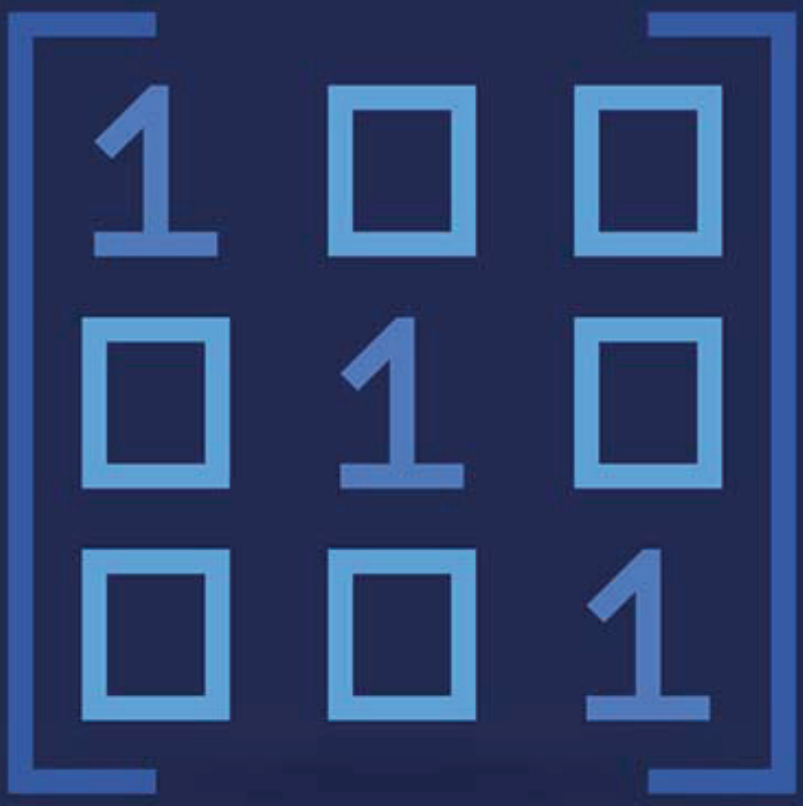
GLOBAL EDITION



MATLAB® for Engineers

FIFTH EDITION

Holly Moore

Pearson

MATLAB® for Engineers

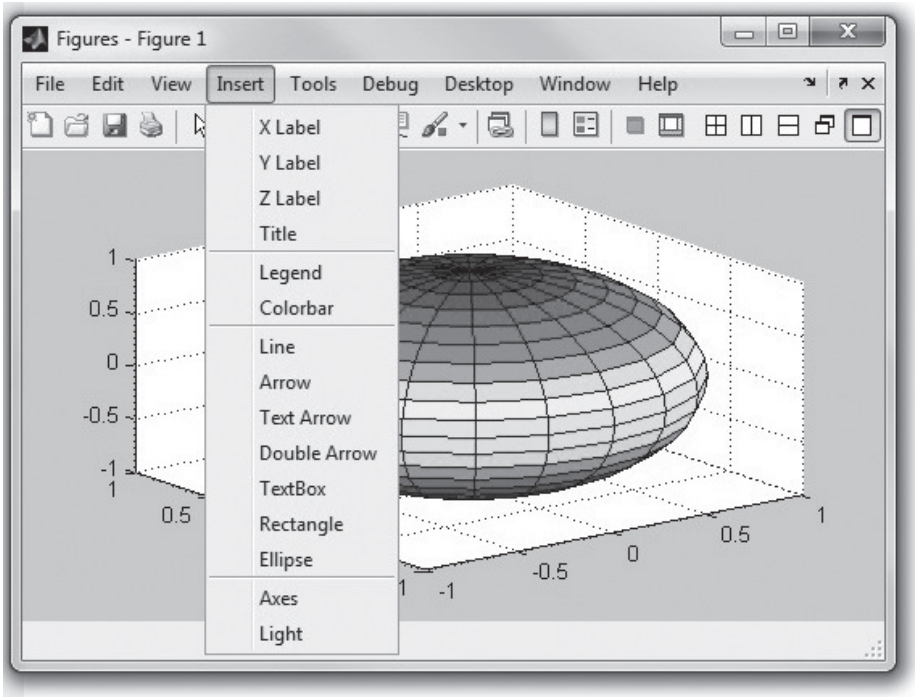


Figure 5.32
MATLAB® offers interactive tools, such as the insert tool, that allow the user to adjust the appearance of graphs.

