Chapter 26
Vector Field Plots

This chapter describes how to plot a two-dimensional vector field by representing *x* and *y* components of a vector as complex numbers.

This chapter contains the following sections:

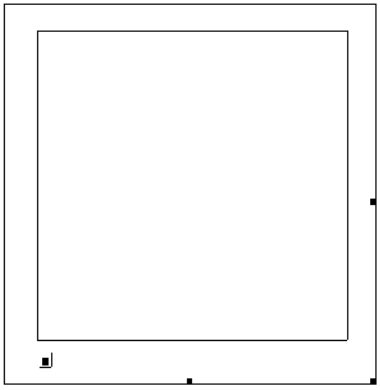
Creating a vector field plot

In a vector field plot, each point in the *xy* plane is assigned a two-dimensional vector. To create a vector field plot, you must define a rectangular array of points and assign a vector to each point. You can do this by creating a matrix of complex numbers in which:

- The rows and columns represent *x* and *y* coordinates.
- The real part of each matrix element is the *x* component of the vector associated with that row and column.
- The imaginary part of each element is the *y* component of the vector associated with that row and column.

To create a vector field plot:

- Create a matrix as described above.
- Choose **Graph⇒Vector Field Plot** from the **Insert** menu. Mathcad shows a box with a single placeholder as shown below:



- Type the name of the matrix in the placeholder.

Just as with an equation, Mathcad will not process the vector field plot until you click outside of it.

Mathcad plots the matrix by rotating it so that the (0,0) element is at the lower-left corner. Thus the rows of the matrix correspond to values on the *x*-axis, increasing to the right, and the columns correspond to values along the *y*-axis, increasing toward the top.

What you'll see is a collection of $m \cdot n$ vectors as shown in Figure 26-1. The base of each vector sits on the *x* and *y* values corresponding to its row and column. The magnitude and direction of each vector are derived from the real and imaginary parts of the matrix element.

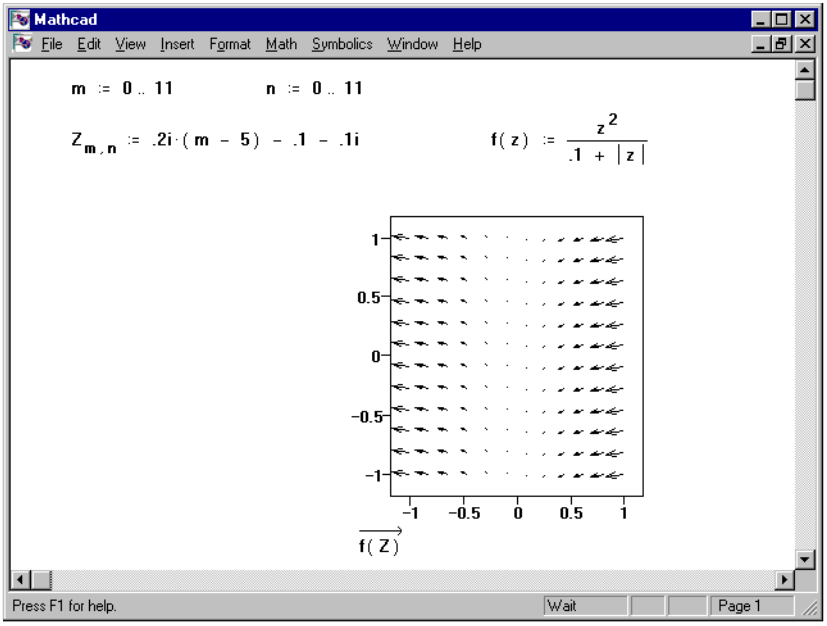


Figure 26-1: A sample vector plot from a complex matrix.

You can also create a vector field plot by using two matrices of real numbers rather than a single matrix of complex members. The two matrices must have the same number of rows and columns. The first matrix should have the *x* components of the vectors; the second should have the *y* components. Figure 26-2 shows the same vector field as that shown in Figure 26-1, but it is plotted using two real matrices rather than a single complex matrix.

