text{Student[CalculusI][Roots]}((11), 0 .. 2 \pi) \\ & \left[\arccos\left(\frac{2}{3}\right), \frac{2\pi}{3}, \frac{4\pi}{3}, 2\pi - \arccos\left(\frac{2}{3}\right) \right] \end{aligned} \quad (5.12)$
Express the roots in floating-point form:	$\begin{aligned} > \text{evalf}((12)) \\ & [0.8410686705, 2.094395103, 4.188790204, \\ & \quad 5.442116638] \end{aligned} \quad (5.13)$

Analytic Solution

1. **Ctrl**+drag the equation to a blank document block region.
2. Right-click and select **Left-hand Side**.
3. **Ctrl**+drag the output to a blank document block region.
4. Right-click and select **Factor**.
5. **Ctrl**+drag the first factor to a blank document block region.
6. Right-click and select **Solve**.
7. **Ctrl**+drag the first factor to a blank document block region.
8. Delete x from the expression.
9. **Ctrl**+drag the solution to replace the value of x .
10. Right-click and select **Evaluate and Display Inline**.
11. **Ctrl**+drag the second factor to a blank document block region.
12. Right-click and select **Solve**.

Result:

$$6 \cos^3(x) - \cos(x) - 2 = 0 \xrightarrow{\text{left hand side}} 6 \cos(x)^2 - \cos(x) - 2$$

$$6 \cos(x)^2 - \cos(x) - 2 \xrightarrow{\text{factor}} (2 \cos(x) + 1) (3 \cos(x) - 2)$$

$$(2 \cos(x) + 1) \xrightarrow{\text{solve}} \left\{ x = \frac{2}{3} \pi \right\}$$

$$\left(2 \cos\left(\frac{2}{3} \pi\right) + 1 \right) = 0$$

$$(3 \cos(x) - 2) \xrightarrow{\text{solve}} \left\{ x = \arccos\left(\frac{2}{3}\right) \right\}$$

$$\left(3 \cos\left(\arccos\left(\frac{2}{3}\right)\right) - 2 \right) = 0$$

Example 4 - Inverse Functions

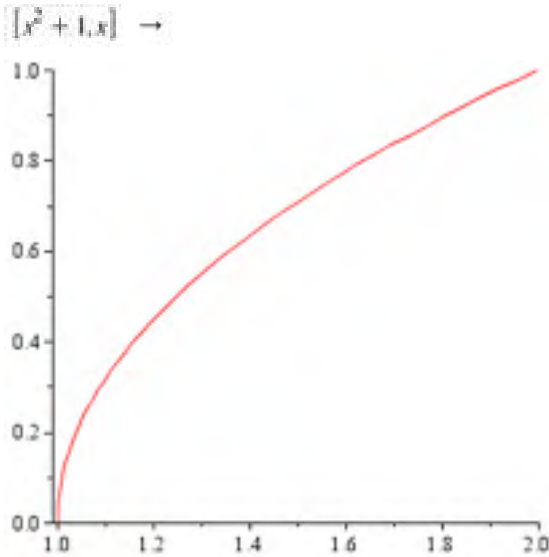
If $f(x) = x^2 + 1, x \geq 0$, find and graph the rule for $f^{-1}(x)$, and its functional inverse.

Implement the Definition Graphically

The graph of the inverse function is the set of ordered pairs formed by interchanging the ordinates and abscissas.

1. In a blank document block, enter $[f(x), x]$ and press **Enter**.
2. Right-click the output and select Plots → Plot Builder.
3. In the Plot Builder : Select Plot Type dialog, ensure **2-D Parametric Plot** is selected in the Select Plot region
4. Adjust the domain for x to the interval $[0, 1]$.
5. Select **Plot** to return the plot to the document.

Result:



6. **Ctrl** + drag the expression for $f(x)$ onto this graph. Notice that the axis ranges alter.

7. **Ctrl** + drag the expression for x onto this graph.