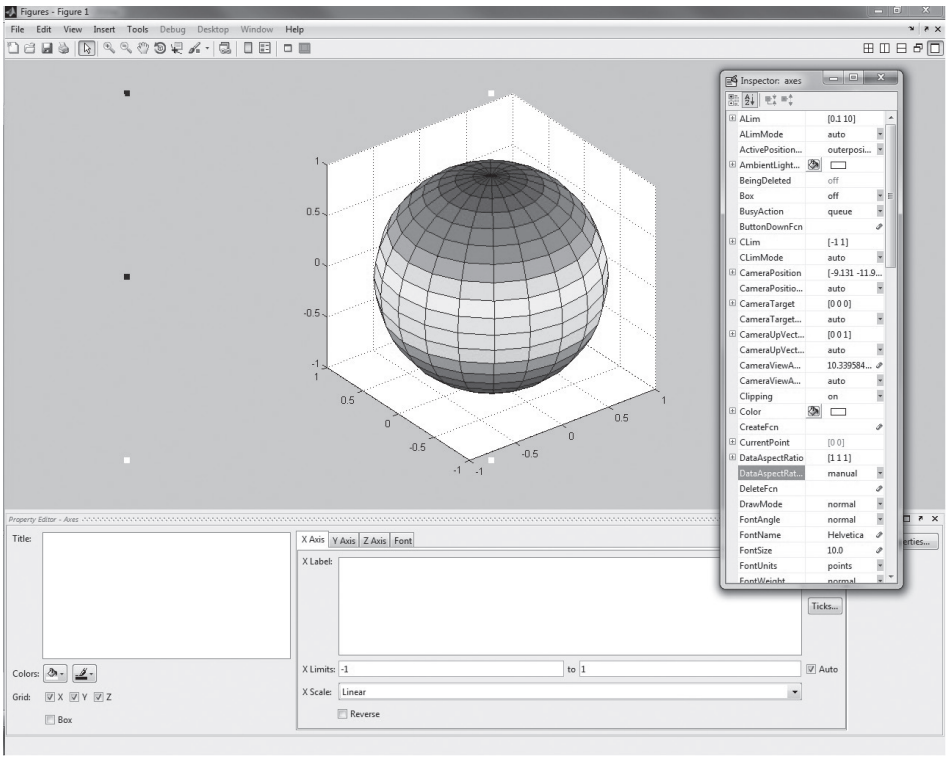


Figure 5.33
MATLAB® allows you to edit plots by using commands from the toolbar.