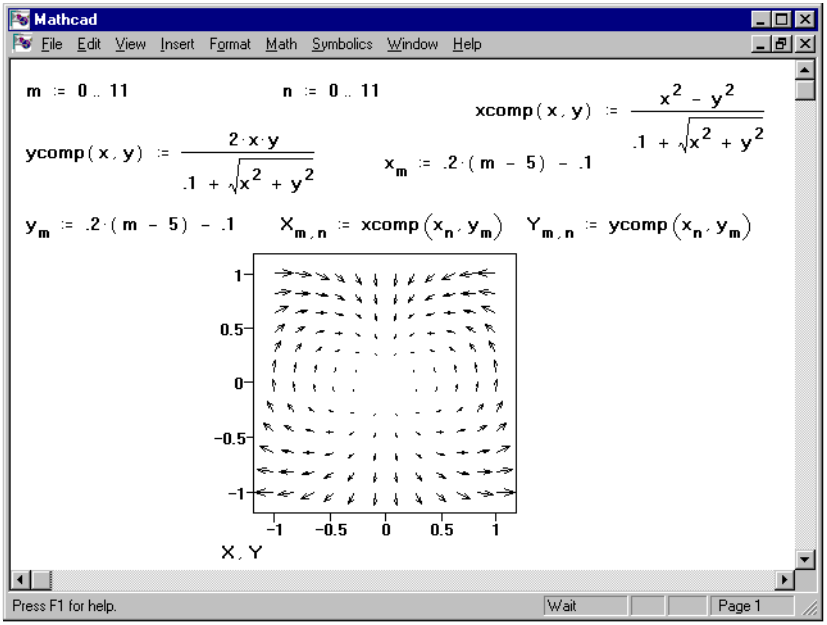


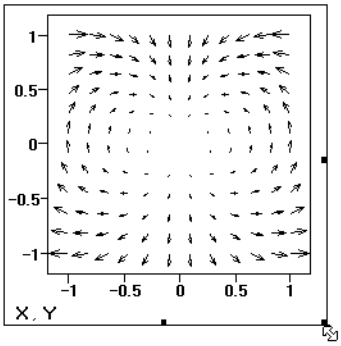
Figure 26-2: A sample vector plot from two matrices of real numbers.

You can specify what labels and grid lines appear on the axes by formatting the vector field plot. This is described in “Formatting vector field plots” on page 571.

Resizing vector field plots

To change the size of a vector field plot, follow these steps:

- Click in the vector field plot to select it.
- Move the mouse pointer to one of the three handles along the edge of the plot. The pointer will change to a double-headed arrow.



- Press and hold down the mouse button. While holding down the button, move the mouse. The plot will stretch in the direction of motion.
- Once the plot is the right size, let go of the mouse button.
- Click outside the vector field plot to deselect it.

Formatting vector field plots

Mathcad gives you control over many of the visual characteristics of vector field plots. These can be categorized in three groups:

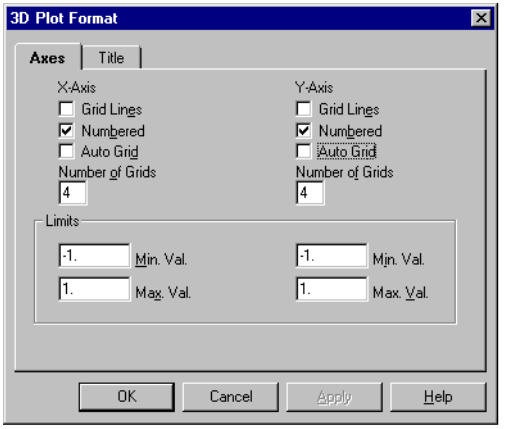
- Axis formatting: whether to show tick marks or grid lines on each axis.
- Title characteristics: how the plot will display titles.

To change any of these plot characteristics, start with the 3D Plot Format dialog box:

- Click on the plot to select it.
- Choose **Graph⇒3D Plot** from the **Format** menu. Alternatively, double-click on the plot itself. Mathcad brings up the 3D Plot Format dialog box. The Axes Page of this dialog box is shown below. The remaining tab takes you to the Title page. The View and the Color & Lines pages are not used for these plots.
- If necessary, click the tab for the page you want to work with.
- Change the appropriate characteristics in the dialog box.
- To see the effect of your changes *without* closing the dialog box, click “Apply.”
- When you're finished, close the dialog by clicking “OK.”

Formatting the axes

The Axes page of the 3D Plot Format dialog box, shown below, lets you modify the format of the *x*- and *y*-axis of your plot. Each axis is described by its own set of check boxes and text boxes.



Mathcad generates grid lines on the plot at the same positions as the tick marks. To choose between using tick marks or grid lines on a selected axis, use the Grid Lines check box. When Grid Lines is checked, Mathcad adds grid lines to the plot. Figure 26-3 shows the same vector field plot with and without grid lines.

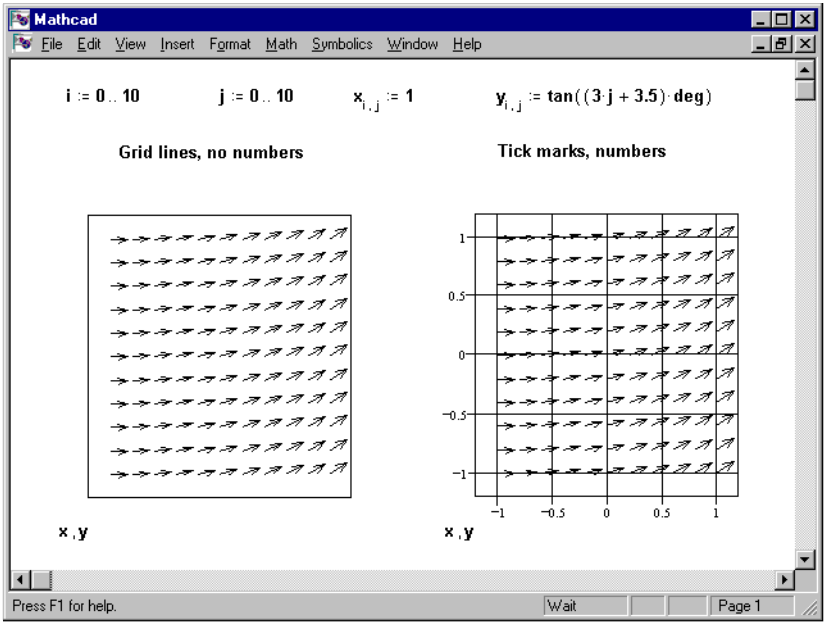


Figure 26-3: Using grid lines and tick marks.