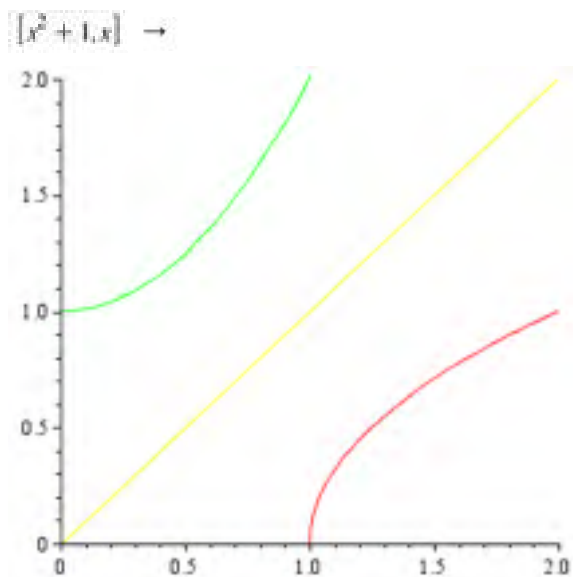
The resulting graph is the graph of $f^{-1}(x)$. Adjust the x and y axis ranges.

8. Right-click on the graph and select **Axes** → **Properties**.

9. In the Axes Properties dialog, de-select **Use data extents** and change the range to $[0, 2]$.

10. Click the **Vertical** tab and repeat step 10. Click **OK** to apply this setting and close the Axes Properties dialog.

Result:



Solution by Tutor

1. Load the Student Calculus 1 package via the Tools/Load Package menu.
2. To a blank document block, **Ctrl** + drag the expression for the function $f(x)$.
3. Right-click and select **Tutors** → **Calculus - Single Variable** → **Function Inverse**. See Figure 5.3.

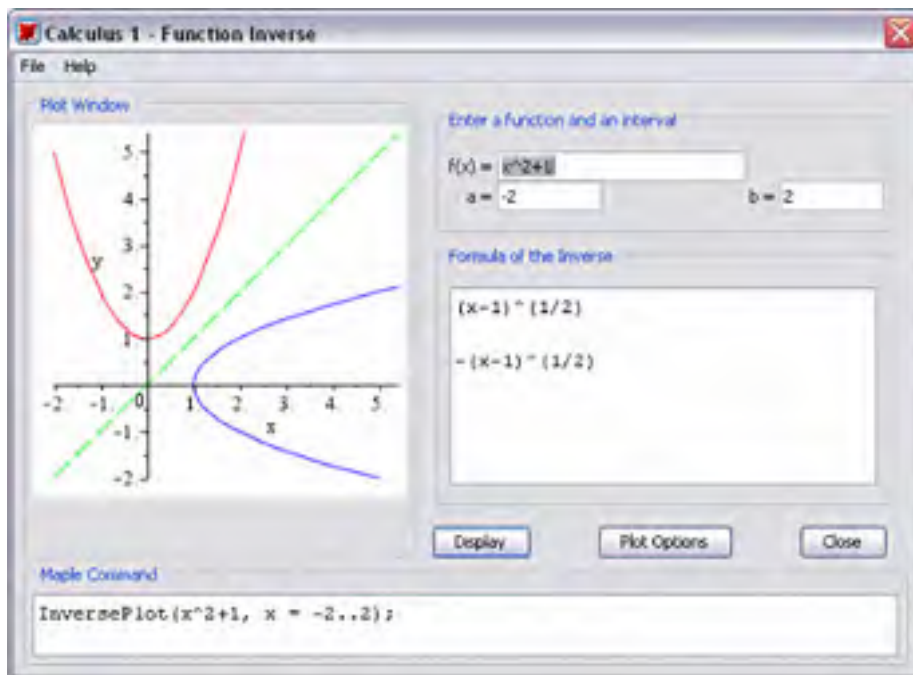
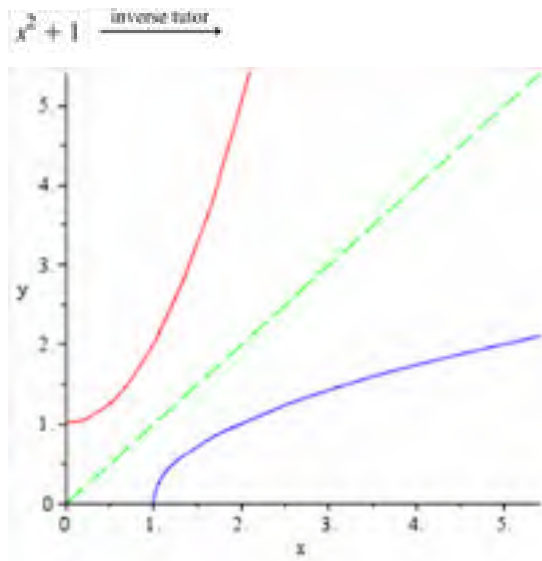


Figure 5.3: Function Inverse

4. Adjust the domain
5. From the Formula of the Inverse region, select the appropriate branch.

Result:

Loading Student:-Calculus1

**Example 5 - Methods of Integration - Trig Substitution**

Evaluate the integral $\int \frac{1}{\sqrt{4-x^2}} dx$ by making the substitution $x = 2 \sin(u)$.