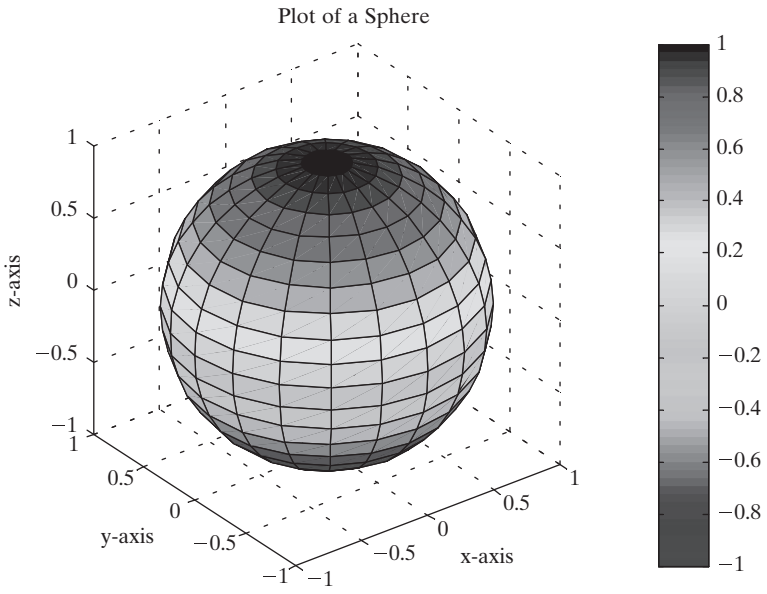


Figure 5.34
Edited plot of a sphere.

Similarly, labels, a title, and a color bar were added (see Figure 5.34) using the Property Editor. They could also have been added by using the **Insert menu** option on the menu bar. Editing your plot in this manner is more interactive and allows you to fine-tune the plot's appearance. The only problem with editing a figure interactively is that if you run your MATLAB® program again, you will lose all of your improvements.

HINT

You can force a plot to space the data equally on all the axes by using the `axis equal` command. This approach has the advantage that you can program **axis equal** into an M-file and retain your improvements.

5.6 CREATING PLOTS FROM THE WORKSPACE WINDOW

A great feature of MATLAB® 9 is its ability to create plots interactively using the variables in the workspace window. Select the variables you would like to plot, then select the **PLOTS** tab from the MATLAB® desktop (shown in Figure 5.35). MATLAB® will list the plotting options it "thinks" are reasonable for the data stored in your variable(s). Simply select the appropriate option, and your plot is created in the current figure window. If you don't like any of the suggested types of plot, choose the drop-down menu, and a new window will open with the complete list of available plotting options for you to choose from. This is especially useful, because it may suggest options that had not occurred to you. For example, Figure 5.35 shows a scatter plot of the `x` and `y` matrices highlighted in the figure. The matrices were created by loading the seamount data set, which is built into MATLAB®.

If you want to plot more than one variable, highlight the first, then hold down the *Ctrl* key and select the additional variables. To annotate your plots, use the

interactive editing process described in Section 5.5. The interactive environment is a rich resource. You'll get the most out of it by exploring and experimenting.

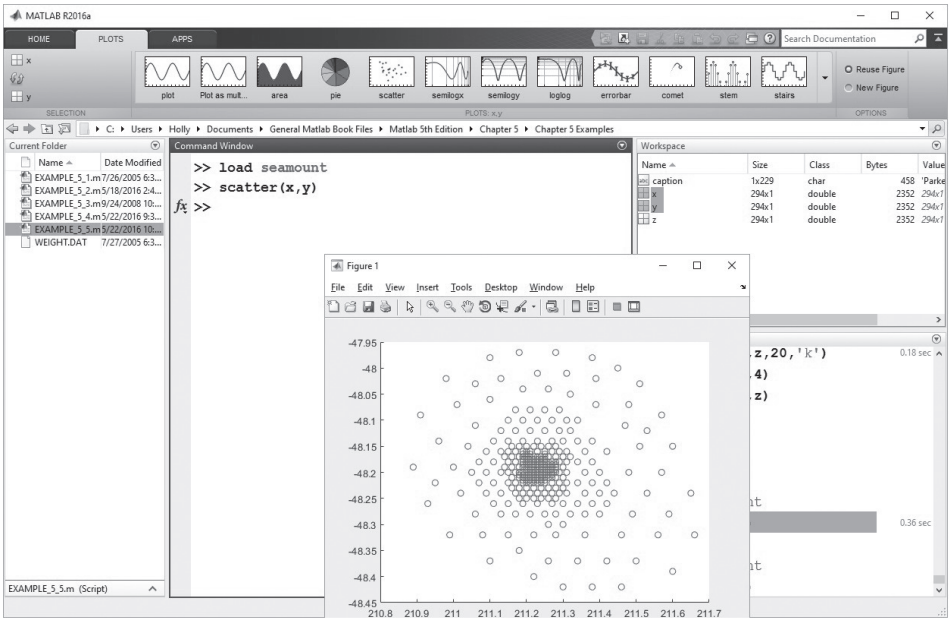


Figure 5.35
Plotting from the workspace window, using the interactive plotting feature.