To add or remove numbers for the tick marks on an axis, use the Numbered check box for that axis. The plot with grid lines in Figure 26-3 doesn't have numbers on the axes while the plot without grid lines does have them.

You can have Mathcad automatically select the number of grid intervals on an axis or you can specify the number yourself. Grid intervals are the spaces between tick marks or grid lines.

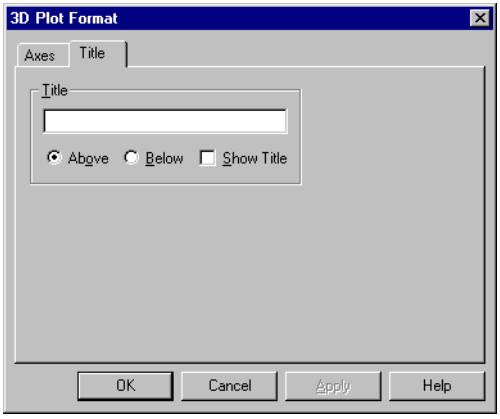
- To have Mathcad select the number of grid intervals, use the Auto Grid check box. When Auto Grid is checked, Mathcad will automatically select the number of grid intervals on the specified axis.
- To specify the number of grid intervals on an axis *yourself*, enter an integer from 1 to 99 in the No. of Grids text box. This text box is only available when Auto Grid is unchecked.

Since a vector field plot is made by plotting the elements of a matrix, Mathcad cannot "know" anything about *x* and *y* coordinates. All it knows is the vector associated with a particular row and column. By default, the coordinates on the *x*- and *y*-axes of a vector field plot will simply be rows and columns.

To change the limits on the maximum or minimum values to be plotted on the *x*- and *y*-axis, enter the new limit in the Max. Val. or Min. Val. text box.

Labeling the vector field plot

The Title page of the 3D Plot Format dialog box lets you add and modify a title on your vector field plot.



To add or edit a title for your vector field plot:

- Type the title for your plot into the Title text box.
- To display the title, click on Show Title to insert a check. To conceal the title without deleting it, click on Show Title to remove the check.
- To position the title, click on either the Above or Below button. Mathcad places the title either directly above or below your plot.
- Click "OK" to close the dialog box when you have finished.

To change the title's text or position, edit the information in the Title group as appropriate. To delete the title, highlight it in the text box and press [**Del**].

If you initiate this process by double-clicking on the title itself, you'll see an equivalent dialog box.

Figure 26-4 shows how Mathcad positions a title on a vector field plot.

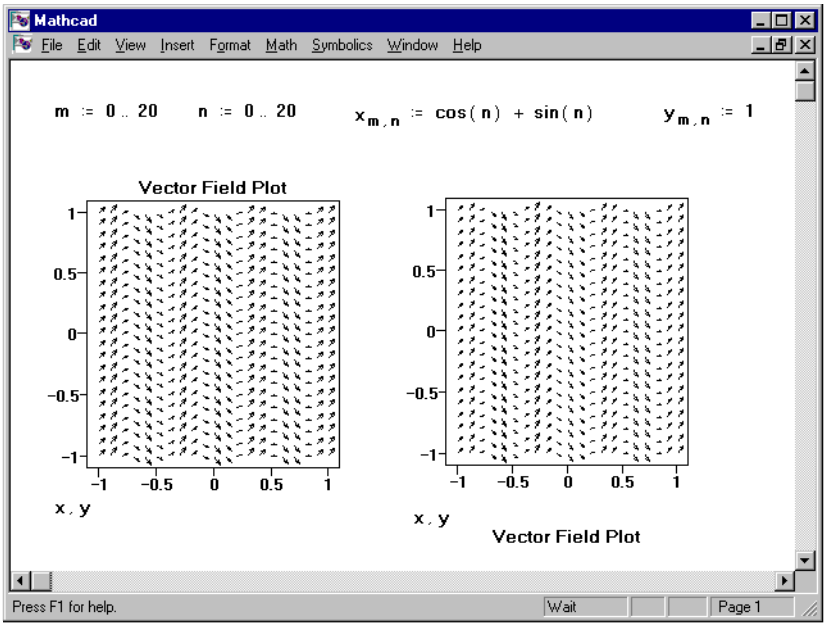


Figure 26-4: Titles on a vector field plot.