Immediate Evaluation of the Integral

1. **Ctrl** + drag the integral to a blank document block region.
2. Right-click and select **Evaluate**.

Result:

$$\int \frac{1}{\sqrt{4-x^2}} dx = \arcsin\left(\frac{x}{2}\right)$$

Solution by Integration Methods Tutor

1. Load the Student Calculus 1 package by selecting **Tools** → **Load Package** → **Student Calculus 1**.
2. **Ctrl** + drag the integral to a blank document block region.
3. Right-click and select **Tutors** → **Calculus Single Variable** → **Integration Methods**.
4. Change the expression by selecting **Change** and entering $u^2 = -1 + \frac{4}{x^2}$. See Figure 5.4.
- 5.4.
5. Apply the constant multiple rule.
6. Apply the revert rule.

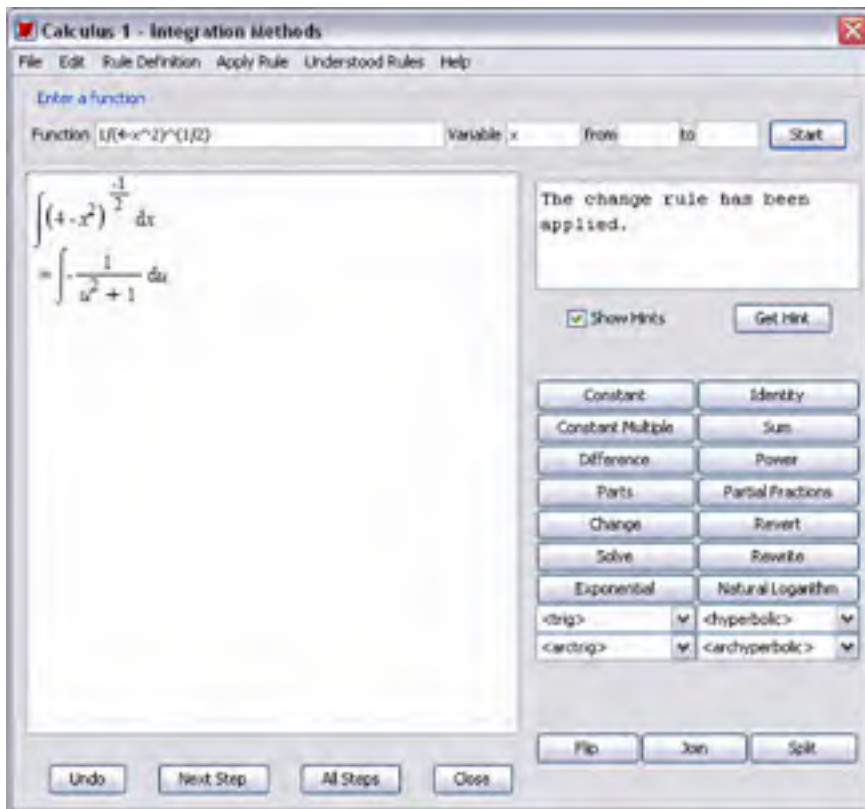


Figure 5.4: Integration Methods Tutor

5. Apply the constant multiple rule.
6. Apply the revert rule.
7. Close the tutor.

Result:

Loading Student:-Calculus1



The image shows a screenshot of the Maple 'integration methods tutor'. On the left, the integrand $\frac{1}{\sqrt{4-x^2}}$ is displayed. An arrow labeled 'integration methods tutor' points to the right, where the same integrand is shown with the substitution $u = \arcsin\left(\frac{1}{2}x\right)$ indicated next to it.

Solution by First Principles

1. **Ctrl** + drag the integrand in a blank document block region.
2. Right-click and select **Evaluate at a point**. In the dialog that displays, enter $x = \sin(u)$.
3. Right-click and select **Simplify** → **Symbolic**.
4. **Ctrl** + drag the result to a blank document block region and press **Enter**.
5. Referencing this result by its equation label, multiply by the derivative of $\sin(u)$ and press the **Enter** key.
6. Right-click and select **Constructions** → **Integral** → **u**.
7. **To revert the substitution:**
8. In a blank document block, place the equation $x = \sin(u)$ and press the **Enter** key.
9. Right-click and select **Solve** → **Solve for a Variable** → **u**.