5.7 SAVING YOUR PLOTS

There are several ways to save plots created in MATLAB®:

- If you created the plot with programming code stored in a script, simply rerunning the code will recreate the figure.
- You can also save the figure from the file menu, using the **Save As …** option. You'll be presented with several choices:

  1. You may save the figure as a **.fig** file, which is a MATLAB®-specific file format. To retrieve the figure, just double-click on the file in the current folder.
  2. You may save the figure in a number of different standard graphics formats, such as jpeg **(.jpg)** and enhanced metafile **(.emf)**. These versions of the figure can be inserted into other documents, such as a Word document.
  3. You can select Edit from the menu bar, then select **copy figure**, and paste the figure into another document.
  4. You can use the file menu to create a script that will recreate the figure.

PRACTICE EXERCISE 5.6

Create a plot of $y = \cos(x)$. Practice saving the file and inserting it into a Word document. The correct answers can be found on the Pearson-website.

SUMMARY

The most commonly used graph in engineering is the x–y plot. This two-dimensional plot can be used to graph data or to visualize mathematical functions. No matter what a graph represents, it should always include a title and x- and y-axis labels. Axis labels should be descriptive and should include units, such as ft/s or kJ/kg.

MATLAB® includes extensive options for controlling the appearance of your plots. The user can specify the color, line style, and marker style for each line on a graph. A grid can be added to the graph, and the axis range can be adjusted. Text boxes and a legend can be employed to describe the graph. The subplot function is used to divide the plot window into an $m \times n$ grid. Inside each of these subwindows, any of the MATLAB® plots can be created and modified.

In addition to x–y plots, MATLAB® offers a variety of plotting options, including polar plots, pie charts, bar graphs, histograms, and x–y graphs with two y-axes. The scaling on x–y plots can be modified to produce logarithmic plots on either or both x- and y-axes. Engineers often use logarithmic scaling to represent data as a straight line.

The function `fplot` allows the user to plot a function without defining a vector of x- and y-values. MATLAB® automatically chooses the appropriate number of points and spacing to produce a smooth graph. Additional function-plotting capability is available in the symbolic toolbox.

The three-dimensional plotting options in MATLAB® include a line plot, a number of surface plots, and contour plots. Most of the options available in two-dimensional plotting also apply to these three-dimensional plots. The `meshgrid` function is especially useful in creating three-dimensional surface plots.

Interactive tools allow the user to modify existing plots. These tools are available from the figure menu bar. Plots can also be created with the interactive plotting option from the workspace window. The interactive environment is a rich resource. You'll get the most out of it by exploring and experimenting.

Figures created in MATLAB® can be saved in a variety of ways, either to be edited later or to be inserted into other documents. MATLAB® offers both proprietary file formats that minimize the storage space required to store figures and standard file formats suitable to import into other applications.

MATLAB® SUMMARY

The following MATLAB® summary lists all the special characters, commands, and functions that were defined in this chapter:

Special Characters

Line Type	Indicator	Point Type	Indicator	Color	Indicator
solid	-	point	.	blue	b
dotted	:	circle	o	green	g
dash-dot	-.	x-mark	x	red	r
dashed	- -	plus	+	cyan	c
		star	*	magenta	m
		square	s	yellow	y
		diamond	d	black	k
		triangle down	v	white	w
		triangle up	^		

(*continued*)

Special Characters (continued)					
Line Type	**Indicator**	**Point Type**	**Indicator**	**Color**	**Indicator**
		triangle left	<		
		triangle right	>		
		pentagram	p		
		hexagram	h		