Result:

$$\frac{1}{\sqrt{4-x^2}} \xrightarrow{\text{evaluate at point}} \frac{1}{\sqrt{4-\sin(u)^2}} \xrightarrow{\text{simplify symbolic}} \frac{1}{\sqrt{3+\cos(u)^2}}$$

$$\frac{1}{\sqrt{3+\cos(u)^2}}$$

$$\frac{1}{\sqrt{3+\cos(u)^2}}$$

(14) diff(sin(u), u)

$$\frac{\cos(u)}{\sqrt{3+\cos(u)^2}}$$

$$\frac{\cos(u)}{\sqrt{3+\cos(u)^2}} \xrightarrow{\text{integrate w.r.t. u}} \int \frac{\cos(u)}{\sqrt{3+\cos(u)^2}} du$$

Example 6 - Initial Value Problem

Solve the initial value problem

$$y''(t) + 4y'(t) + 13y(t) = \cos(2t)$$

$$y(0) = 2$$

$$y'(0) = -1$$

On the same set of axes, obtain a graph of $y(t)$ and $y'(t)$. Obtain a graph of the orbit this solution makes in the phase plane.

Solution by ODE Analyzer Assistant

The ODE Analyzer Assistant lets you solve ODE's numerically or symbolically and displays a plot of the solution.

1. **Ctrl** + drag the ODE to a blank document block.
2. Right-click and select **Solve DE Interactively**. The ODE Analyzer Assistant displays with the ODE automatically inserted. See Figure 5.5.

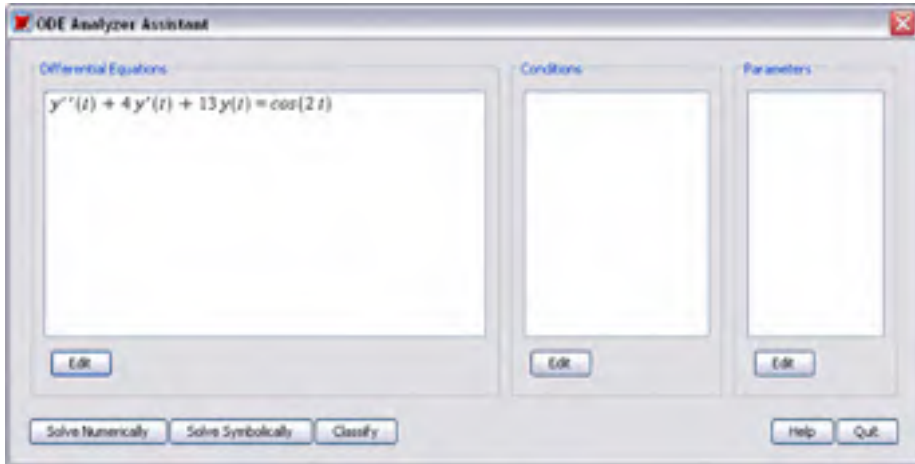


Figure 5.5: ODE Analyzer Assistant

To insert the initial conditions: 3. In the **Conditions** region, click **Edit**. The **Edit Conditions** dialog opens. 4. In the **Add Condition** region, with **y** selected in the drop-down menu, enter **0** in the text field to the right and then **2** in the second text region. Click **Add**. Your entry should match Figure 5.6.

5. To enter the initial condition for y' , select y' from the drop-down menu. In the text field to the right, enter **0** and then **1** in the second text field. Click **Add**. Click **Done** to close this dialog and return to the main dialog.



Figure 5.6: Edit Conditions Dialog

5. Click **Solve Numerically**.

To solve the initial value problem:

6. Click **Solve**.

To plot the solution of the DE:

7. Click **Plot**.

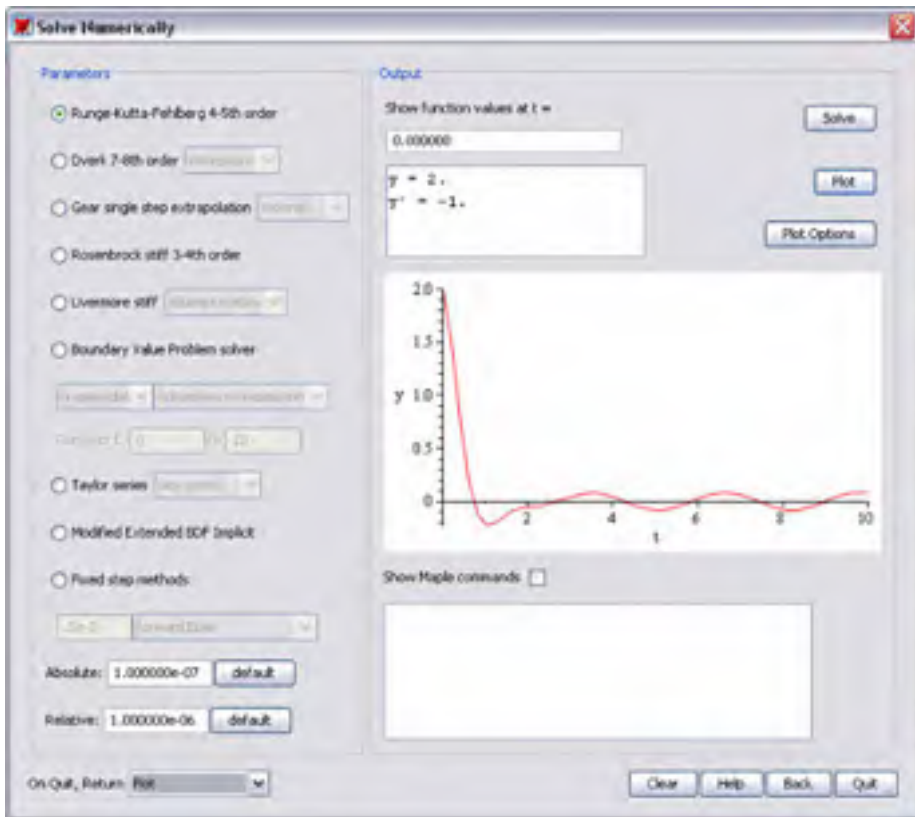


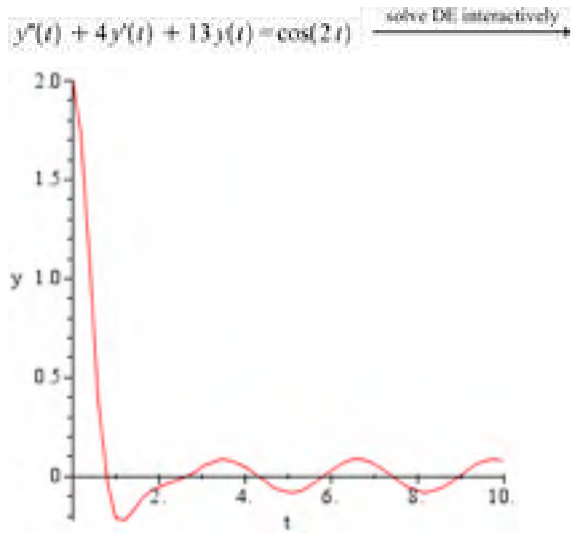
Figure 5.7: Solve Numerically Dialog

8. To change the plot options:

Click the **Plot Options** button to modify the default graph.

9. Click **Quit** to close the ODE Analyzer and return a plot of the DE to the Maple document.

Result:



5.2 Calculus Examples

Maple is a powerful application with many resources to guide you. The following examples provide you with scenarios to learn about using Maple resources and the Maple program.

When using Maple to solve a problem, consider the following process.

1. Formulate your problem.
2. Obtain Maple resources that allow you to solve it.

Problem

Scenario A:

Your company is designing a bottle for its new spring water product. The bottle must contain 18 ounces of water and the height is fixed. The design includes an undulating curved surface. You know the amplitude and equation of the curve, but you must find the radius. You require the **Volume of Revolution**.



Scenario B:

You want to teach your students the concept of a **Volume of Revolution**. Specifically, you want to plot and compute the volume of a solid of revolution generated by rotating $f(x)$, $a \leq x \leq b$, about an axis or a line parallel to an axis.



Figure 5.8: Flowchart of solving a problem

Check for Existing Tools: Tutor

Begin by examining the **Tools** menu for a **Tutor** to a Volume of Revolution problem.

To access a Tutor for the Volume of Revolution:

1. From the **Tools** menu, select **Tutors**, and then **Calculus-Single Variable**. Notice that a Volume of Revolution tutor exists.
2. Click the **Volume of Revolution** menu item. The document is populated with the following Maple command.

```
> Student[Calculus I][VolumeOfRevolutionTutor]();
```

The **Volume of Revolution Tutor** is displayed. See Figure 5.9. Use this tutor to enter a function and an interval, view and manipulate the corresponding plot, and view the full Maple command associated with your entries and selections.