Commands and Functions	
`autumn`	optional colormap used in surface plots
`axis`	freezes the current axis scaling for subsequent plots or specifies the axis dimensions
`axis equal`	forces the same scale spacing for each axis
`bar`	generates a bar graph
`bar3`	generates a three-dimensional bar graph
`barh`	generates a horizontal bar graph
`bar3h`	generates a horizontal three-dimensional bar graph
`bone`	optional colormap used in surface plots
`clabel`	add labels to a contour plot
`clf`	clear figure
`close`	close the current figure window
`close all`	close all open figure windows
`colorcube`	optional colormap used in surface plots
`colormap`	color scheme used in surface plots
`comet`	draws an *x*–*y* plot in a pseudo animation sequence
`comet3`	draws a three-dimensional line plot in a pseudo animation sequence
`contour`	generates a contour map of a three-dimensional surface
`contourf`	generates a filled contour map of a three-dimensional surface
`cool`	optional colormap used in surface plots
`copper`	optional colormap used in surface plots
`figure`	opens a new figure window
`flag`	optional colormap used in surface plots
`fplot`	creates an *x*–*y* plot based on a function
`gtext`	similar to text; the box is placed at a location determined interactively by the user by clicking in the figure window
`grid`	adds a grid to the current plot only
`grid off`	turns the grid off
`grid on`	adds a grid to the current and all subsequent graphs in the current figure
`histogram`	generates a histogram
`histcounts`	returns the number of data points in each bin
`hold off`	instructs MATLAB® **to** erase figure contents before adding new information
`hold on`	instructs MATLAB® **not to** erase figure contents before adding new information
`hot`	optional colormap used in surface plots
`hsv`	optional colormap used in surface plots
`jet`	default colormap used in surface plots
`legend`	adds a legend to a graph
`linspace`	creates a linearly spaced vector

Commands and Functions	
`loglog`	generates an *x*–*y* plot with both axes scaled logarithmically
`mesh`	generates a mesh plot of a surface
`meshgrid`	places each of two vectors into separate two-dimensional matrices, the size of which is determined by the source vectors
`pause`	pauses the execution of a program until any key is hit
`pcolor`	creates a pseudo color plot similar to a contour map
`peaks`	creates a sample matrix used to demonstrate graphing functions
`pie`	generates a pie chart
`pie3`	generates a three-dimensional pie chart
`pink`	optional colormap used in surface plots
`plot`	creates an *x*–*y* plot
`plot3`	generates a three-dimensional line plot
`polarplot`	creates a polar plot
`prism`	optional colormap used in surface plots
`semilogx`	generates an *x*–*y* plot with the *x*-axis scaled logarithmically
`semilogy`	generates an *x*–*y* plot with the *y*-axis scaled logarithmically
`shading flat`	shades a surface plot with one color per grid section
`shading interp`	shades a surface plot by interpolation
`sphere`	sample function used to demonstrate graphing
`spring`	optional colormap used in surface plots
`subplot`	divides the graphics window into sections available for plotting
`summer`	optional colormap used in surface plots
`surf`	generates a surface plot
`surfc`	generates a combination surface and contour plot
`text`	adds a text box to a graph
`title`	adds a title to a plot
`white`	optional colormap used in surface plots
`winter`	optional colormap used in surface plots
`xlabel`	adds a label to the *x*-axis
`ylabel`	adds a label to the *y*-axis
`yyaxis`	specifies which *y*-axis to use
`zlabel`	adds a label to the *z*-axis

PROBLEMS

Two-Dimensional ($x - y$) Plots

5.1 Plot the following set of data:

$$y = [12, 14, 12, 22, 8, 9]$$

Allow MATLAB® to use the matrix index number as the parameter for the x-axis.

5.2 Create plots of the following functions from $x = 0$ to 10.

(a) $y = e^x$
(b) $y = \sin(x)$
(c) $y = ax^2 + bx + c$, where $a = 5$, $b = 2$, and $c = 4$
(d) $y = \sqrt{x}$