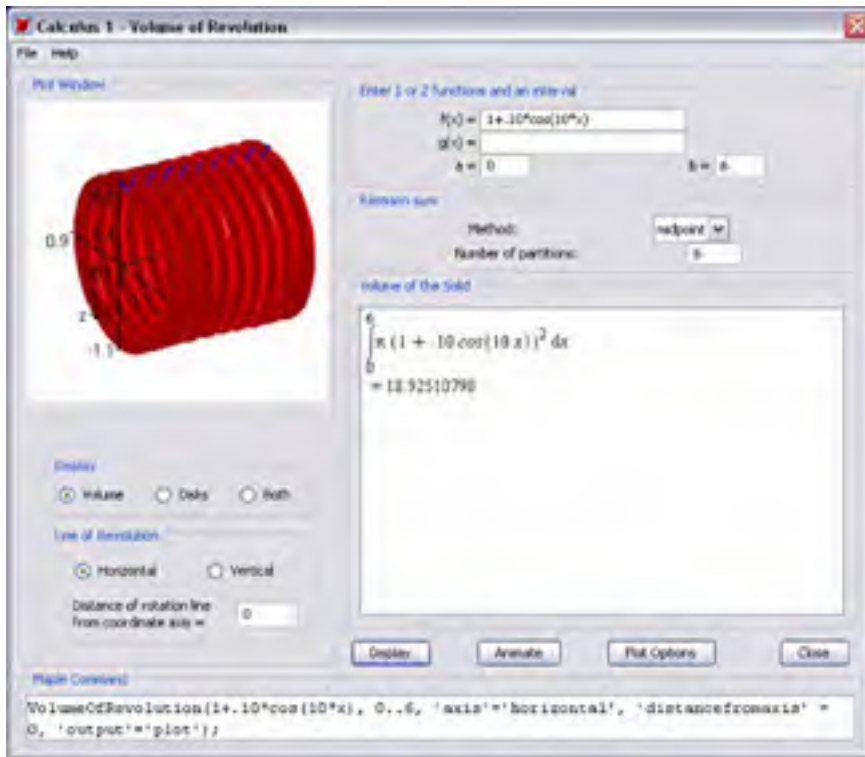


Figure 5.9: Volume of Revolution Tutor

After you **Close** the tutor, the plot is inserted into your worksheet.

Check for Existing Tools: Task Template

1. From the **Tools** menu, select **Task**, and then **Browse**. The **Browse Tasks** dialog opens, displaying a list of tasks. The tasks are sorted by subject to help you quickly find the desired task.
2. Expand the **Calculus** folder.
3. From the displayed list, select **Volume of Revolution**. The **Volume of Revolution** task is displayed in the right pane of the **Browse Tasks** dialog.
4. Select the **Insert into New Worksheet** check box.

5. Click **Insert Default Content**. Before inserting a task, Maple checks whether the task variables have assigned values in your worksheet. If any task variable is assigned, the **Task Variables** dialog opens allowing you to modify the names. Maple uses the edited variable names for all variable instances in the inserted task. The content is inserted into your document. See Figure 5.10.



Figure 5.10: Inserted Task Template

6. When a Task Template is inserted, parameters are marked as placeholders. To navigate between placeholders, press the **Tab** key. After updating any parameters, run the command by pressing **Enter**.

Check for Instructions: Help Page and Example Worksheet

The help system provides command syntax information.

To access a help page:

1. From the **Help** menu, select **Maple Help**.

2. In the search field, enter **volume of revolution** and click **Search**. The search results include the command help page, the dictionary definition, and the associated tutor help page.
3. Review the calling sequence, parameters, and description in the **Student[Calculus1][Volume of Revolution]** help page.
4. Copy the examples into your worksheet: From the help system **Edit** menu, select **Copy Examples**.
5. Close the Help Navigator.
6. In your document, from the **Edit** menu, select **Paste**. The examples are pasted into your document.
7. Run the examples and examine results.

To access an example worksheet:

1. In the worksheet, enter **?index/examples**. The **Example Worksheet Index** opens.
2. Expand the **Calculus** topic.
3. Click the **Calculus1IntApps** link. The **Calculus1: Applications of Integration** worksheet opens. See Figure 5.11.
4. Expand the **Volume of Revolution** topic.
5. Examine and run the examples.

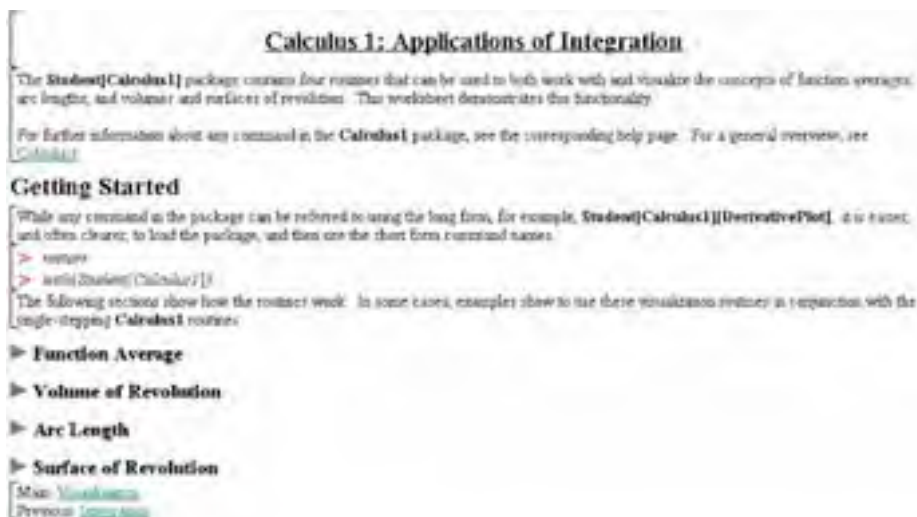


Figure 5.11: Example Worksheet

Check for Other Ready-To-Use Resources: Application Center

The Maple Application Center contains free user-contributed applications related to mathematics, education, science, engineering, computer science, statistics and data analysis, finance, communications, graphics, and more.

To access a free application for volume of revolution:

1. Go to the Maplesoft Web site, <http://www.maplesoft.com>.
2. In the menu of the main Web page, click **User Community**, and then **Application Center**.
3. In the sidebar, click **Education PowerTools**.
4. Click the **Calculus II** link, and then the **CalculusII: Complete Set of Lessons** link.
5. From the **Options** area and click **Download Maple Worksheet**. See Figure 5.12.

6. Login in as a guest or Maplesoft Member.
7. Download the **.zip** file.
8. Extract the **L2-volumeRevolution.mws** file.
9. Run the worksheet and examine the results.

The screenshot shows the Maplesoft Application Center interface. At the top, there is a navigation bar with links for 'Home', 'Maple Applications Center', 'Education PowerTools', and 'Calculus'. Below the navigation bar, there are tabs for 'Top Rated Applications', 'New Applications', and 'Most Downloaded'. A search bar is present with the text 'Conduct a search: '. The main content area displays the details for the application 'Calculus II: Complete Set of Lessons'. The application title is 'Calculus II: Complete Set of Lessons' with a star rating of 4.22/5. The author is Jack Wagner, and the application type is 'Maple Worksheet Education PowerTool'. The publish date is October, 2009. The language is English. There are three options: 'View HTML version', 'Download Maple Worksheet (20,391.5Kb)', and 'E-mail to a colleague'. The abstract states: 'This is a complete set of Maple lessons for a Calculus II course. The University of Wisconsin-Milwaukee Department of Mathematics developed 24 of the lessons as part of their calculus sequence. Dr. Jack Wagner recently supplemented the collection with 12 new lessons.' Below the abstract, there are 'Related Application Categories' including 'Education: Calculus II' and 'Education PowerTools - Calculus II'. A 'Member Rating' section shows a rating of 4.22/5 and a link to 'Login to rate this application'.

Figure 5.12: Maple Application Center: PowerTools

6 Available Resources

Your work with Maple is supported by numerous resources.


In this chapter:

Online Help and Examples	Maple's online help system offers help pages, example and applications, and a dictionary of mathematical and engineering terms.
Maple Tour and New User Roadmap	For new users, the Maple Tour and New User Roadmap helps get you started.
Web Site Resources	Illustrates the numerous resources available from the Maplesoft Website.

6.1 Online Help and Examples

Help Pages

The online help system helps you find information about a specific topic, command, package, or feature. You can access help three ways.

- From the **Help** menu, select **Maple Help**.
- In the toolbar, click the Help icon .
- In the document or worksheet, enter **?topicname**. For example, enter **?LinearAlgebra** and then press **Enter**.

Dictionary

More than 5000 mathematical and engineering terms with over 300 figures and plots.

1. From the **Help** menu, select **Maple Help**.
2. In **Resources** drop-down list, select **Definition**.
3. Enter search word or expand alphabetical listing.

Applications and Example Worksheets

Applications

Sample applications demonstrate how Maple can be used to find and document a solution to a specific problem. Some applications allow for input or contain animations that you can run; however, their primary use is for demonstrations. Topics include DC Motor Control Design, Digital Filter Design, Frequency Domain System Identification, Harmonic Oscillator, Mathematical Model to Simulation Code, Mobile Robot Modeling and Simulation, and Black-Scholes Model.

Examples

Sample examples are executable documents covering topics that demonstrate syntax or invoke a user interface to make complex problems easy to solve and visualize. You can copy and modify the examples as needed. Topics include Algebra, Calculus, Connectivity, Discrete Mathematics, General Numerics and Symbolics, and Integral Transforms.

- From the **Help** menu, select **Manuals, Dictionary, and more**, and then **Applications and Examples**.

6.2 Maple Tour and New User Roadmap

Maple Tour

The **Maple Tour** consists of interactive sessions on several of the following topics: Ten Minute Tour, Numeric and Symbolic Computations, Matrix Computations, Differential Equations, Statistics, Programming and Code Generation, Units and Tolerances, and Education Assessment, Maple T.A.

- From the **Help** menu, select **Take a Tour of Maple**.

New User Roadmap

Find the most efficient path to solving a problem immediately or learning principles and reviewing major features.

- From the **Help** menu, select **Manuals, Dictionary, and more**, and then **New User Roadmap**.

6.3 Web Site Resources

Welcome Center

A Maple Web site offering all of Maplesoft's key user resources in one central location. In the Welcome Center you can view sample applications, participate in user forums, access exclusive premium content, and listen to Podcasts. In addition, you will have access to our support services, be able to view training videos, download user manuals, and much more.

1. Go to **<http://www.maplesoft.com>**.
2. In the menu of the main Web page, click **Site Resources** and then **Welcome Center**.

Student Help Center

The Student Help Center offers a Maple Student Forum, Online Math Oracles, Training Videos, and a Math Homework Resource Guide.

1. Go to **<http://www.maplesoft.com>**.
2. In the menu of the main Web page, click **Site Resources** and then **Student Help Center**.

Teacher Resource Center

The Teacher Resource Center is designed to ensure you get the most out of your Maple teaching experience. It provides sample applications, course material, training videos, white papers, eBooks, Podcasts, and tips.

1. Go to **<http://www.maplesoft.com>**.
2. In the menu of the main Web page, click **Site Resources** and then **Teacher Resource Center**.

Application Center

Maple Web site resource for free applications related to mathematics, education, science, engineering, computer science, statistics and data analysis, finance, communications, graphics. Many applications are available in translation (French, Spanish, and German).

1. Go to **<http://www.maplesoft.com>**.
2. In the menu of the main Web page, click **User Community** and then **Application Center**.

PowerTools

A Maple Web site resource for free complete course curricula and add-on Maple packages and courses, developed by experts in their fields to help users configure Maple for research in specific application areas.

1. Go to **<http://www.maplesoft.com>**.
2. In the menu of the main Web page, click **User Community** and then **Application Center**.
3. In the sidebar of the Web page, click **Research PowerTools** or **Education PowerTools**.

Training

Maplesoft offers a comprehensive set of complementary training materials. From complete training videos to recorded training seminars to downloadable documentation, you have many options to get up to speed with Maplesoft products. In addition, whether you are an expert or someone who is considering a new license purchase, we can provide a custom training session that is right for you and/or your organization.

1. Go to **<http://www.maplesoft.com>**.
2. In the menu of the main Web page, click **Site Resources** and then **Training**.

MaplePrimes

A Web community dedicated to sharing experiences, techniques, and opinions about Maple and related products, as well as general interest topics in math and computing.

1. Go to **<http://www.maplesoft.com>**.
2. In the menu of the main Web page, click **User Community** and then **MaplePrimes**.

Technical Support

A Maple Web site and resources for FAQs, downloads and service packs, links to discussion groups, and request technical support form.

1. Go to **<http://www.maplesoft.com>**.
2. In the menu of the main Web page, click **Customer Support** and then **Support & Customer Service**.

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